Body size, sexual dimorphism and allometry in adult Hydropsychidae (Trichoptera)
by Jason Earl Jannot

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Biological Sciences
Montana State University

Abstract:
Body size and shape impacts biological processes—from metabolic rates to the outcome of interspecific interactions. At least since Darwin, researchers have noticed that males and females of a single species can be different sizes or shapes. These morphological differences are called sexual dimorphism, or, in the case of body size, sexual size dimorphism (SSD). Sexual dimorphism often reflects mating and reproductive behaviors. Anecdotal reports of adult hydropsychid caddisflies (Hydropsychidae: Trichoptera) indicate some species may be sexually dimorphic.

Reports indicate sexual dimorphism in a variety of characters and that species show wide variability in patterns (females larger; males larger; no dimorphism). However, sexual dimorphism has not been quantified within the Hydropsychidae. I used the comparative method to examine how phylogenetic constraints and allometry influence body size, SSD, and sexual dimorphism in the adults of 29 species of Hydropsychidae and 12 species of closely related families (outgroups). I examined the distribution of body size and SSD, and the correlation between these two variables (Rensch's rule) within the Hydropsychidae and among the outgroups. I also used allometry to quantify sexual dimorphism in seven morphological characters: wing length and width; antennal length; eye width; and mesotibial length and width. Relatively closely related genera had very different body sizes suggesting that body size among genera was not constrained by phylogenetic history. However, SSD did not vary among genera and may have been constrained. Most of the variation in SSD was attributable to differences among species within genera (nested ANOVA, 41%) and among families within the suborder Annulipalpia (59%), indicating that SSD was not constrained among these groups. There was no correlation between SSD and body size within the hydropsychids. Among the outgroups, SSD declined with increasing body size. Allometric regressions revealed that, in general, females had longer or wider wings, and wider mesotibiae, whereas, males had longer antennae. The exception to this pattern was M. zebratum, where males had longer and wider wings than females. These results support currently accepted hypotheses about the evolution of the Hydropsychidae and can be used to develop testable hypotheses about selective pressures operating on adult hydropsychids.

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This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

Body size and shape impacts biological processes--from metabolic rates to the outcome of interspecific interactions. At least since Darwin, researchers have noticed that males and females of a single species can be different sizes or shapes. These morphological differences are called sexual dimorphism, or, in the case of body size, sexual size dimorphism (SSD). Sexual dimorphism often reflects mating and reproductive behaviors. Anecdotal reports of adult hydropsychid caddisflies (Hydropsychidae: Trichoptera) indicate some species may be sexually dimorphic. Reports indicate sexual dimorphism in a variety of characters and that species show wide variability in patterns (females larger; males larger; no dimorphism). However, sexual dimorphism has not been quantified within the Hydropsychidae. I used the comparative method to examine how phylogenetic constraints and allometry influence body size, SSD, and sexual dimorphism in the adults of 29 species of Hydropsychidae and 12 species of closely related families (outgroups). I examined the distribution of body size and SSD, and the correlation between these two variables (Rensch's rule) within the Hydropsychidae and among the outgroups. I also used allometry to quantify sexual dimorphism in seven morphological characters: wing length and width; antennal length; eye width; and mesotibial length and width. Relatively closely related genera had very different body sizes suggesting that body size among genera was not constrained by phylogenetic history. However, SSD did not vary among genera and may have been constrained. Most of the variation in SSD was attributable to differences among species within genera (nested ANOVA, 41%) and among families within the suborder Annulipalpia (59%), indicating that SSD was not constrained among these groups. There was no correlation between SSD and body size within the hydropsychids. Among the outgroups, SSD declined with increasing body size. Allometric regressions revealed that, in general, females had longer or wider wings, and wider mesotibiae, whereas, males had longer antennae. The exception to this pattern was *M. zebratum*, where males had longer and wider wings than females. These results support currently accepted hypotheses about the evolution of the Hydropsychidae and can be used to develop testable hypotheses about selective pressures operating on adult hydropsychids.

INTRODUCTION

Body size and shape have important ramifications on an organism's ability to function and survive. Both size and shape can determine critical processes at all levels of biological organization-- from metabolic rates to the outcome of interspecific interactions (Schmidt-Nielsen 1984). Calder (1984) claims that "...any biological study must first consider size as the most significant characteristic of an animal..." (p. ix) and the literature across many disciplines attests to this fact (e.g., Flecker et al. 1988, Berrigan and Locke 1991, Charnov 1992, Alroy 1998). However, in concluding his book on scaling, Schmidt-Nielsen (1984) says that "...[the] answers are not simple, and animal size is a complex subject that is of fundamental importance..."(p. 214). Furthermore, at present there is no complete and coherent theory of body size and scaling, although several attempts have been forwarded (Gould 1966, Calder 1984, Schmidt-Nielsen 1984).

It has long been recognized that females and males of a number of taxa exhibit size and shape differences (Darwin 1859). Of particular interest is the phenomenon of sexual size dimorphism (SSD), where females and males of a species display different body sizes. SSD is relatively common among a wide range of organisms including insects (Alcock 1993, McLain et al. 1993), crustaceans (Shuster 1992) and mammals (Owen-Smith 1993). Morphological differences are often reflected in behavioral differences between the sexes. For example, females of the butterfly *Euphydryas phaeton*, are twice the size of males, causing the sexes to differ in flight and thermoregulatory behavior (Gilchrist 1990). Considering the different reproductive roles of males and females, it is not surprising that SSD is ubiquitous among sexually reproducing organisms (Shine 1989).

In addition, organisms maybe sexually dimorphic in other characters besides body size. For example, appendages (Moore and Wilson 1993, Roff and Fairbairn 1993), internal organs (Calder 1984), physiology (Gilchrist 1990, Bailey and Romer 1991, Radhika et al. 1998), development and growth (Reiss 1989, Ernst and Wilgenbusch 1998), behavior (Gilchrist 1990, Roelke and Sogard 1993, Svensson 1997), and even mortality (Shuster 1990, Owen-Smith 1993) may all be sexually dimorphic.

SSD and other forms of sexual dimorphism have been the subject of recent review papers (Slatkin 1984, Shine 1989, Fairbairn 1990, 1997 #543, Nylin and Wendell 1994, Andersson and Iwasa 1996), and a number of hypotheses, both non-adaptive and adaptive, have emerged (see Background section below). The most widely invoked non-adaptive hypothesis for SSD and sexual dimorphism is phylogenetic history (Fairbairn 1990, Nylin and Wendell 1994). In this scenario, sexual dimorphism may be the result of the history of the organism(s), that is, ancestral species were dimorphic and therefore extant species are dimorphic via shared characteristics (body size is usually highly heritable). More typically, SSD and sexual dimorphism have been explained by adaptive mechanisms. Sexual selection, fecundity selection, and ecological selection, either singly, or in combination, have all been implicated in the production of sexual dimorphism (Slatkin 1984, Shine 1988, 1989, Fairbairn 1990, Andersson and Iwasa 1996, Preziosi et al. 1996).

One fruitful method of examining sexual dimorphism is by using allometric relationships, that is, how two traits vary with respect to each other (Webster 1992, Shine et al. 1998, Tseng and Rowe 1999). For example, SSD, when compared among taxa, sometimes varies as body size changes (Abouheif 1995, Fairbairn 1997). Alternatively, within species, morphological characters often scale with body size, a common aspect of SSD. Therefore, within species comparisons can provide information about how morphological traits differ between the sexes (Fairbairn 1990). Allometric methods are particularly amenable to developing hypotheses about selective pressures acting on growth, development, and behavior, both within and between taxa (Reiss 1989, Klingenberg 1996, Tseng and Rowe 1999).

The frequency and taxonomic distribution of sexual dimorphism in the caddisfly family Hydropsychidae (Order Trichoptera) has not been explored. Anecdotal information about several species suggests that hydropsychids can be sexually dimorphic, in terms of body size (both males larger than females and females larger than males), and other characters (Betten 1934, Ross 1944). Morphological differences could reflect behavioral differences between the sexes. These behavioral differences could be manifested in both larval and adult stages. For example, the dispersal behavior of *Ceratopsyche slossonae* larvae varies depending upon both size and sex (Kerans 1992; Kerans and Genito in prep; Jannot unpublished data). In the adults of other caddisflies (Family Leptoceridae), morphological differences between the sexes echo behavioral differences (Gullefors and Petersson 1993). Gullefors and Petersson (1993) found that male leptocerids that fly in copula with females have longer forewings than the females and these larger wings enhance the male's ability to carry her during copulation. Not much is known about the reproductive behavior and ecology of adult hydropsychids (Badcock 1953, Mori and Matubani 1953, Fremling 1960, Deutsch 1984, 1985, Lofstedt et al. 1994), and to my knowledge, no hypotheses have yet been posed about mating strategies in adult Hydropsychidae.

This study examines patterns of body size, SSD, and sexual dimorphism of the adults within the caddisfly family Hydropsychidae. This study does not test any selective mechanisms, rather the purpose of this work is three-fold:

1) to determine the role of phylogeny in producing body size and sexual size dimorphism in the hydropsychids and compare the pattern with closely related groups;
2) through analysis of allometry, quantify the distribution and extent of sexual dimorphism in size and morphological characters and;
3) to acquire background data on multiple species of hydropsychids that can be used to propose testable hypotheses about adult dispersal, mating strategies, and reproductive behaviors.

Background

Sexual Size Dimorphism Among Taxa

Although any number of characters of an organism can be sexually dimorphic, recently much attention has been devoted to sexual dimorphism in general body size, often referred to as sexual size dimorphism or SSD (Leimar et al. 1994, Nylin and

Wendell 1994, Abouheif 1995, Maly and Maly 1998, Zamudio 1998, Smith 1999, Stoks 1999). I use a strict definition of SSD which is, a ratio of the body sizes, measured as body length, of the two sexes.

A considerable number of hypotheses have arisen to explain the occurrence of SSD. Most have focused on adaptive mechanisms (see below). However, non-adaptive hypotheses, such as phylogenetic history, may also be responsible for patterns of SSD across taxa (Fairbairn 1990). SSD may merely be a historical artifact and reflect the evolutionary history of the organism(s). Phylogenetic history has been implicated to a high degree in many cases of body size and SSD (Abouheif 1995, Andersen 1997). Rather than the result of selection, differences among, and similarities between taxa may only indicate patterns of descent (Fairbairn 1990). By placing sexual size dimorphism in the context of phylogeny, this study highlights the patterns of selection versus evolutionary history in hydropsychid caddisflies.

Allometry is a conspicuous component of patterns of SSD among species, and as such, requires an explanation (Fairbairn 1997). Allometry for SSD simply means that if body sizes increase across taxa, the degree of SSD across taxa also becomes larger. Presently, there are multiple, non-exclusive hypotheses about the functional mechanism for the relationship between SSD and size (see Fairbairn 1997, for review). Most functional hypotheses either have no empirical basis, provide explanations only for limited cases, or cannot alone account for allometry for SSD (Fairbairn 1997).

Rensch (1960) proposed a general, descriptive rule for the relationship between body size and SSD. This rule was proposed from empirical observations in numerous taxa that SSD generally increases with body size in species where males are the larger sex (Reiss 1989, Webster 1992, Fairbairn and Preziosi 1994, Abouheif and Fairbairn 1997). Formally stated, if males are the larger sex, SSD will increase as body size increases; if females are the larger sex, SSD will decrease with increasing body size (Rensch 1960, Abouheif 1995). Alternatively, if for every increase in body size there is an equivalent increase in SSD (at the same scale), then there is no overall change in SSD across taxa. This represents the null hypothesis in tests of allometry for SSD (Fairbairn 1990, 1997 #543, Abouheif 1995). There is no known mechanism describing why this pattern is so prevalent (Abouheif and Fairbairn 1997, Fairbairn 1997). One goal of this study is to document the presence (or absence) and the nature of allometry for SSD within this clade and determine if adult hydropsychids follow Rensch's rule.

Sexual Dimorphism and Selection

Sexual dimorphism, whether for body size or other characters, is most often attributed to adaptive selective pressures. Adaptive hypotheses include both natural and sexual selection. These two influences are very often difficult to tease apart. Sexual selection acts on individuals, so that the sex with larger (or smaller) character(s) have increased mating success. The offspring of successful individuals will have, on average, larger (or smaller) character(s) and therefore increased mating success. The process will continue (until balanced by opposing selection) to select for larger and larger (or smaller and smaller) character(s), creating sexual dimorphism. In species where sexual dimorphism is selected for by natural selection, it is some dimension of the niche that determines sexual dimorphism. Presumably, natural selection acts differentially on the sexes. For example, sexual size dimorphism may become established if larger individuals of one sex have an advantage over smaller ones when exploiting their niche, whereas, in the other sex, there is an advantage to remaining small (Futuyma 1986, Shine 1989).

The sexual selection hypothesis has historically been the most popular mainly because of its (presumed) testable and parsimonious nature (Shine 1989). But as Fairbairn (1990) and others have pointed out, sexual selection could occur in conjunction with natural selection (Arak 1988), and in some cases could be relatively less important than natural selection (Fairbairn 1990). Moreover, sexual selection may be no more testable than natural selection (Shine 1989).

The idea that sexual dimorphism may have arisen through pressures from natural selection has only recently been seriously entertained (Shine 1989, Fairbairn 1990). Any ecological difference displayed between sexes could set the stage for selection for sexual dimorphism. For instance, niche partitioning between the sexes could be caused by competition between the sexes for resources (Slatkin 1984). In this situation the sexual dimorphism would be amplified. Alternatively, slightly different habitat requirements between the sexes could be a passive consequence of sexual dimorphism. Any adaptation to similar local environments would act to reduce the effects of sexual dimorphism (Shine 1989).

The evolution and maintenance of sexual dimorphism by natural selection is often difficult to demonstrate. Nonetheless, several alternative hypotheses have been proposed. These hypotheses are not exclusive, and any or all may be at work alone or in combination in any given taxon. There are at least three major adaptive hypotheses that recur throughout the literature. These are the "Developmental Constraints Hypothesis", the "Loading Constraints Hypothesis", and the "Migration by Flight Hypothesis".

The Developmental Constraints Hypothesis was proposed by Thornhill and Alcock (1983, p. 103). This hypothesis assumes that body size is positively correlated with fecundity and development time in females. It follows that females, in order to maximize their fecundity, would be under selective pressure to have long development times. A longer development time allows females to acquire more resources for growth and presumably a larger body. In males, reproductive success does not directly correlate with body size, implying that males are under selective pressures to mature quickly so that they can enter the breeding population and maximize fitness by copulating as many times as possible. If juvenile mortality is high, selection would strongly favor quick male development. This mechanism seems to account for protandrous males (males maturing prior to females) and sexual size dimorphism biased toward larger females (Thornhill and Alcock 1983, Fairbairn 1990). This process may be particularly important in insects where growth and reproduction occur in separate life stages (Thornhill and Alcock 1983, Honek 1993).

A second hypothesis often invoked as a mechanism of selection for sexual dimorphism is the Loading Constraints Hypothesis. This hypothesis predicts that one sex is under a "load" which the other sex does not experience. For example, in water striders of the family Gerridae, the females must carry males on their backs during reproduction. The cost to females while carrying males is increased risk of predation and increased energy expenditure (Arnqvist 1989). Risks are proportionally higher for smaller females, and therefore selection produces larger females, and a female-biased sexual size dimorphism (Fairbairn 1990).

Another possible hypothesis is the Migration by Flight Hypothesis. This hypothesis suggests that increasing body size is positively correlated with the velocity, duration and distance an organism could fly. Consequently, males who actively fly to search for mates may be selected to increase body size, whereas females who disperse to oviposit or search for mates would also be selected to have large body sizes. Depending upon the system this could promote or maintain sexual dimorphism, or it could reduce the effect of sexual dimorphism (Fairbairn 1990).

Sexual dimorphism could be produced by selective pressures acting on different stages (other than the sexual stage) of an organism with a complex life history. For example, selection acting on the larval stage of an organism might affect the adult stage in various ways. In some aquatic insects, including most Trichoptera, females do not feed significantly in the adult stage (Merritt and Cummins 1995). This means that all the resources necessary for egg production (selective force in the adult stage) must be acquired in the larval stage. In this case, female larvae would be under selective pressure to delay development and increase the growth period as long as possible.

Sexual Dimorphism and Allometry Within Taxa

As stated previously, SSD can correlate with increases in body size across taxa. However, allometric relationships can also provide information on sexual dimorphism within taxa, that is the relationship between body size and other morphological characters (Ernst and Wilgenbusch 1998, Tseng and Rowe 1999).

Allometric relationships are defined as variations in shape as a correlated response to a change in size (Gould 1966, Klingenberg 1996). These correlated changes can occur at any, or all of several organizational levels of the organism (e.g., chemical, physiological, morphological). Growth is the most obvious period in an organism's life when allometry plays an important role. Studies of allometry as an organism grows, or ontogenetic allometry, requires that character measurements be taken on the same individuals over time (Gould 1966, Klingenberg 1996).

In this study, I have concentrated on two other types of allometry. Static allometry, sometimes known as size allometry, is the variation among individuals of the same population and age group (Gould 1966, refers to this as intraspecific allometry;, Klingenberg 1996). This is the type of allometry that provides information about sexual dimorphism within species (this study, Chapter 3; Tseng and Rowe 1999). Most studies have found that one variable is adequate for predicting character size or shape and that a model of simple static allometry is appropriate (Klingenberg 1996). This model is often given by the relationship:

$$Y = \alpha X^{\beta}$$

which when log transformed becomes:

$$\log Y = \log \alpha + \beta \log X$$

where X and Y are trait measurements and α and β are constants. Log α is the intercept and the constant β is the slope in log-log plots of X and Y (Gould 1966, Klingenberg

1996). Typically, the null hypothesis is isometry, that is for every change in X there is an equivalent change in Y and $\beta \approx 1.0$.

This equation has a long history and is a good description of various size-mediated biological processes across all levels of organization (Huxley 1932, Thompson 1942, Gould 1966, Reiss 1989). Recently, researchers have begun to question this model as a universal descriptor (see discussion in Reiss 1989, and references therein). In many cases, exact, proximate mechanisms responsible for allometry are unknown (Klingenberg 1996), although, some headway has been made in recent years to describe the underlying developmental processes that give rise to static allometry (Emlen 1996, Nijhout and Wheeler 1996, 1998).

The final type of allometry (and the other type this study addresses) is evolutionary allometry. This type of allometry reflects covariation among changes in different traits along branches of a phylogeny (Gould 1966, refers to this as interspecific allometry', Klingenberg 1996). The data collected on evolutionary allometry may take two forms: a) comparisons may be made between extant, closely related species (non-directional data, Harvey and Pagel 1991); or b) comparisons may be made along a single evolutionary branch to infer changes in character states from ancestral to extant species (directional data, Harvey and Pagel 1991). In this study, I have gathered information on present-day species only (non- directional data). This method requires that all specimens be in the same developmental stage. This is relatively easy to accomplish in organisms with determinate growth such as insects (Klingenberg 1996; this study). Another problem with comparative studies of evolutionary allometry is that species, because they are related, do not form independent data points (Harvey and Pagel 1991, Klingenberg 1996). Comparative methods require special statistical analyses to circumvent this problem (Harvey and Pagel 1991, Nylin and Wendell 1994).

Allometry at different levels (ontogenetic, static and evolutionary) are often correlated and interdependent. Variation in developmental processes (ontogeny) creates variation in terminal characters (static). Variation in terminal structures determines the behavioral abilities and constraints (and ultimately, success) of individuals within a population, and is thereby the raw material upon which selection can act (McPeek 1995). Comparisons among different levels of allometry often reveal that patterns are similar among levels but not identical (Klingenberg 1996). Comparing several levels of allometry gives a broader picture of the selective forces operating within populations and among species. This observational-comparative approach is employed in this study to emphasize areas where experimental tests of selection could be carried out in the future.

Caddisflies

Caddisflies (Order: Trichoptera) are close relatives to Lepidoptera (Merritt and Cummins 1995). They are holometabolous insects, passing through egg, larvae, pupae and adult stages (Ross 1944, Merritt and Cummins 1995). The larvae of most species are aquatic and relatively long-lived, surviving anywhere from a few months to a few years (Ross 1944, Merritt and Cummins 1995). The adults are terrestrial, with shorter life spans (from a few days up to a month) and feed very little (Ross 1944). Thus, almost all resources needed for reproduction are gained through the aquatic larval stages.

The Hydropsychidae are widespread throughout stream systems and larval biology is relatively well known (Alstad 1978, Cuffney and Minshall 1981, Hauer and Stanford 1981, Miller 1984, Georgian and Thorp 1992, Kerans 1992, Merritt and Cummins 1995, Wiggins 1996, Englund et al. 1997). Larval hydropsychids build silken nets that they use to filter particles from the water column (Merritt and Cummins 1995, Wiggins 1996). Filtered particles range from fine bacteria and phytoplanktonic particles to detritus and invertebrates (Morse 1993, Merritt and Cummins 1995, Wiggins 1996).

Much less is known about the behavior and habits of adult Hydropsychidae. Some adult hydropsychids form swarming aggregations, most likely for the purposes of mating (Mori and Matubani 1953, Fremling 1960). Pheromones, probably for mating and aggregation, have been isolated from adults of one European species (Lofstedt et al. 1994). Observations of females suggest that a number of species swim underwater to oviposit (Badcock 1953, Deutsch 1984, 1985). However, most of these records are observational or anecdotal. To my knowledge, there are no observations or hypotheses about mating strategies in adult Hydropsychidae.

There are five currently recognized subfamilies of the monophyletic Hydropsychidae family: Arctopsychinae, Diplectroninae, Hydropsychinae, Smicrideinae and Macronematinae (Figure 1.1; Flint et al. 1987, Schefter 1996; J. Morse, Clemson University, pers. com.). The North American Arctopsychinae contains 11 species in two genera (Wiggins 1996). The North American Diplectroninae contains 14 species in four genera (Wiggins and Mackay 1978, Morse 1993, Wiggins 1996). The subfamily Hydropsychinae is the largest group in the Hydropsychidae with 114 North American

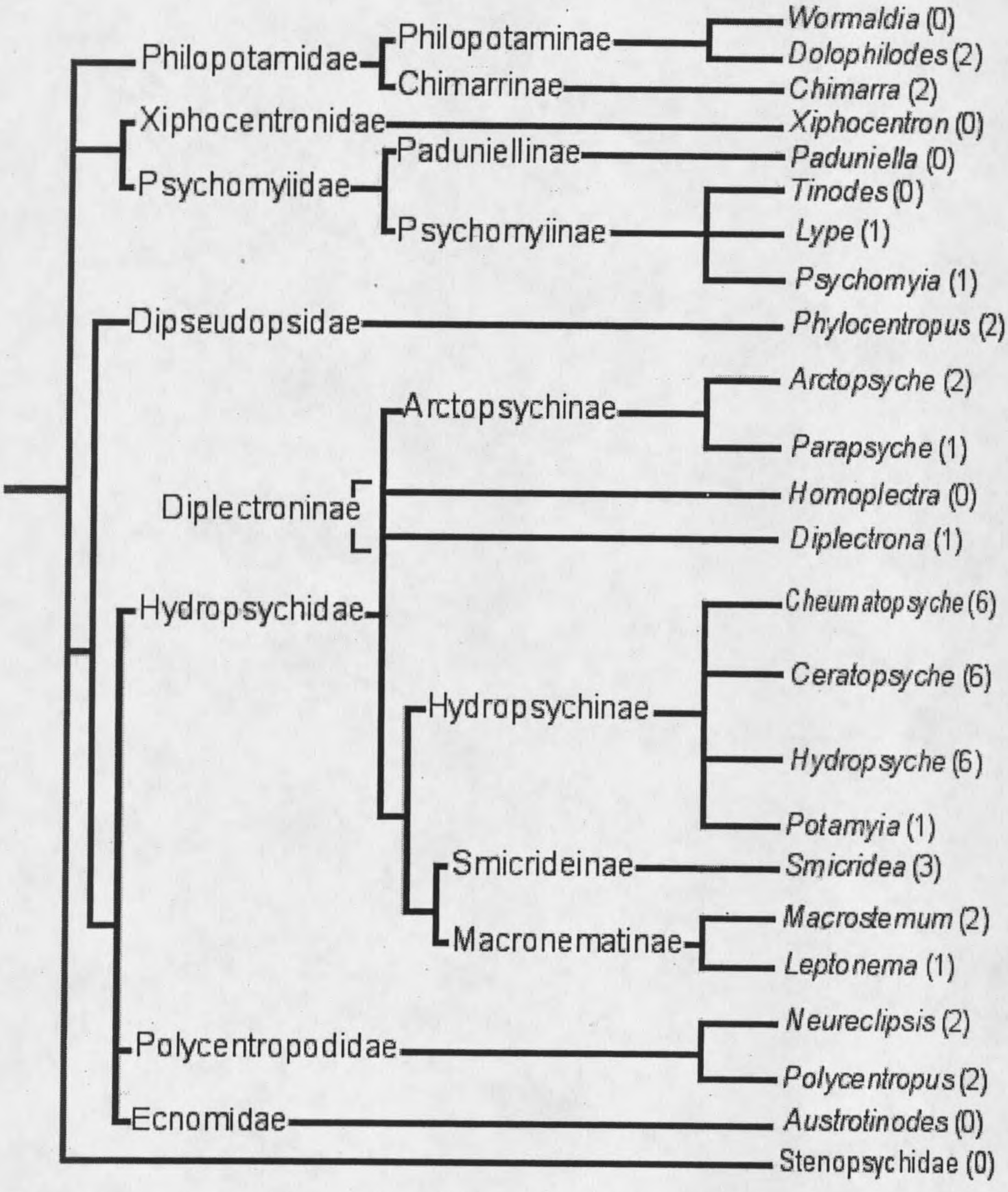


Figure 1.1 Hypothesized relationships of the caddisfly suborder Annulipalpia in North America. Numbers in parentheses represents the number of species examined (adapted from Schefter 1996, Wiggins 1996, Weaver and Malicky 1994).

species in six genera (Morse 1993, Wiggins 1996). The relatively newly erected subfamily Smicrideinae includes four North American species in a single genus (Merritt and Cummins 1995, Schefter 1996). In the subfamily Macronematinae, only four species from 2 genera occur in the United States (Betten 1934, Morse 1993, Wiggins 1996).

The five subfamilies contain characters that separate them into distinct groups (Flint et al. 1987). Distinctive characters in the larval stage include: the number of spines on the anterior margin of each foreleg in the fifth instar, the shape of the mandibles, the shape and number of abdominal gills, and the shape of the submental gular area under the head (Flint 1974, Wallace 1975, Flint et al. 1987). Adult characteristics that separate subfamilies are variations in: the shape of the wings and antennae; the post-costal cell (cu_2) in the forewing; the form of the wing coupling mechanism; and the type of male genitalia (Flint 1974, 1987; J. Morse, pers. comm.).

At this point in time, the relationship between the Arctopsychinae and Diplectroninae remains unresolved, although the evidence suggests that one of these two subfamilies is the most basal group within the Hydropsychidae (Flint et al. 1987, Schefter 1996). The three derived (and demonstrably monophyletic) subfamilies could have evolved from a common Diplectroninae ancestor. There are two genera of Diplectroninae, *Oropsyche* Ross and *Homoplectra* Ross, that are very similar to Arctopsychinae in most respects, although, there are a few important differences. Species of *Oropsyche* and *Homoplectra* have more complete wing venation and the apices of the subcostal and radial veins in the hind wings curve slightly forward. This curvature becomes much more pronounced in other genera of the subfamilies. The forewings are narrower and the tips of the apical veins are fused in the hind wings of both the Hydropsychinae and the Macronematinae (Flint et al. 1987). This evidence led researchers to suggest that Hydropsychinae (including Smicrideinae) and Macronematinae probably rose from a common ancestor (Flint et al. 1987, Schefter 1996). Schefter's analysis (1996) of the subfamilies, using modern phylogenetic techniques, supported monophyly for the Arctopsychinae and a more restricted Hydropsychinae. Her analysis placed the Smicrideinae as a sister group of the Macronematinae. However, monophyly of the Diplectroninae was not supported by her analysis (Schefter 1996).

The hydropsychid caddisflies are an interesting group in which to examine sexual dimorphism and SSD. The taxonomic literature suggests that species show a wide variety of patterns: females larger than males; males larger than females; and neither sex larger (Betten 1934, Ross 1944; Jannot unpub. data). This plasticity suggests that selection acts on morphology in various ways. For example, natural selection probably plays a relatively larger role in the larval feeding stage, whereas sexual selection may be more important in the adult sexual stage. If one sex is larger in the adult stage (because of selective pressures *in the adult stage*), selection may act in the larval stage to increase food consumption or quality. In other words, morphological adaptations in the adult stage may be produced by behavioral adaptations in the larval stage, or vice versa. By placing SSD in a phylogenetic context, I hope to highlight evolutionary pathways where selection might be acting to produce sexual dimorphism.

Very little is known about the specific ecology of adult hydropsychids, although selective pressures in the adult stage could have impacts on the larval stage. For example, wing shape could play a role in determining distribution, colonization, and succession in aquatic invertebrate assemblages, since females fly to disperse and oviposit (Jackson 1988) and in many aquatic insects, including caddisflies, adults form mating swarms (Allan and Flecker 1989, Petersson 1989, McLachlan and Neems 1995). Studies of other organisms have shown that morphology is important in structuring communities, particularly aquatic communities (Cadle and Greene 1993, Allan 1995).

The relationship between adult morphology and behavior in caddisflies has rarely been studied, and it has been completely overlooked in hydropsychids. In other caddisfly species sexual selection operates on the adults. Adult behavior correlates with morphological characters and differs between sexes and among species in the caddisfly family Leptoceridae. For example, in the species *Mystacides azurea*, females fly towards a group of swarming males. The males quickly spot the female and race towards her. She turns and begins to fly away rapidly. The first male to catch the female, flies with her to vegetation to copulate. Two morphological characters, eye size and wing length, were found to be correlated with spotting the female and catching her in flight. The males had larger eyes for spotting females and longer wings for faster flight to catch the females (Gullefors and Petersson 1993). In effect, the females were "choosing" males with larger eyes and longer wings (Solem and Solem 1991). In another species, *Athripsodes commutatus*, females and males copulate while flying and the male must carry the female. If the male cannot carry the female, reproduction is not achieved and the female searches for a mate that can carry her (Solem 1978). Moreover, ecological selection may be acting on hydropsychid females to produce sex-specific characters. For example, it has been noted that within several species of hydropsychid caddisflies, females crawl or swim underwater to deposit their eggs (Badcock 1953, Deutsch 1984, 1985). Ross (1967) and Deutsch (1985) observed that females in several families of caddisflies, including hydropsychids, have expanded, flattened legs. Both authors suggest that this aided the female during the underwater egg-laying.

The results of this study are organized into two chapters, each of which is self-contained and written in a format suitable for peer-reviewed publication. In chapter two I examine the role of non-adaptive hypotheses in the evolution of body size and sexual size dimorphism across species within the caddisfly family Hydropsychidae. I outline the relationship between phylogeny and body size and between phylogeny and sexual size dimorphism. In addition, I test for allometry for sexual size dimorphism across species. In chapter three I examine static and evolutionary allometry within adult hydropsychids. Static allometric relationships of characters other than size are examined between sexes, within species, to determine what structures, if any, are sexually dimorphic.

, broader wings (Ross 1967). Flight differences in varying environments may be reflected in behavioral differences. For example, narrower, longer wings might have developed in conjunction with sexual behavior where males must "chase" females in flight prior to copulation. By placing sexual dimorphism in the context of phylogeny, I hope to show species that might be interesting models to test some of these proposed hypotheses.

The results of this study are organized into two chapters, each of which is self-contained and written in a format suitable for peer-reviewed publication. In chapter two I examine the role of non-adaptive hypotheses in the evolution of body size and sexual size dimorphism across species within the caddisfly family Hydropsychidae. I outline the relationship between phylogeny and body size and between phylogeny and sexual size dimorphism. In addition, I test for allometry for sexual size dimorphism across species. In chapter three I examine static and evolutionary allometry within adult hydropsychids. Static allometric relationships of characters other than size are examined between sexes, within species, to determine what structures, if any, are sexually dimorphic.

Literature Cited

Abouheif, E. 1995. A comparative analysis of the allometry for sexual size dimorphism: Testing Rensch's Rule. Masters thesis, Concordia University, Montreal.

Abouheif, E. and D. J. Fairbairn. 1997. A comparative analysis of allometry for sexual size dimorphism: assessing Rensch's rule. *American Naturalist*, 149:540-562.

Alcock, J. 1993. The effects of male body size on territorial and mating success in the landmark-defending fly *Hermetia comstocki* (Stratiomyidae). *Ecological Entomology*, 18:1-6.

Allan, J. D. 1995. *Stream Ecology: Structure and Function of Running Waters*. 1st ed. Chapman and Hall, London.

Allan, J. D. and A. S. Flecker. 1989. The mating biology of a mass-swarming mayfly. *Animal Behaviour*, 37:361-371.

Alroy, J. 1998. Cope's Rule and the dynamics of body mass evolution in North American fossil mammals. *Science*, 280:731-734.

Alstad, D. N. 1978. Distributional and community ecology of filtering caddisflies (Trichoptera: Hydropsychidae). Dissertation thesis, University of Utah, Salt Lake City.

Andersen, N. M. 1997. A phylogenetic analysis of the evolution of sexual dimorphism and mating systems in water striders (Hemiptera: Gerridae). *Biological Journal of the Linnean Society*, 61:345-368.

Andersson, M. and Y. Iwasa . 1996. Sexual selection. *Trends in Ecology and Evolution*, 11:53-58.

Arak, A. 1988. Sexual dimorphism in body size: A model and a test. *Evolution*, 42:820-825.

Arnqvist, G. 1989. Multiple mating in a water strider: mutual benefits of intersexual conflict? *Animal Behavior*, 38:749-756.

Badcock, R. 1953. Observations of the oviposition underwater of the aerial insect *Hydropsyche augustipennis* (Curtis) (Trichoptera). *Hydrobiologia*, 5:222-225.

Bailey, W. J. and H. Romer. 1991. Sexual differences in auditory sensitivity: Mismatch of hearing threshold and call frequency in a Tettigoniid (Orthoptera, Tettigoniidae: Zaprochilinae). *Journal of Comparative Physiology*, 169:349-353.

Berrigan, D. and S. Locke, J. 1991. Body size and male reproductive performance in the flesh fly, *Neobellieria bullata*. *Journal of Insect Physiology*, 37:757-581.

Betten, C. 1934. The caddisflies of New York. *New York Museum Bulletin*, 292:1-576.

Cadle, J. E. and H. W. Greene. 1993. Phylogenetic patterns, biogeography and ecological structure of neotropical snake assemblages. In R. E. Ricklefs and D. Schulter (eds.), *Species Diversity in Ecological Communities*, pp. 281-292. The University of Chicago Press, Chicago.

Calder, W. A. I. 1984. *Size, Function and Life History*. Harvard University Press, Cambridge and London.

Charnov, E. L. 1992. Allometric aspects of population dynamics: A symmetry approach. *Evolutionary Ecology*, 6:307-311.

Cuffney, T. F. and G. W. Minshall. 1981. Life history and bionomics of *Arctopsyche grandis* (Trichoptera) in a central Idaho stream. *Holarctic Ecology*, 4:252-262.

Darwin, C. 1859. *The Origin of the Species by Natural Selection*. Penguin Books, Middlesex, UK.

Deutsch, W. G. 1984. Oviposition of Hydropsychidae (Trichoptera) in a large river. *Canadian Journal of Zoology*, 62:1988-1994.

Deutsch, W. G. 1985. Swimming modifications of adult female Hydropsychidae compared with other Trichoptera. *Freshwater Invertebrate Biology*, 4:35-40.

Emlen, D. J. 1996. Artificial selection on horn length-body size allometry in the horned beetle *Onthophagus acuminatus* (Coleoptera: Scarabaeidae). *Evolution*, 50:1219-1230.

Emlen, D. J. 1998. Competition among body parts in the development and evolution of insect morphology. *Proceedings of the National Academy of Sciences USA*, 95:3685-3689.

Englund, G., B. Malmqvist and Y. Zhang. 1997. Using predictive models to estimate effects of flow regulation on net-spinning caddis larvae in north Swedish streams. *Freshwater Biology*, 37:687-697.

Ernst, C. H. and J. C. Wilgenbusch. 1998. Growth allometry and sexual dimorphism in the Florida box turtle. *Herpetological Journal*, 8:72-78.

Fairbairn, D. J. 1990. Factors influencing sexual size dimorphism in temperate waterstriders. *American Naturalist*, 136:61-86.

Fairbairn, D. J. 1997. Allometry for sexual size dimorphism: Pattern and process in the coevolution of body size in males and females. *Annual Review of Ecology and Systematics*, 28:659-687.

Fairbairn, D. J. and R. F. Preziosi. 1994. Sexual selection and the evolution of allometry for sexual size dimorphism in the water strider, *Aquarius remigis*. *American Naturalist*, 144:101-118.

Flecker, A. S., J. D. Allen and N. L. McClintock. 1988. Male body size and mating success in swarms of the mayfly *Eporus longimanus*. *Holarctic Ecology*, 11:280-285.

Flint, O. S. 1974. Studies of neotropical caddisflies, XVIII: The Genus *Smicridea* from North America and Central America (Trichoptera: Hydropsychidae). *Smithsonian Contributions to Zoology*, 167:1-65.

Flint, O. S., J. F. McAlpine and H. H. Ross. 1987. A revision of the genus *Leptonema* Guerin (Trichoptera: Hydropsychidae: Macronematinae). *Smithsonian Contributions to Zoology*, 450:1-193.

Fremling, C. R. 1960. Biology and possible control of nuisance caddisflies of the upper Mississippi River. *Iowa State University Science and Technical Research Bulletin*, 483:856-879.

Futuyma, D. J. 1986. *Evolutionary Biology*. 2nd ed. Sinauer Associates Inc., Sunderland, MA.

Georgian, T. and J. H. Thorp. 1992. Effects of microhabitat selection on feeding rates of net-spinning caddisfly larvae. *Ecology*, 73:229-240.

Gilchrist, G. W. 1990. The consequences of sexual dimorphism in body size for butterfly flight and thermoregualtion. *Functional Ecology*, 4:475-487.

Gould, S. J. 1966. Allometry and size in ontogeny and phylogeny. *Biological Review*, 41:587-640.

Gullefors, B. and E. Petersson. 1993. Sexual dimorphism in relation to swarming and pair formation patterns in Leptocerid caddisflies (Trichoptera: Leptoceridae). *Journal of Insect Behavior*, 6:563-577.

Harvey, P. H. and M. D. Pagel. 1991. *The Comparative Method in Evolutionary Biology*. Oxford University Press, Oxford.

Hauer, F. R. and J. A. Stanford. 1981. Larval specialization and phenotypic variation in *Arctopsyche grandis* (Trichoptera: Hydropsychidae). *Ecology*, 62:645-653.

Honek, A. 1993. Intraspecific variation in body size and fecundity in insects - A general relationship. *Oikos*, 66:483-492.

Huxley, J. S. 1932. *Problems of Relative Growth*. Dover Publications, New York.

Jackson, J. K. 1988. Diel emergence swarming and longevity of selected adult aquatic insects from a Sonoran Desert stream. *American Midland Naturalist*, 119:344-352.

Kerans, B. L. 1992. Season and body size influence movement of hydropsychid caddisflies larvae (Trichoptera: Hydropsychidae). *Canadian Journal of Fisheries and Aquatic Sciences*, 49:259-265.

Klingenberg, C. P. 1996. Multivariate allometry. In L. F. Marcus and et al. (eds.), *Advances in Morphometrics*, pp. 23-49. Plenum Press, New York.

Leimar, O., B. Karlsson and C. Wiklund . 1994. Unpredictable food and sexual size dimorphism in insects. *Proceedings of the Royal Society of London Series B. Biological Sciences*, 258:121-125.

Lofstedt, C., B. S. Hansson, E. Petersson, P. Valeur and A. Richards. 1994. Pheromonal secretions from glands on the 5th abdominal sternite of hydropsychid and rhyacophilid caddisflies (Trichoptera). *Journal of Chemical Ecology*, 20:153-170.

Maly, E. J. and M. P. Maly. 1998. Body size and sexual size dimorphism in calanoid copepods. *Hydrobiologia*, 391:173-179.

McLachlan, A. and R. Neems. 1995. Swarm-based mating systems. In S. R. Leather and J. Hardie (eds.), *Insect Reproduction*, pp. 199-213. CRC Press Inc., Boca Raton, FL.

McLain, D. K., L. B. Burnette and D. A. Deeds. 1993. Within season variation in the intensity of sexual selection on body size in the bug *Margus obscurator* (Hemiptera Coreidae). *Ethology Ecology & Evolution*, 5:75-86.

McPeek, M. A. 1995. Morphological evolution mediated by behavior in the damselflies of two communities. *Evolution*, 49:749-769.

Merritt, R. W. and K. W. Cummins. 1995. An Introduction to the Aquatic Insects of North America, pp. 862. Kendall/Hunt Publishing Company, Dubuque, Iowa.

Miller, J. C. 1984. Competition predation and catchnet differentiation among net-spinning caddisflies (Trichoptera). *Oikos*, 43:117-120.

Moore, A. J. and P. Wilson. 1993. The evolution of sexually dimorphic earwig forceps - Social interactions among adults of the toothed earwig, *Vostox apicedentatus*. *Behavioral Ecology*, 4:40-48.

Mori, S. and K. Matubani. 1953. Daily swarming of some caddisfly adults and their habitat segregations. *Zoology Magazine (Tokyo)*, 62:191-198.

Morse, J. 1993. Checklist of the Trichoptera of North America, including Greenland and Mexico. *Transactions of the American Entomological Society*, 119:47-93.

Nijhout, H. F. and D. E. Wheeler. 1996. Growth models of complex allometries in holometabolous insects. *American Naturalist*, 148:40-56.

Nylin, S. and N. Wendell. 1994. Sexual size dimorphism and comparative methods. In P. Eggleton and R. I. Vane-Wright (eds.), *Phylogenetics and Ecology*, Vol. 17, pp. 254-277. Academic Press LTD, London.

Owen-Smith, N. 1993. Comparative mortality rates of male and female kudus - The costs of sexual size dimorphism. *Journal of Animal Ecology*, 62:428-440.

Petersson, E. 1989. Mating in swarming caddisflies (Trichoptera: Leptoceridae). Dissertation thesis, Acta Universitatis Upsaliensis, Uppsala.

Preziosi, R. F., D. J. Fairbairn, D. A. Roff and J. M. Brennan. 1996. Body size and fecundity in the waterstrider *Aquarius remigis*: A test of Darwin's fecundity advantage hypothesis. *Oecologia*, 108:424-431.

Radhika, M., A. K. A. Nazar and K. Nellaiappan. 1998. Sex-linked differences in phenol oxidase in the fairy shrimp *Streptocephalus dichotomus* Baird and their possible role (Crustacea: Anostraca). *Hydrobiologia*, 377:161-164.

Reiss, M. J. 1989. *The Allometry of Growth and Reproduction.* Cambridge University Press, Cambridge.

Rensch, B. 1960. *Evolution Above the Species Level.* Columbia University Press, New York.

Roelke, D. L. and S. M. Sogard. 1993. Gender-based differences in habitat selection and activity level in the northern pipefish (*Syngnathus fuscus*). *Copeia*, 2:528-532.

Roff, D. A. and D. J. Fairbairn. 1993. The evolution of alternate morphologies: Fitness and wing morphology in male sand crickets. *Evolution*, 47:1572-1584.

Ross, H. H. 1944. The caddis flies, or Trichoptera, of Illinois. *Bulletin of the Illinois Natural History Survey*, 23:1-326.

Ross, H. H. 1967. The evolution and past dispersal of the Trichoptera. *Annual Review of Entomology*, 12:169-206.

Schefter, P. W. 1996. Phylogenetic relationships among subfamily groups in the Hydropsychidae (Trichoptera) with diagnoses of the Smicrideinae, new status, and the Hydropsychinae. *Journal of the North American Benthological Society*, 15:615-633.

Schmidt-Nielsen, K. 1984. *Scaling: Why Is Animal Size So Important?* Cambridge University Press, Cambridge.

Shine, R. 1988. The evolution of large body size in females: A critique of Darwin's Fecundity Advantage Model. *American Naturalist*, 131:124-131.

Shine, R. 1989. Ecological causes for the evolution of sexual dimorphism: A review of the evidence. *Quarterly Review of Biology*, 64:419-461.

Shine, R., P. S. Harlow, J. S. Keogh and Boeadi. 1998. The allometry of life-history traits: Insights from a study of giant snakes. *Journal of Zoology (London)*, 244:405-414.

Shuster, S., M. 1990. Predation and sexual dimorphism in a marine isopod crustacean. *Trends in Ecology and Evolution*, 5.

Shuster, S. M. 1992. The reproductive behavior of alpha, beta and gamma male morphs in *Paracerceis sculpta*, a marine isopod crustacean. *Behavior*, 121:231-258.

Slatkin, M. 1984. Ecological causes of sexual dimorphism. *Evolution*, 38:622-630.

Smith, R. J. 1999. Statistics of sexual size dimorphism. *Journal of Human Evolution*, 36:423.

Solem, J. O. 1978. Swarming and habitat segregation in the family Leptoceridae (Trichoptera). *Norwegian Journal of Entomology*, 25:145-148.

Solem, J. O. and T. Solem. 1991. Mate location and pre-mating behaviour in *Apatania fimbriata* Pictet (Trichoptera, Limnephilidae). *Aquatic Insects*, 13:1-8.

Stoks, R. 1999. The effect of lamellae autotomy and sexual size dimorphism on startle response performance in larvae of a lestid damselfly (Odonata). *Journal of Zoology (London)*, 247:269-273.

Svensson, B. G. 1997. Swarming behavior sexual dimorphism and female reproductive status in the sex-role reversed dance-fly species *Rhamphomyia marginata. Journal of Insect Behavior*, 10:783-804.

Thompson, D. A. W. 1942. *On Growth and Form*, Cambridge, U.K.

Thornhill, R. and J. Alcock. 1983. *The Evolution of Insect Mating Systems*. Harvard University Press, Cambridge, MA.

Tseng, M. and L. Rowe. 1999. Sexual dimorphism and allometry in the giant water strider *Gigantometra gigas. Canadian Journal of Zoology*, 77:923-929.

Wallace, J. B. 1975. The larval retreat and food of *Arctopsyche*, with phylogenetic notes on feeding adaptations in Hydropsychidae larvae (Trichoptera). *Annals of the Entomological Society of America*, 68:167-173.

Webster, M. S. 1992. Sexual dimorphism, mating system and body size in New World blackbirds (Icterinae). *Evolution*, 46:1621-1641.

Wiggins, G. B. 1996. *Larvae of the North American Caddisfly Genera (Trichoptera)*. 2nd ed. University of Toronto Press, Toronto and Buffalo.

Wiggins, G. B. and R. J. Mackay. 1978. Some relationships between systematics and trophic ecology in Nearctic aquatic insects with special reference to Trichoptera. *Ecology*, 59:1211-1220.

Zamudio, K. R. 1998. The evolution of female-biased sexual size dimorphism: A population level comparative study in horned lizards (Phrynosoma). *Evolution*, 52:1821-1833.

BODY SIZE AND SEXUAL DIMORPHISM IN HYDROPSYCHID CADDISFLIES (TRICHOPTERA: HYDROPSYCHIDAE): PHYLOGENY AND ALLOMETRY FOR SEXUAL SIZE DIMORPHISM

Introduction

The goal of evolutionary biology is to interpret patterns of present day biological diversity and phenomena that are the result of largely historical processes. Since these processes are historical, they cannot be observed in extant species (Futuyma 1986, Harvey and Pagel 1991, Gittleman and Decker 1994). However, current patterns of diversity in extant species can be used to infer the evolutionary history of organisms and to provide insight into how selection operates (Futuyma 1986, Harvey and Pagel 1991, Gittleman and Decker 1994). One of the most powerful methods used to study adaptation and selection is the comparative method, where characteristics of groups of closely related organisms are contrasted (Harvey and Pagel 1991).

Comparative analyses typically begin with the observation of a pattern of biological variation in extant organisms (e.g. physiology, morphology, behavior). Other variables (e.g. environment) are identified and correlated to the observed pattern to determine whether they contribute to the pattern. Comparative methods are then employed to cautiously infer adaptation (Harvey and Pagel 1991). The evidence for adaptive evolution revealed by these studies is merely correlative, but nonetheless, can be informative and even compelling (Harvey and Pagel 1991). This process automatically assumes that the pattern(s) observed are adaptive and, in many cases, this assumption may be justified. However, an adaptive presupposition is not always necessary, may cloud the issues, and may not lead to any new insights (Gould and Lewontin 1979). This may be especially true among speciose groups like the insects, where the choice of species to use in a comparative study may be ambiguous simply because of the overwhelming number of possible comparisons.

An alternative to this approach is to use the comparative method to first test non-adaptive hypotheses before assuming an adaptive role for the trait or pattern observed. Non-adaptive explanations for character states simply acknowledge that the pattern may not have been produced by natural selection currently operating on the trait. Non-adaptive hypotheses for character states presently observed in species include genetic drift, pleiotropy, allometry, as well as others (Gould and Lewontin 1979). One frequently studied non-adaptive hypothesis is phylogenetic constraint (Gould and Lewontin 1979, Cheverud et al. 1985, Fairbairn 1990, Webster 1992). This hypothesis predicts that closely related groups should have similar character states because of common patterns of descent. Thus, variation in characters in extant species could exist because of selective pressures acting on related ancestral species and may not necessarily be the result of present day selective pressure. Not all evolutionary pathways are open to any group of organisms at any one time because: a) developmental pathways are conservative and may be difficult to alter; b) closely related taxa tend to evolve in similar niches; c) closely related taxa have similar genetic variance for selection to act upon; and d) closely related taxa have similar phenotypes that tend to respond to environmental change in a like manner (Gould and Lewontin 1979, Futuyma 1986, Harvey and Pagel 1991, Slater and

Halliday 1994). Therefore, in the absence of other information, the null hypothesis is that closely related taxa should exhibit similar character states.

Using the comparative method combined with information on the phylogenetic history, traits in extant species can be placed in the context of closely related taxa that share a common ancestry and test the prediction that all groups are alike (Harvey and Pagel 1991). The closely related taxa that have very different character states (contrary to the null prediction), are the taxa used to develop and experimentally test adaptive hypotheses. This approach achieves three goals. First, in the spirit of objective science, consideration of non-adaptive hypotheses helps avoid Panglossian adaptive story-telling (Gould and Lewontin 1979). Second, non-adaptive hypotheses provide valuable information about the limits on natural selection and adaptation. Finally, non-adaptive hypotheses can be viewed as null hypotheses against which adaptive hypotheses can be intelligently posed and thus, avoids the problems mentioned above (Gould and Lewontin 1979). This approach can provide a sound basis for testing evolutionary theories without wasting time on comparisons that might provide little or no new information.

I used the comparative method to examine phylogenetic constraints on body size and SSD in caddisflies of the family Hydropsychidae (Trichoptera). Hydropsychid caddisflies are a ubiquitous component of the insect communities in streams. There is a considerable amount of information available on the ecology and behavior of the aquatic larval stage (Wallace 1975, Alstad 1978, Mackay 1979, Miller 1984, Thorp et al. 1986, Downes and Jordan 1993, Merritt and Cummins 1995, Englund et al. 1997). However, much less is known about the reproductive behavior and ecology of adult hydropsychids

(Badcock 1953, Mori and Matubani 1953, Fremling 1960, Deutsch 1984, 1985, Lofstedt et al. 1994), and to my knowledge, no hypotheses have yet been posed about mating strategies in adult Hydropsychidae.

Three pieces of information led me to examine body size and SSD in the Hydropsychidae. First, body size is a critical component of reproductive biology and mating systems in many types of insects and the importance of body size can be different for the two sexes (Flecker et al. 1988, Berrigan and Locke 1991, Alcock 1993b, McLachlan and Neems 1995, Preziosi and Fairbairn 1996, Hernandez and Benson 1998, Robertson 1998, Savalli and Fox 1998, Cueva Del Castillo et al. 1999). For example, male body size can be critical in male-male competitive interactions that determine access to mates (Zeh et al. 1992, Hanks et al. 1996, Savalli and Fox 1999), whereas female body size is often correlated with fecundity in insects (Honek 1993, Leather 1995).

Second, within a clade, there is often a correlation between SSD and body size (Fairbairn 1997). Rensch (1960) proposed a general, descriptive rule for this correlation (Abouheif 1995, Abouheif and Fairbairn 1997, Fairbairn 1997). The rule states that, in clades where females are the larger sex, there is a negative correlation between SSD and body size and in clades where males are the larger sex, SSD and body size are positively correlated (Abouheif 1995, Fairbairn 1997). This rule was proposed from empirical observations of a variety of taxa including, birds, mammals, and insects (Reiss 1989, Webster 1992, Fairbairn and Preziosi 1994, Abouheif and Fairbairn 1997). The mechanism that produces these patterns is unclear (see Fairbairn 1997 for review of hypotheses). Even so, Rensch's rule has had wide acceptance and been applied to many taxa (Leutenegger 1978, Webster 1992, Abouheif 1995, Abouheif and Fairbairn 1997, Fairbairn 1997). Fairbairn (1997) concluded that, because SSD was correlated with body size in such a wide variety of taxa (primates to waterstriders), Rensch's rule deserves further study.

Finally, qualitative information from the taxonomic literature on Hydropsychidae suggests that species from this family may show either one of two patterns of SSD (females larger; males larger) or no SSD (Jannot unpub. data, Betten 1934, Ross 1944). Variability in SSD suggests that the reproductive biology and mating systems might also differ among species. Since SSD is a measure of the ratio of male to female size, then this ratio is probably important during mating when the two sexes are interacting most. The qualitative nature of this information is often conflicting, based on small sample sizes (a few individuals from each species) and, more often than not, anecdotal (Betten 1934, Ross 1944, Smith 1968; Flint 1974, 1982, 1987). Therefore, it is unclear which hydropsychid species would be the best candidates for comparative studies of reproductive behavior.

My goal was to determine the importance of phylogenetic constraint as a mechanism producing patterns of adult body size and SSD in extant North American caddisfly species of the family Hydropsychidae. The study had two objectives. First, I used the comparative method to examine how body size and SSD were distributed among the genera within this family. Second, I used the comparative method to examine the correlation between body size and sexual size dimorphism within the family. The quantitative results of this study will provide a sound basis for developing and experimentally testing hypotheses about the selective pressures operating on body size, mating systems, and reproductive ecology of hydropsychid caddisflies.

Methods

In North America, the family Hydropsychidae contains 11 genera with 144 species (Wiggins 1996). I examined a total of 29 species within 10 genera, representing about 20% of the described North American species (see Results section, Table 2.2). Hydropsychid species were randomly chosen within genera (as far as possible by availability) and in proportion to the number of species in each genus. I chose 1 to 3 species from each of the seven genera with between one and seven species (*Arctopsyche*, *Parapsyche*, *Diplectrona*, *Potamyia*, *Smicridea*, *Macrostemum*). The other three genera (*Cheumatopsyche*, *Ceratopsyche*, *Hydropsyche*) each contain more than 25 species and represent 76% of the total North American hydropsychid species (Wiggins 1996). Six species were examined from each of these larger genera (62% of the species examined).

Caddisfly species in the families Polycentropodidae (4 species), Dipseudopsidae (2 species), Philopotamidae (4 species) and Psychomyiidae (2 species) served as outgroups and were chosen in the same manner as described for the hydropsychids. Outgroups are taxa that are not considered to be among the clade of interest (Hydropsychidae), but are closely related to this group (Futuyma 1986, Campbell 1996). It is important to use an outgroup for comparison because, if we observed the same pattern (e.g., for body size) for all the taxa within the Hydropsychidae, we would not know if this pattern was unique to the Hydropsychidae (and therefore due to selection on the hydropsychid ancestor), or if this pattern was shared by close relatives and therefore had evolved before the Hydropsychidae (Alcock 1993a). These outgroup families are the closest relatives of the Hydropsychidae. The ancestor to these families (including Hydropsychidae) diverged from ancestral Trichoptera before they diverged from each other (Merritt and Cummins 1995, Schefter 1996, Wiggins 1996; J. Morse pers. comm.). Therefore, species from these families were the best choice for outgroups (Futuyma 1986). Figure 1.1, adapted from the literature, provides a phylogenetic hypothesis for the relationships of the families, subfamilies, and genera of the caddisfly suborder Annulipalpia (caddisflies whose larvae spin silk to make a fixed retreat) from North America (Weaver 1984, 1994, Schefter 1996, Wiggins 1996). All specimens used in this study were obtained from museums and collections in the United States and Canada (Appendix B).

Body length (BL) was used as an estimator of overall body size. Body length was measured from the center of the head between the eyes to the posterior margin of the 8th sternite to exclude genitalia. Body length measurements and sex determinations were made with a zoom stereoscopic microscope (Leica MZ6 mag.=8x) with a high powered fiber-optic light source (Volpi Cold Light Source NCL 150). Length measurements were made using an ocular micrometer (Leica) calibrated with a 5.000 mm stage micrometer (Leica). In most cases I measured 20 individuals of each sex; however, this was not always possible because some specimens were damaged and some species were not widely available (see Table 2.2 for sample sizes).

I used two indices of sexual size dimorphism (SSDI) recommended by Smith

(1999). Both indices use ratios of the body length of one sex on the other. Ratios have been widely criticized on statistical grounds (Fairbairn and Preziosi 1994, Abouheif and Fairbairn 1997). However, ratios are easy to compute, provide a simple means for comparing the relative size of males and females, and give a single value for each species which can be compared to other species. Smith (1999) examined 25 data sets to determine the statistical properties of five different SSD ratios. He concluded that ratios were statistically robust and that two ratios, one on a linear scale and one on a logarithmic scale, were the most statistically acceptable. Moreover, the two ratios sometimes give different results, leading to different biological insights (Smith 1999, R.J. Smith pers. comm.). The linear ratio was first developed and proposed by Lovich and Gibbons (1992) and subsequently simplified and modified by Smith (1999) into the "two-step ratio". The two-step ratio is calculated differently depending on which sex is larger most frequently in the data set. For example, in most insects (including hydropsychids), females are the larger sex, so the two-step ratio can be calculated, for each taxon as:

(1) If ♀BL ≥ ♂BL, dimorphism ratio = ♀BL/♂BL, *or*

(2) If ♂BL ≥ ♀BL, dimorphism ratio = 2 - ♂BL/♀BL;

where BL is the mean body length (body size indicator) of each sex. The ratio is linear, intuitive, and greater than 1 when females are larger (the most frequent pattern among invertebrate species). Values are linear and less than 1 when males are the larger sex. A value equal to 1 indicates no SSD (Smith 1999).

The logarithmic ratio of SSD is defined as: ln (larger sex/smaller sex). The results using the logarithmic ratio can differ from the linear form when the magnitude of dimorphism is large. The mean of the male and female BL for each species was used to calculate both indices. I examined both indices, but since the results from both were almost identical, I only present results from the two-step ratio.

To determine whether body size is constrained by phylogeny within the Hydropsychidae, I calculated the mean BL of each sex of each species. Species means were used to visually compare mean BL among genera, within higher taxonomic levels of the Hydropsychidae, and among the outgroups. I used nested analysis of variance to calculate the amount of variation in BL attributable to each taxonomic level. Each sex was run separately, and every individual measured from each sex was included in the analysis. The variance in BL was calculated among individuals within species (error term); among species within genera; among genera within subfamilies; among subfamilies within families; and among families in the suborder. The percent of the total variation represents the amount of variation that can be attributed to differences among groups within a level. For example, the percent of the total variation at the genus level represents the variation attributed to differences among species within genera and therefore represents the degree to which genera constrain species; larger amounts of variation indicate less constraint (Bell 1989). The analyses were conducted using SAS version 7.0 for Windows® (SAS Institute 1998)

To determine whether SSD is constrained by phylogeny, I used the mean BL of each sex to calculate the two-step ratio (sexual size dimorphism index or SSDI) for each species. Values greater than 1 indicate species where females are larger than the males, values less than 1 are species whose males are larger. I used the species SSDI values to calculate and visually compare the mean and range of SSDI among genera, within higher taxonomic levels of the Hydropsychidae, and among the outgroups. A two sided t-test (Bonferroni correction for α) was used to indicate if SSDI values for each genus differed from 1. In addition, species SSDI values were used in a nested analysis of variance to calculate the variance in SSDI among species within genera; among genera within subfamilies; among subfamilies within families; and among families within the suborder. The interpretation of the percent of the total variation is the same as that described above.

Finally, to determine if and how SSD correlates with body size, I regressed the SSDI for each species against mean male BL for each species. Regressing a ratio against it's numerator (in this case mean female BL) can produce very odd results (R.J. Smith pers. comm.). Therefore, the independent variable in the regression is mean male BL, since the SSDI is calculated as mean female BL / mean male BL. Regression statistics were obtained using ordinary least squares regression (OLS). Smith (1999) found that the OLS better reflects the distribution of the error when regressing a ratio of SSD against size. For regressions of a SSD ratio against body size, a slope of zero indicates no change in dimorphism with change in size (Fairbairn 1997, Smith 1999). I compared the slopes and intercepts obtained from the regression of species within the Hydropsychidae to the slopes and intercepts obtained from the regression among the outgroup species.

Results

Phylogeny and Body Size

Variation in body length among species within a genus was relatively low (Table

2.2) and species within a genus had similar body lengths (Figure 2.1; Table 2.2). Therefore, a species body size may be relatively constrained.

Table 2.1 Nested analysis of variance for body length in female hydropsychid caddisflies. Results were similar for males and thus, are not shown.

Level	df	Sums of Squares	Mean Squares	Variance Component	% Total
sub-order	0				
among families	4	603.99	151.00	-2.03	0
among sub-families	5	1690.13	338.03	3.89	48.7
among genera	7	936.97	133.85	2.62	32.8
among species	26	361.50	13.90	0.87	10.9
among individuals	652	395.81	0.61	0.61	7.60
Total	694	3988.39	5.75	7.99	

Contrary to phylogenetic constraints, relatively closely related genera and subfamilies had very different body sizes (Figure 2.1). For example, body sizes ranged from 3.8 to 6.3 mm for the genus *Cheumatopsyche*. The values for *Ceratopsyche*, a genus in the same subfamily, ranged from 6.4 to 8.3, indicating that genera can have very different body sizes (Figure 2.1; Table 2.2). In support of this, the majority of the variation in body size was accounted for by differences among genera within subfamilies (33%) and among subfamilies within families (49%), suggesting that body size among genera and among sub-families was not constrained by phylogenetic history (Table 2.1).

At the family level, the largest hydropsychids had body sizes beyond the range of any of the outgroup families examined (Hydropsychidae: 3.8 to 14.4 mm; outgroup range: 2.5 to 9.1 mm; Table 2.2; Figure 2.1). However, none of the variation in body length was

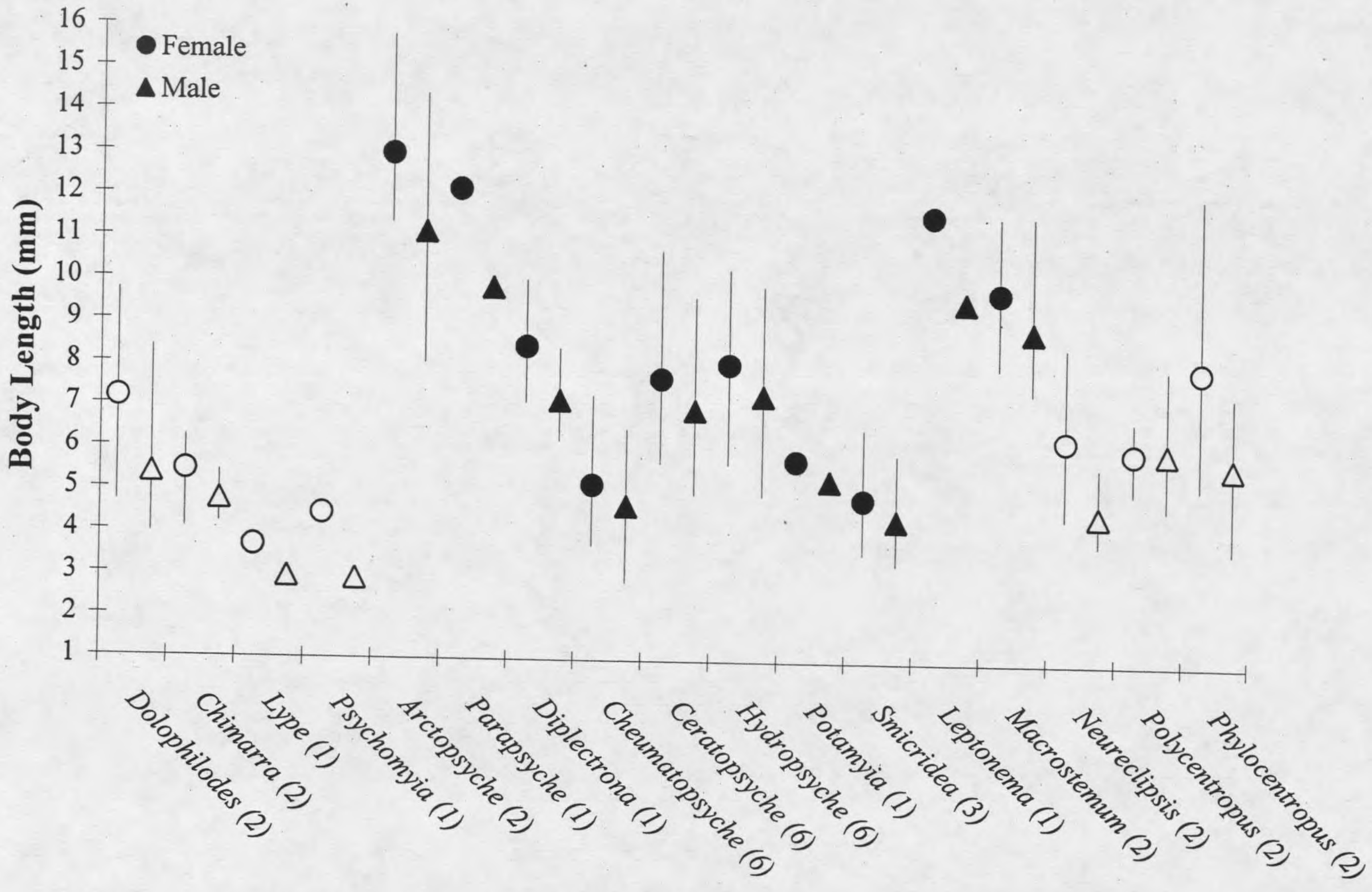


Figure 2.1 Body size range for each genus. Symbol is generic mean (filled = Hydropsychidae, open = outgroups), lines represent ranges. See Figure 1.1 for relationships.

Table 2.2 Sample sizes, mean body sizes of males and females, linear SSD index. See Figure 1.1 for hypothesized relationships.

Family Subfamily *Genus species*	**Sample Size**		**Male Body Length** mm(±SE)	**Female Body Length** mm(±SE)	**Linear SSD Index**
	M	**F**			
Philopotamidae					
Philopotaminae					
Dolophilodes aequalis	12	16	7.02 (0.20)	8.10 (0.27)	1.15
Dolophilodes distinctus	23	9	4.51 (0.06)	5.49 (0.23)	1.22
Chimarrinae					
Chimarra aterrima	20	20	4.74 (0.07)	5.69 (0.07)	1.20
Chimarra texana	5	16	4.79 (0.11)	5.13 (0.15)	1.07
Psychomyiidae					
Psychomyiinae					
Lype diversa	20	20	2.93 (0.12)	3.67 (0.11)	1.25
Psychomyia flavida0	10	10	2.89 (0.11)	4.43 (0.06)	1.53
Hydropsychidae					
Arctopsychinae					
Arctopsyche grandis	20	20	9.63 (0.24)	12.55 (0.22)	1.30
Arctopsyche irrorata	20	6	12.63 (0.15)	14.43 (0.41)	1.14
Parapsyche elsis	20	15	9.82 (0.13)	12.15 (0.25)	1.24
Diplectroninae					
Diplectrona modesta	20	20	7.16 (0.13)	8.43 (0.19)	1.18

Table 2.2 Continued.

Family Subfamily *Genus species*	**Sample Size** M	F	**Male Body Length** mm(±SE)	**Female Body Length** mm(±SE)	**Linear SSD Index**
Hydropsychinae *Cheumatopsyche aphanta*	19	15	3.84 (0.09)	4.11 (0.08)	1.07
Cheumatopsyche gracilis	26	20	4.35 (0.09)	4.33 (0.06)	0.996
Cheumatopsyche harwoodi	14	12	4.85 (0.13)	5.54 (0.29)	1.14
Cheumatopsyche minuscula	12	21	4.73 (0.10)	5.38 (0.10)	1.14
Cheumatopsyche pettiti	20	21	5.80 (0.11)	6.26 (0.14)	1.08
Cheumatopsyche speciosa	9	4	3.98 (0.29)	4.57 (0.33)	1.15
Ceratopsyche alternans	20	20	6.40 (0.17)	6.98 (0.13)	1.09
Ceratopsyche cockerelli	20	15	7.55 (0.27)	8.29 (0.34)	1.10
Ceratopsyche morosa	20	20	6.51 (0.29)	7.55 (0.14)	1.16
Ceratopsyche oslari	17	18	6.57 (0.15)	8.31 (0.19)	1.27
Ceratopsyche slossonae	18	19	7.73 (0.24)	8.26 (0.19)	1.07
Ceratopsyche sparna	20	20	6.78 (0.09)	7.00 (0.11)	1.03
Hydropsyche betteni	21	20	8.41 (0.14)	9.56 (0.11)	1.14
Hydropsyche confusa	20	20	5.87 (0.18)	8.14 (0.17)	1.39

Table 2.2 Continued.

Family Subfamily *Genus species*	**Sample Size** M	F	**Male Body Length** mm(±SE)	**Female Body Length** mm(±SE)	**Linear SSD Index**
Hydropsychinae *Hydropsyche elissoma*	21	20	7.90 (0.08)	7.79 (0.13)	0.986
Hydropsyche hageni	18	6	7.33 (0.15)	8.50 (0.54)	1.16
Hydropsyche occidentalis	21	20	6.01 (0.11)	6.43 (0.10)	1.07
Hydropsyche scalaris	20	5	8.32 (0.16)	8.65 (0.39)	1.04
Potamyia flava	20	18	5.31 (0.10)	5.77 (0.13)	1.09
Smicrideinae					
Smicridea dispar	20	12	3.82 (0.05)	4.31 (0.12)	1.13
Smicridea dithyra	20	20	4.45 (0.05)	4.65 (0.08)	1.04
Smicridea fasciatella	20	20	4.87 (0.10)	5.41 (0.13)	1.11
Macronematinae					
Leptonema albovirens	10	14	9.56 (0.14)	11.60 (0.36)	1.21
Macrostemum carolina	20	20	8.76 (0.11)	9.66 (0.23)	1.10
Macrostemum zebratum	40	31	8.94 (0.14)	9.86 (0.17)	1.10
Polycentropodidae					
Polycentropodinae					
Neureclipsis bimaculata	20	19	4.67 (0.12)	6.92 (0.24)	1.48

Table 2.2 Continued.

Family Subfamily *Genus species*	**Sample Size** M	**Sample Size** F	**Male Body Length** mm(±SE)	**Female Body Length** mm(±SE)	**Linear SSD Index**
Polycentropodidae					
Polycentropodinae					
Neureclipsis crepuscularis	20	18	4.39 (0.09)	5.63 (0.14)	1.29
Polycentropus cinereus	20	20	5.45 (0.08)	5.94 (0.08)	1.09
Polycentropus crassicornis	12	21	7.01 (0.19)	6.12 (0.10)	0.85
Dipseudopsidae					
Phylocentropus lucidus	14	8	4.70 (0.12)	5.46 (0.07)	1.16
Phylocentropus placidus	23	19	6.34 (0.11)	9.07 (0.43)	1.43

accounted for by differences among the families, suggesting that body length may be constrained within the suborder Annulipalpia (Table 2.1).

Phylogeny and SSD

Contrary to the prediction of phylogenetic constraint, almost half (41%) of the variation in SSDI was attributable to differences among species within genera, indicating that SSD was not phylogenetically constrained among closely related species (Table 2.3). Most species (93%) had SSDI values greater than one, indicating that the females were generally the larger sex. However, the SSDI range among these species was very wide: females ranged from 3% larger than males (SSDI=1.03) to 53% larger than males (SSDI=1.53; Table 2.2; Figure 2.2). In addition, three species– two hydropsychids (*Ch.*

gracilis, H. elissoma) and one outgroup (*Polycentropus crassicornis*)—had values less than one indicating that males were the larger sex (Table 2.2).

In contrast, SSD did not vary among genera or subfamilies and may have been constrained at these two levels. In only two genera (from different subfamilies), did the SSDI values differ significantly from one, indicating that females from these two genera were significantly larger than males (*Macrostemum*, *Cheumatopsyche*; $p<0.005$; Figure 2.2). None of the variation in SSDI was accounted for by differences among genera within subfamilies or by differences among subfamilies within families (Table 2.3; Figure 2.2).

Table 2.3 Nested analysis of variance for SSD in hydropsychid caddisflies.

Level	df	Sums of Squares	Mean Squares	Variance Component	% Total
sub-order	0				
among families	5	0.35	0.07	0.02	58.6
among sub-families	6	0.05	0.008	-0.02	0.00
among genera	6	0.05	0.009	-0.0008	0.00
among species	25	0.28	0.01	0.01	41.4
Total	42	0.73	0.02	0.03	

Differences among families within the suborder Annulipalpia described more than 50% of the variation in SSDI and therefore the linages have probably not been subject to phylogenetic constraints on SSD since the time of divergence (Table 2.3).

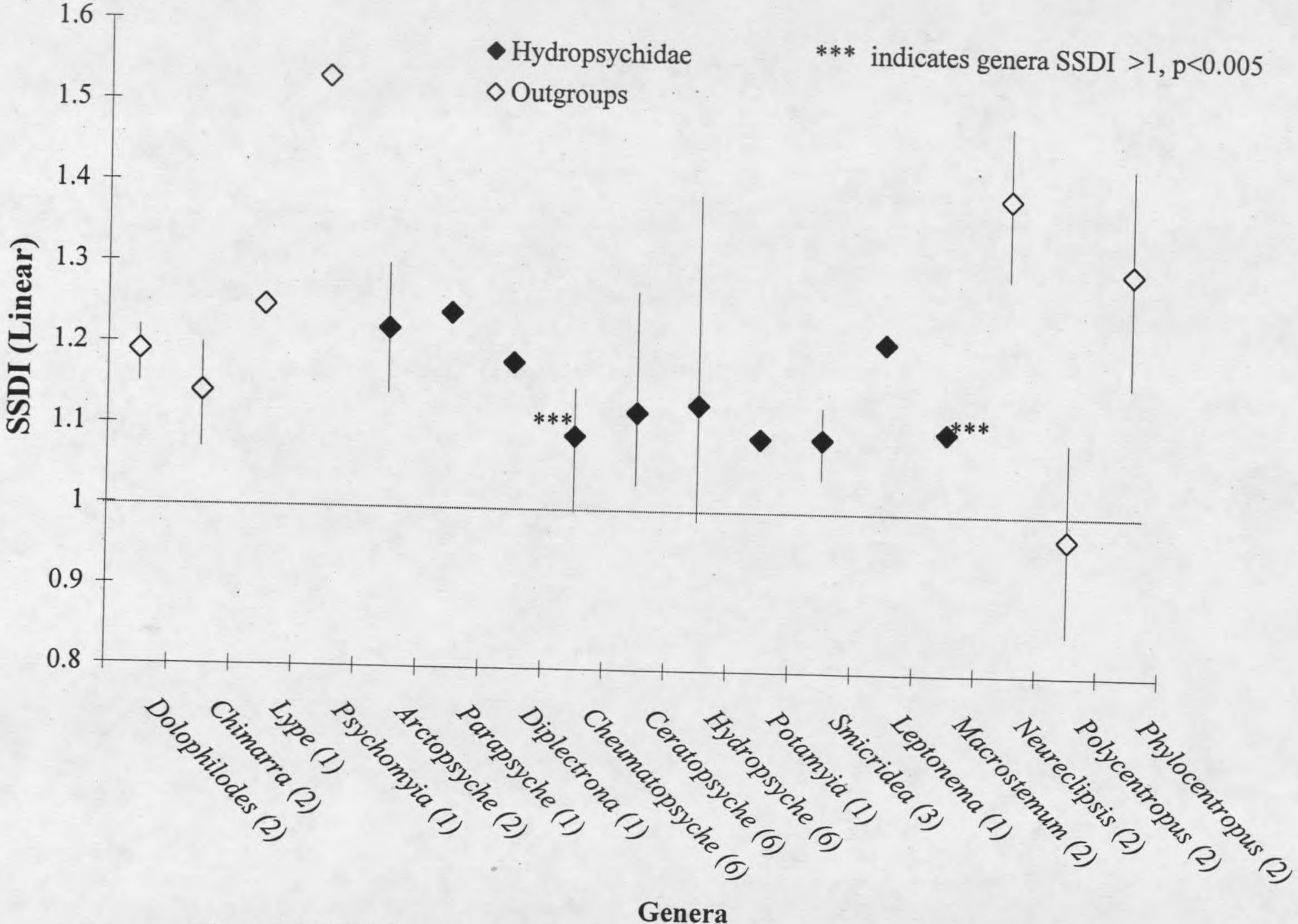


Figure 2.2 SSDI for each genus. Values >1 are genera with larger females; <1= larger males. Symbol is generic mean; solid lines indicate ranges; and dashed line indicates females = males.

SSD and Body Size

Among genera within subfamilies, body size was highly variable, yet SSD remained relatively constant (Figure 2.3). For example, *Arctopsyche* were 61% larger than *Smicridea*, but the difference in SSD between the two genera was only 11% (Figure 2.3). The outgroups exhibited higher variation in SSDI and smaller variation in body sizes than the hydropsychids (Figure 2.3).

There was no correlation between SSDI and body size within the hydropsychids, which was in direct contrast to both Rensch's rule and the outgroups (Figure 2.4). The SSDI remained constant with increasing body size for the hydropsychids (p= 0.4, Figure 2.4). For every unit change in body size, SSDI did not change thus, male size stayed the same relative to female size across taxa within the family. Rensch's rule predicts a negative correlation between SSD and body size in groups where females are generally the larger sex (i.e. Hydropsychidae). Thus, the hydropsychids did not conform to Rensch's rule.

Among the outgroups, SSDI declined with body size in accordance with Rensch's rule and in contrast to the Hydropsychidae (Figure 2.4). The slope of the outgroup line was different from the slope of the line for the hydropsychids (p= 0.04). When *Polycentropus crassicornis* (only outgroup species where males> females) was excluded from the analysis, the pattern remained the same, but the relationship was not significant (outgroup slope = - 0.04).

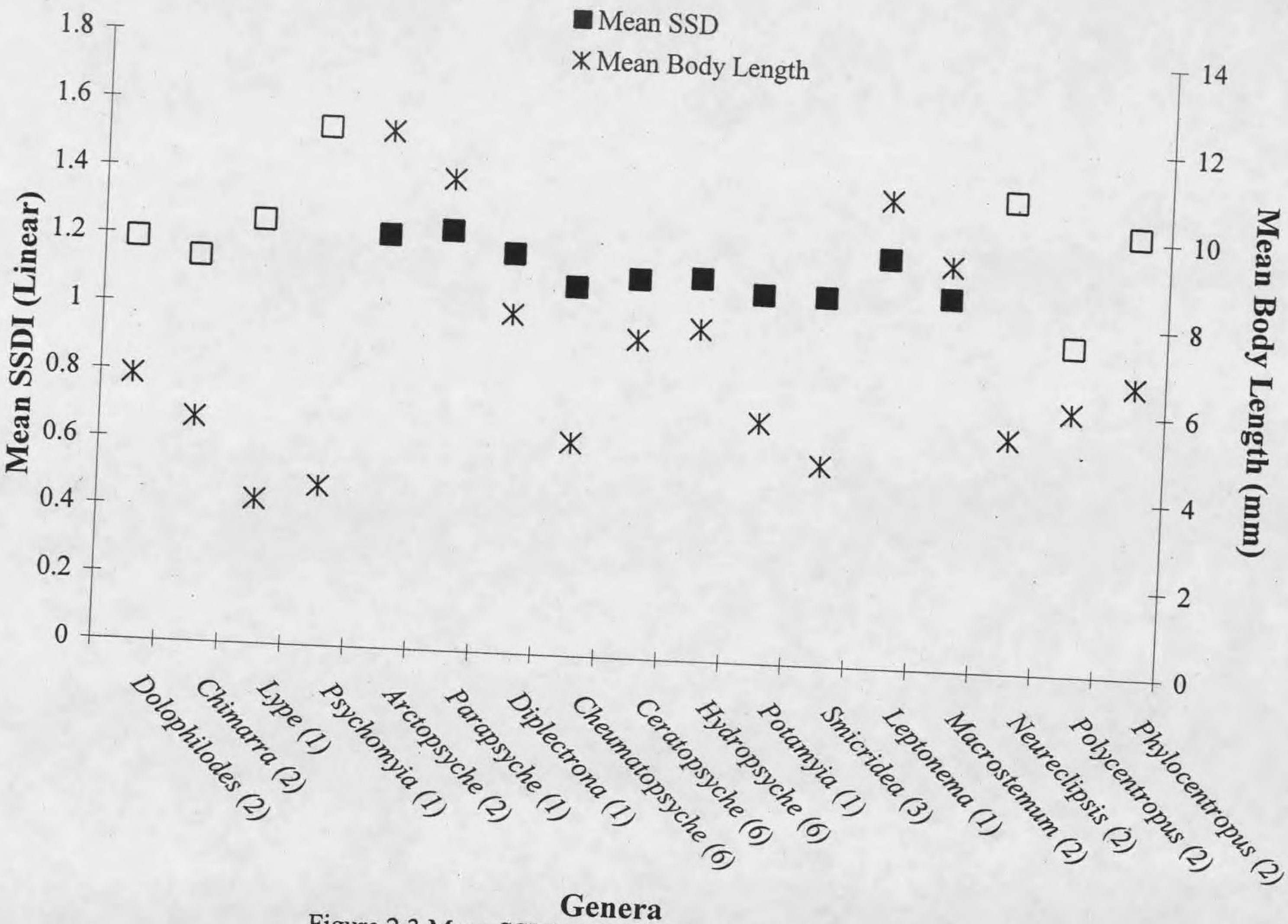


Figure 2.3 Mean SSDI and body length for each genus. Filled symbols are Hydropsychidae, open symbols are outgroups.

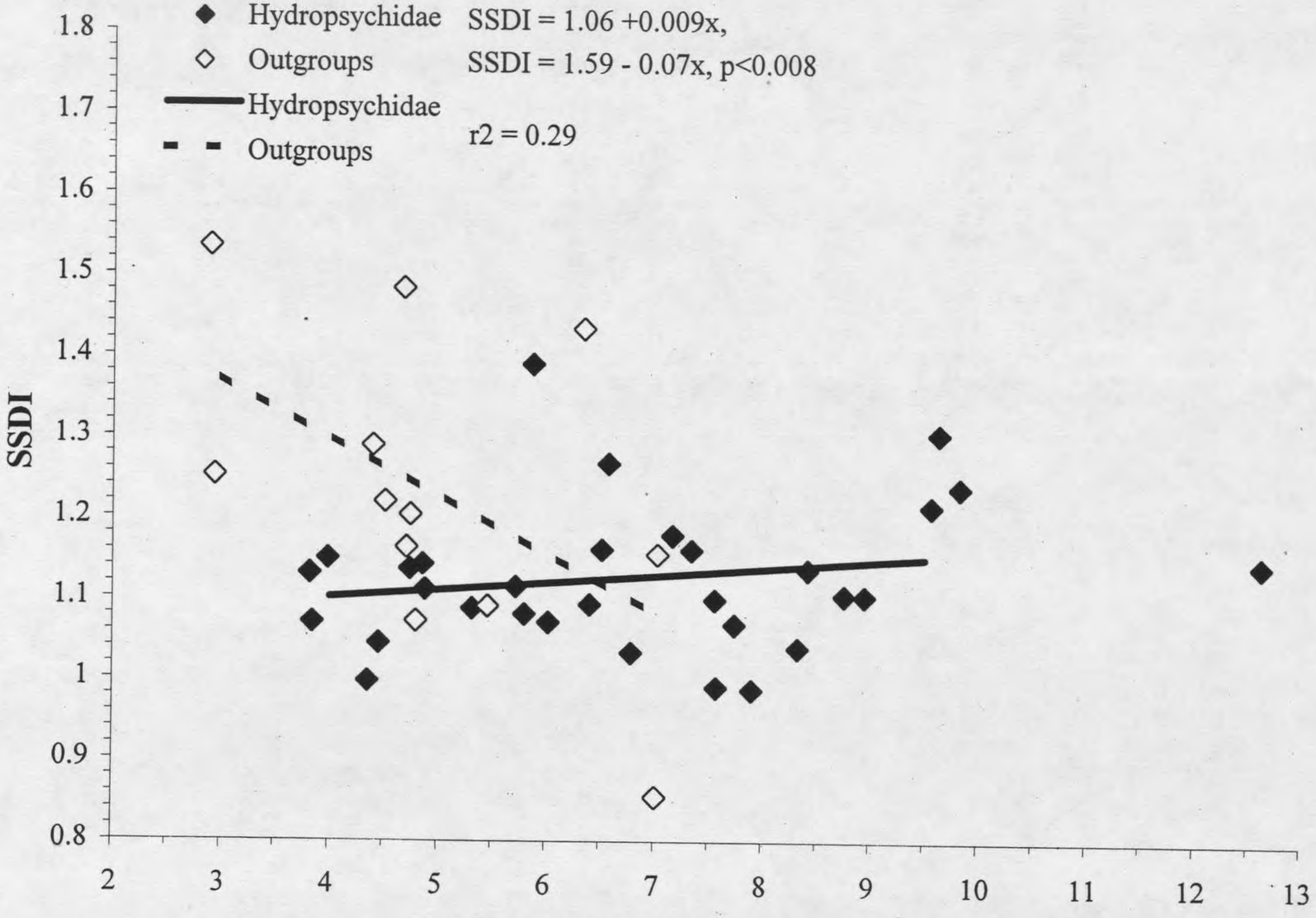


Figure 2.4 SSDI as a function of male body length. Each point is a species. Slope for the outgroup is significantly different from Hydropsychidae.

Discussion

This study has contributed two pieces of information to our understanding of the evolution of hydropsychid caddisflies. First, patterns of variation in body size and SSD have been described for a range of North American species in this family and this variation has been partitioned among different levels in the currently accepted phylogeny. Second, it appears that these two variables are uncorrelated within the Hydropsychidae. The largest amount of variation in body size was attributed to differences among genera and among subfamilies, levels in the taxonomy that contributed no variation to the pattern of SSD. In addition, the regression of SSD against body size also showed that the two variables were independent within the Hydropsychidae. These two pieces of information, combined with our current knowledge of the phylogeny of these organisms (Figure 1.1; Schefter 1996), can be used to develop testable hypotheses about selective pressures operating on hydropsychids.

In general, variability in body size was attributed to differences among genera and among subfamilies. Body size was relatively more constrained within and among species, and among families within the suborder. However, the pattern observed for SSD was exactly opposite to that observed for body length. Variability in SSD was attributed to differences among species and among families. Sexual size dimorphism was relatively more constrained among genera and subfamilies. Finally, Rensch's rule predicts that, in clades where females are the larger sex (i.e. Hydropsychidae), as body size increases, SSD should decrease. Contrary to Rensch's rule, body size and SSD were not correlated in the Hydropsychidae, although they were correlated in the predicted direction among the outgroups.

The fact that the pattern of variation for the two characters differed both among taxonomic levels and between characters at the same taxonomic level, suggests that the relative importance of the selective pressures acting on these two characters also differed. In addition, the selective pressures operating on body size and SSD may be fundamentally different from each other since the two characters appear to be uncorrelated in the Hydropsychidae. For example, the variance in body size generated since the divergence of genera within subfamilies (33%) was much greater than the variance generated since the divergence of species within genera (11%). However, the opposite was true of sexual size dimorphism. The variance in SSD produced since divergence of genera was negligible compared to the variance generated since the divergence of species (41%). This suggests that the selective pressures on these two characters were different and the importance and strength of these pressures has varied through time.

This pattern (differences in body sizes at the generic level, differences in SSD at the species level) lends support to two proposed hypotheses about evolution of the Hydropsychidae (Wiggins and Mackay 1978, Plague 1998, 1999). The first hypothesis is that, among North American hydropsychids, diversification of Hydropsychidae caddisflies may have been caused (or maintained) by ecological selection operating on the larvae (Thorp 1983, Miller 1984, 1984, Thorp et al. 1986, Georgian and Thorp 1992). In addition, these ecological differences are recognized as generic differences in the currently accepted hydropsychid phylogeny (Wiggins and Mackay 1978, Mackay and

Wiggins 1979). The second hypothesis is that reproductive isolation of adult conspecifics, via assortative mating, must have occurred in order for sympatric speciation to be completed (Plague 1998, Plague 1999). This hypothesis predicts that selective pressures in the adults would favor some type of mate choice (Plague 1998, Plague 1999). Below I examine how the patterns of body size and SSD from this study supports this combined view of hydropsychid evolution.

Since body size is so critical to ecological processes in many organisms, including hydropsychids (Mackay 1979, Calder 1984, Schmidt-Nielsen 1984, Muotka 1990, Kerans 1992), body size variation may represent ecological variation within the Hydropsychidae. As stated above, a large portion of the variation in body size was attributed to differences between genera. These data are consistent with the theory that Trichoptera genera represent not only monophyletic morphological types, but also ecological types (Wiggins and Mackay 1978). For example, many authors have provided evidence to suggest that most North American hydropsychid genera have restricted distributions along the longitudinal stream continuum (Ross 1967, Wallace 1975, Alstad 1978, Wiggins and Mackay 1978). Larval distribution of each genus is based on the net mesh size, which determines the type of food resources exploited, and abiotic factors such as temperature, stream flow and oxygen content (Wiggins and Mackay 1978). Since body size is important for ecological processes, it comes as no surprise that ecological units (genera) should have different body sizes to exploit different resources and habitats (Calder 1984, Schmidt-Nielsen 1984).

The most dramatic example of body size differences between comparatively closely related genera in this study were the two genera, *Smicridea* and *Macrostemum.* Larvae in both of these genera inhabit large, warm rivers in the southern United States (Flint 1974, Wallace and Sherberger 1974, 1975, Wallace 1975). *Smicridea* are found mostly in the desert and intermountain southwest, whereas *Macrostemum* are found in the warm, wet regions of the southeast (Flint 1974, Wallace and Sherberger 1974, 1975, Wallace 1975). One hypothesis for the body size differences between these two genera is that the larvae of *Smicridea* may be more dictated by hydroperiod or temperature (or both) than *Macrostemum* and may have adapted a life history strategy consistent with southwest streams that are subject to annual drying (Jackson 1988). For example, *Smicridea* larvae may have higher metabolic, developmental, and maturation rates than *Macrostemum* larvae. Increased developmental rates in *Smicridea* may be the result of selective pressure to rapidly progress through larval instars to avoid dessication, or alternatively, a by-product of higher developmental temperatures found in desert streams of the southwest United States. In either case, the result would be *Smicridea* emerging at smaller body sizes than *Macrostemum.* Little is known about the specific distribution, life history, and developmental processes of *Smicridea* or *Macrostemum* larvae (Flint 1974, Wallace and Sherberger 1974, 1975, 1975, Parker and Voshell 1982). However, the body size differences between these genera may reflect environmental differences. A comparison of the developmental processes and life history strategies of these two relatively closely related genera could provide insight into the selective pressures operating to produce hydropsychid caddisfly diversity.

Within the hydropsychids, SSD was similar among the genera and was more variable among species within genera. In addition, Rensch's rule was violated, and male size stayed the same relative to female size regardless of the species size. In sum, species differed in the amount of SSD, however, SSD was not dictated by the size of the species. This makes intuitive sense because body size variation at the species level was small relative to size differences at the generic level. So, it appears that body size variation may be dictated by ecological selective pressures (described above) that produced different genera with similar sized species; however, the species within a genus, regardless of size, have different levels of sexual size dimorphism.

One hypothesis for this pattern of SSD among species is that the different species within a genus are responding to selective pressures acting in the adult stage. Within the Hydropsychidae, mating behaviors or positions may require a strict ratio of male to female body size in order to achieve copulation. In this scenario, the size of the two sexes may be correlated so that selection on body size in one sex produces a change in mean body size of both sexes (Fairbairn 1997). For example, if one sex carries the other during mating or courtship, or if mating pairs remained joined for long periods during copulation (common among invertebrates), then mating success may depend upon the relative size of the sexes to each other (DeFrenza et al. 1986, Adams and Greenwood 1987, Marden 1989, Fairbairn 1990). One way that closely related, sympatric species keep from interbreeding is by altering mating behaviors (Tauber and Tauber 1982). Behavioral mechanisms operating to reproductively isolate sympatric species have been identified in insects (e.g. lacewings, Tauber and Tauber 1982; , fireflies, Futuyma 1986, p. 112). Size is important in insect mating systems and assortative mating based on size (big mates with big and small mates with small) is not uncommon among insects (Burley 1983, McLain 1985, Gage 1998, Hernandez and Benson 1998, Neems et al. 1998, Thornhill and Moller 1998, Cueva Del Castillo et al. 1999, Harari et al. 1999, Savalli and Fox 1999). Interestingly, recent models have shown that sympatric speciation based on assortative mating and heritable mate choice can occur (Dieckmann and Doebeli 1999, Kondrashov and Kondrashov 1999, Tregenza and Butlin 1999). Sympatric speciation has been proposed in the caddisfly families Hydroptilidae (Botosaneanu 1997) and Hydropsychidae (Plague 1999). However, currently no empirical evidence exists for this mechanism of sympatric speciation within the Hydropsychidae. Hydropsychid caddisflies could be a good group to examine how assortative mating and mate choice based on size and SSD may contribute to sympatric speciation.

In conclusion, if body size is a good indicator of ecological diversity within the Hydropsychidae, then generic level diversity may be, in large part, a result of ecological processes operating in the larval stage (net mesh differentiation, selection for abiotic conditions). However, body size differences of congeneric species were relatively minor. Therefore, species level diversity may be more dependent upon the selective pressures of assortative mating and mate choice operating to maintain a strict male/female size ratio (SSD) in the adult stage. Hydropsychid mating systems are virtually unknown and a comparative study of mating behaviors may provide insight into the evolution of species within this family. By placing this study in the context of phylogeny, I hoped to show which species might be useful for these, and other, adaptive comparisons.

Literature Cited

Abouheif, E. 1995. A comparative analysis of the allometry for sexual size dimorphism: Testing Rensch's Rule. Masters thesis, Concordia University, Montreal.

Abouheif, E. and D. J. Fairbairn. 1997. A comparative analysis of allometry for sexual size dimorphism: assessing Rensch's rule. *American Naturalist*, 149:540-562.

Adams, J. and P. J. Greenwood. 1987. Loading constraints, sexual selection and assortative mating in peracarid Crustacea. *Journal of Zoology (London)*, 211:35-46.

Alcock, J. 1993a. *Animal Behavior: An Evolutionary Approach*. 5th ed. Sinauer Associates, Inc., Sunderland, MA.

Alcock, J. 1993b. The effects of male body size on territorial and mating success in the landmark-defending fly *Hermetia comstocki* (Stratiomyidae). *Ecological Entomology*, 18:1-6.

Alstad, D. N. 1978. Distributional and community ecology of filtering caddisflies (Trichoptera: Hydropsychidae). Dissertation thesis, University of Utah, Salt Lake City.

Badcock, R. 1953. Observations of the oviposition underwater of the aerial insect *Hydropsyche augustipennis* (Curtis) (Trichoptera). *Hydrobiologia*, 5:222-225.

Bell, G. 1989. A comparative method. *American Naturalist*, 133:553-571.

Berrigan, D. and S. Locke, J. 1991. Body size and male reproductive performance in the flesh fly, *Neobellieria bullata*. *Journal of Insect Physiology*, 37:757-581.

Betten, C. 1934. The caddisflies of New York. *New York Museum Bulletin*, 292:1-576.

Botosaneanu, L. 1997. Possible Sympatric Speciation in Hydroptilidae. In R. W. Hozenthal and O. S. Flint (eds.), *Proceedings of the 8th International Symposium on Trichoptera*, pp. 43-48. Ohio Biological Survey Columbus, OH.

Burley, N. 1983. The meaning of assortative mating. *Ethology and Sociobiology*, 4:191-203.

Calder, W. A. I. 1984. *Size, Function and Life History*. Harvard University Press, Cambridge and London.

Campbell, N. A. 1996. *Biology*. 4th ed. Benjamin/Cummings Publishing Company Inc., Menlo Park.

Cheverud, J. M., M. M. Dow and W. Leutenegger. 1985. The quantitative assessment of phylogenetic constraints in comparative analyses: sexual dimorphism in body weight among primates. *Evolution*, 39:1335-1351.

Cueva Del Castillo, R., J. Nunez-Farfan and Z. Cano-Santana. 1999. The role of body size in mating success of *Spenarium purpurascens* in Central Mexico. *Ecological Entomology*, 24:146.

DeFrenza, J., R. J. Kirner, E. J. Maly and H. C. van Leeuwen. 1986. The relationships of sex-size ratio and season to mating intensity in some Calanoid copepods. *Limnology and Oceanography*, 31:491-496.

Deutsch, W. G. 1984. Oviposition of Hydropsychidae (Trichoptera) in a large river. *Canadian Journal of Zoology*, 62:1988-1994.

Deutsch, W. G. 1985. Swimming modifications of adult female Hydropsychidae compared with other Trichoptera. *Freshwater Invertebrate Biology*, 4:35-40.

Dieckmann, U. and M. Doebeli. 1999. On the origin of species by sympatric speciation. *Nature*, 400:354-357.

Downes, B. J. and J. Jordan. 1993. Effects of stone topography on abundance of net-building caddisfly larvae and arthropod diversity in an upland stream. *Hydrobiologia*, 252:163-174.

Englund, G., B. Malmqvist and Y. Zhang. 1997. Using predictive models to estimate effects of flow regulation on net-spinning caddis larvae in north Swedish streams. *Freshwater Biology*, 37:687-697.

Fairbairn, D. J. 1990. Factors influencing sexual size dimorphism in temperate waterstriders. *American Naturalist*, 136:61-86.

Fairbairn, D. J. 1997. Allometry for sexual size dimorphism: Pattern and process in the coevolution of body size in males and females. *Annual Review of Ecology and Systematics*, 28:659-687.

Fairbairn, D. J. and R. F. Preziosi. 1994. Sexual selection and the evolution of allometry for sexual size dimorphism in the water strider, *Aquarius remigis*. *American Naturalist*, 144:101-118.

Flecker, A. S., J. D. Allen and N. L. McClintock. 1988. Male body size and mating success in swarms of the mayfly *Eporus longimanus*. *Holarctic Ecology*, 11:280-285.

Flint, O. S. 1974. Studies of neotropical caddisflies, XVIII: The Genus *Smicridea* from North America and Central America (Trichoptera: Hydropsychidae). *Smithsonian Contributions to Zoology*, 167:1-65.

Flint, O. S., jr. and J. Bueno-Soria. 1982. Studies of neotropical caddisflies XXXII: The immature stages of *Macronema variipenne* Flint and Bueno, with the division of *Macronema* by the resurrection of *Macrostemum* (Trichoptera: Hydropsychidae). *Proceedings of the Biological Society of Washington*, 95:358-370.

Flint, O. S., J. F. McAlpine and H. H. Ross. 1987. A revision of the genus *Leptonema* Guerin (Trichoptera: Hydropsychidae: Macronematinae). *Smithsonian Contributions to Zoology*, 450:1-193.

Fremling, C. R. 1960. Biology and possible control of nuisance caddisflies of the upper Mississippi River. *Iowa State University Science and Technical Research Bulletin*, 483:856-879.

Futuyma, D. J. 1986. *Evolutionary Biology*. 2nd ed. Sinauer Associates Inc., Sunderland, MA.

Gage, M. J. G. 1998. Influences of sex, size and symmetry on ejaculate expenditure in a moth. *Behavioral Ecology*, 9:592-597.

Georgian, T. and J. H. Thorp. 1992. Effects of microhabitat selection on feeding rates of net-spinning caddisfly larvae. *Ecology*, 73:229-240.

Gittleman, J. L. and D. M. Decker. 1994. The phylogeny of behavior. In P. B. J. Slater and T. R. Halliday (eds.), *Behavior and Evolution*, pp. 80-105. Cambridge University Press, Cambridge.

Gould, S. J. and R. C. Lewontin. 1979. The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptationist programme. *Proceedings of the Royal Society of London, Series B*, 205:581-598.

Hanks, L. M., J. G. Millar and T. D. Paine. 1996. Body size influences mating success of the eucalyptus longhorned borer (Coleoptera: Cerambycidae). *Journal of Insect Behavior*, 9:369-382.

Harari, A. R., A. M. Handler and P. J. Landolt. 1999. Size-assortative mating, male choice and female choice in the curculionid beetle *Diaprepes abbreviatus*. *Animal behaviour*, 8:1191.

Harvey, P. H. and M. D. Pagel. 1991. *The Comparative Method in Evolutionary Biology*. Oxford University Press, Oxford.

Hernandez, M. I. M. and W. W. Benson. 1998. Small-male advantage in the territorial tropical butterfly *Heliconius sara* (Nymphalidae): A paradoxical strategy? *Animal Behavior*, 56:533-540.

Honek, A. 1993. Intraspecific variation in body size and fecundity in insects - A general relationship. *Oikos*, 66:483-492.

Jackson, J. K. 1988. Diel emergence swarming and longevity of selected adult aquatic insects from a Sonoran Desert stream. *American Midland Naturalist*, 119:344-352.

Kerans, B. L. 1992. Season and body size influence movement of hydropsychid caddisflies larvae (Trichoptera: Hydropsychidae). *Canadian Journal of Fisheries and Aquatic Sciences*, 49:259-265.

Kondrashov, A. S. and F. A. Kondrashov. 1999. Interactions among quantitative traits in the course of sympatric speciation. *Nature*, 400:351-354.

Leather, S. R. 1995. Factors affecting fecundity, fertility, oviposition and larviposition in insects. In S. R. Leather and J. Hardie (eds.), *Insect Reproduction*, pp. 143-174. CRC Press, Boca Raton, FL.

Leutenegger, W. 1978. Scaling of sexual dimorphism in body size and breeding systems in primates. *Nature*, 272:610-611.

Lofstedt, C., B. S. Hansson, E. Petersson, P. Valeur and A. Richards. 1994. Pheromonal secretions from glands on the 5th abdominal sternite of hydropsychid and rhyacophilid caddisflies (Trichoptera). *Journal of Chemical Ecology*, 20:153-170.

Lovich, J. E. and J. W. Gibbons. 1992. A review of techniques for quantifying sexual size dimorphism. *Growth, Development and Aging*, 56:269-281.

Mackay, R. J. 1979. Life history patterns of some species of *Hydropsyche* (Trichoptera: Hydropsychidae) in southern Ontario. *Canadian Journal of Zoology*, 57:963-975.

Mackay, R. J. and G. B. Wiggins. 1979. Ecological diversity in Trichoptera. *Annual Review of Entomology*, 24:185-208.

Marden, J. H. 1989. Effects of lad-lifting constraints on the mating system of a dance fly. *Ecology*, 70:496-502.

McLachlan, A. and R. Neems. 1995. Swarm-based mating systems. In S. R. Leather and J. Hardie (eds.), *Insect Reproduction*, pp. 199-213. CRC Press Inc., Boca Raton, FL.

McLain, D. K. 1985. Clinal variation in morphology and assortative mating in the solider beetle *Chauliognathus pennsylvanicus*. *Biol. J. Linn. Soc.*, 25:105-117.

Merritt, R. W. and K. W. Cummins. 1995. An Introduction to the Aquatic Insects of North America, pp. 862. Kendall/Hunt Publishing Company, Dubuque, Iowa.

Miller, J. C. 1984. Competition predation and catchnet differentiation among net-spinning caddisflies (Trichoptera). *Oikos*, 43:117-120.

Mori, S. and K. Matubani. 1953. Daily swarming of some caddisfly adults and their habitat segregations. *Zoology Magazine (Tokyo)*, 62:191-198:

Muotka, T. 1990. Coexistence in a guild of filter feeding caddis larvae: Do different instars act as different species? *Oecologia*, 85:281-292.

Neems, R. M., J. Lazarus and A. J. McLachlan. 1998. Lifetime reproductive success in a swarming midge: trade-offs and stabilizing selection for male body size. *Behavioral Ecology*, 9:279-.

Parker, C. R. and J. R. Voshell. 1982. Life histories of some filter-feeding Trichoptera in Virginia. *Canadian Journal of Zoology*, 60:1732-1742.

Plague, G. R. 1999. Evolution of net-spinning caddisflies: a hypothetical mechanism for the reproductive isolation of conspecific competitors. *Oikos*, 87:204.

Plague, G. R. a. J. V. M. 1998. Genetic diversity vs. geographic distribution of five congeneric caddisflies. *Hydrobiologia*, 362:1-8.

Preziosi, R. F. and D. J. Fairbairn. 1996. Sexual size dimorphism and selection in the wild waterstrider *Aquarius remigis*: Body size, components of body size, and male mating success. *Journal of Evolutionary Biology*, 9:317-336.

Reiss, M. J. 1989. *The Allometry of Growth and Reproduction.* Cambridge University Press, Cambridge.

Rensch, B. 1960. *Evolution Above the Species Level.* Columbia University Press, New York.

Robertson, I. C. 1998. "Flight muscle changes in male pine engraver beetles during reproduction: the effects of body size, mating status and breeding failure". *Physiological Entomology*, 23:75-80.

Ross, H. H. 1944. The caddis flies, or Trichoptera, of Illinois. *Bulletin of the Illinois Natural History Survey*, 23:1-326.

Ross, H. H. 1967. The evolution and past dispersal of the Trichoptera. *Annual Review of Entomology*, 12:169-206.

Savalli, U. M. and C. W. Fox. 1998. Sexual selection and the fitness consequences of male body size in the seed beetle *Stator limbatus*. *Animal Behavior*, 55:473-483.

Savalli, U. M. and C. W. Fox. 1999. The effect of male size, age, and mating behavior on sexual selection in the seed beetle *Callosobruchus maculatus*. *Ethology Ecology & Evolution*, 11:49.

Schefter, P. W. 1996. Phylogenetic relationships among subfamily groups in the Hydropsychidae (Trichoptera) with diagnoses of the Smicrideinae, new status, and the Hydropsychinae. *Journal of the North American Benthological Society*, 15:615-633.

Schmidt-Nielsen, K. 1984. *Scaling: Why Is Animal Size So Important?* Cambridge University Press, Cambridge.

Slater, P. B. J. and T. H. Halliday. 1994. Behavior and Evolution, pp. 348. Cambridge University Press, Cambridge, UK.

Smith, R. J. 1999. Statistics of sexual size dimorphism. *Journal of Human Evolution*, 36:423.

Smith, S. D. 1968. The Arctopsychinae of Idaho (Trichoptera: Hydropsychidae). *Pan Pacific Entomologist*, 44:102-112.

Tauber, C. A. and M. J. Tauber. 1982. Sympatric speciation in *Chrysopa*: Further discussion. *Annals of the Entomological Society of America*, 75:1-2.

Thornhill, R. and A. P. Moller. 1998. The relative importance of size and asymmetry in sexual selection. *Behavioral Ecology*, 9:546-551.

Thorp, J. H. 1983. An evaluation of hypotheses on the evolutionary differentiation of catchnets in net-spinning caddisflies (Hydropsychidae). *Oikos*, 40:308-312.

Thorp, J. H. 1984. Evolutionary differentiation of caddisfly catchnets: perspectives on the roles of competition and predation. *Oikos*, 43:121-124.

Thorp, J. H., J. B. Wallace and T. J. Georgian . 1986. Untangling the web of caddisfly evolution and distribution. *Oikos*, 47:253-256.

Tregenza, T. and R. K. Butlin. 1999. Speciation without isolation. *Nature*, 400:311-312.

Wallace, J. B. 1975. Food partitioning in net-spinning Trichoptera larvae *Hydropsyche venularis*, *Cheumatopsyche etrona*, and *Macronema zebratum* (Hydropsychidae). *Annals of the Entomological Society of America*, 68:463-472.

Wallace, J. B. and F. F. Sherberger. 1974. The larval retreat and feeding net of *Macronema carolina* Banks (Trichoptera: Hydropsychidae). *Hydrobiologia*, 45:177-184.

Wallace, J. B. and F. F. Sherberger. 1975. The larval dwelling and feeding structure of *Macronema transversum* (Walker) (Trichoptera: Hydropsychidae). *Animal Behavior*, 25:592-596.

Weaver, J. S. 1984. The evolution and classification of Trichoptera Part I: The groundplan of Trichoptera. In J. C. Morse (ed.), *Proceedings of the 4th International Symposium on Trichoptera*, pp. 413-419. Dr. W. Junk, The Hague.

Weaver, J. S., III and H. Malicky. 1994. The genus *Dipseudopsis* Walker from Asia (Trichoptera: Dipseudopsidae). *Tijdschrift voor Entomologie*, 137:95-142.

Webster, M. S. 1992. Sexual dimorphism, mating system and body size in New World blackbirds (Icterinae). *Evolution*, 46:1621-1641.

Wiggins, G. B. 1996. *Larvae of the North American Caddisfly Genera (Trichoptera)*. 2nd ed. University of Toronto Press, Toronto and Buffalo.

Wiggins, G. B. and R. J. Mackay. 1978. Some relationships between systematics and trophic ecology in Nearctic aquatic insects with special reference to Trichoptera. *Ecology*, 59:1211-1220.

Zeh, D. W., J. A. Zeh and G. Tavakilian. 1992. Sexual selection and sexual dimorphism in the harlequin beetle *Acrocinus longimanus*. *Biotropica*, 24:86-96.

ALLOMETRY AND SEXUAL DIMORPHISM FOR WING, LEG, AND SENSORY STRUCTURES IN ADULT HYDROPSYCHID CADDISFLIES (TRICHOPTERA: HYDROPSYCHIDAE)

Introduction

Sexual dimorphism, phenotypic differences between females and males, has long been recognized in a number of taxa and species (Darwin 1859). Sexual dimorphism is relatively common among a wide range of organisms including (but not limited to) insects (Alcock 1993, McLain 1993), nematodes (Poulin 1997), crustaceans (Shuster 1992), amphibians and reptiles (St. Clair 1998, Malmgren and Thollesson 1999) and mammals (Owen-Smith 1993). A multitude of characters maybe sexually dimorphic including: general body size (Bjorklund 1990, Preziosi and Fairbairn 1996), appendages (Moore and Wilson 1993, Roff and Fairbairn 1993), internal organs (Calder 1984), physiology (Bailey and Romer 1991, Radhika et al. 1998), development and growth (Reiss 1989, Ernst and Wilgenbusch 1998), behavior (Roelke and Sogard 1993, Svensson 1997), and even mortality (Owen-Smith 1993).

Sexual dimorphism has been the subject of several recent reviews (Slatkin 1984, Hedrick and Temeles 1989, Shine 1989, Andersson 1994), and a number of hypotheses concerning the mechanisms producing sexual dimorphism have emerged. These hypotheses fall into two broad categories: non-adaptive and adaptive. Non-adaptive hypotheses, such as phylogenetic history, are beginning to be examined as possible causes of sexual dimorphism (Fairbairn 1990, Andersen 1994). For example, in water striders phylogenetic 'constraints' may have shaped patterns of sexual dimorphism (Andersen

1997). More often, attempts have been made to explain sexual dimorphism in terms of adaptive mechanisms (Slatkin 1984, Shine 1989, Andersson 1994). Recent work has divided these adaptive mechanisms into three broad categories: 1) ecological selection; 2) fecundity selection; and 3) sexual selection (Hedrick and Temeles 1989).

Under ecological selection, the morphology of the sexes differ because they have adapted to use resources differently (Slatkin 1984, Shine 1989, Malmgren and Thollesson 1999). This model predicts (among other things) that if two sexes experience different environments during the same life stage, then selection may operate differently on them. For example, in many aquatic insects (Ephemeroptera, Trichoptera, Diptera, aquatic Hymenoptera) the terrestrial adult females crawl or swim underwater to oviposit (Badcock 1953, Merritt and Cummins 1995). Presumably adult males are not required to enter the water after emergence. Thus, females may have leg or wing structures that aid them in oviposition, that are absent or reduced in the males (Deutsch 1984, 1985).

Under fecundity selection, one sex (often females) benefits more (in terms of reproductive output) from a larger body size (Shine 1988, Malmgren and Thollesson 1999). For example, in female insects, abdomen size often determines how many eggs can be carried, and therefore, the abdomen is much larger than in males of the same species (Wickman and Karlsson 1989).

Finally, sexual dimorphism is sometimes attributed to sexual selection (Andersson 1994, 1996). In this scenario, the dimorphic character confers a mating advantage to individuals of one sex, often the males. Typically, individuals with more extreme character development have higher fitness because the character enables better access to the opposite sex (Hedrick and Temeles 1989, Andersson 1994). For example, in the caddisfly species, *Mystacides azurea* (family Leptoceridae), females fly towards a group of swarming males. Males visually recognize the female and race towards her as she turns and flies away. The first male to catch the female, flies with her to the vegetation and succeeds in copulation. Males had larger eyes for detecting females before competitors and longer wings to race other males (Gullefors and Petersson 1993). In effect, the females were "choosing" males with larger eyes and longer wings, and therefore these males had increased mating opportunities (Solem and Solem 1991).

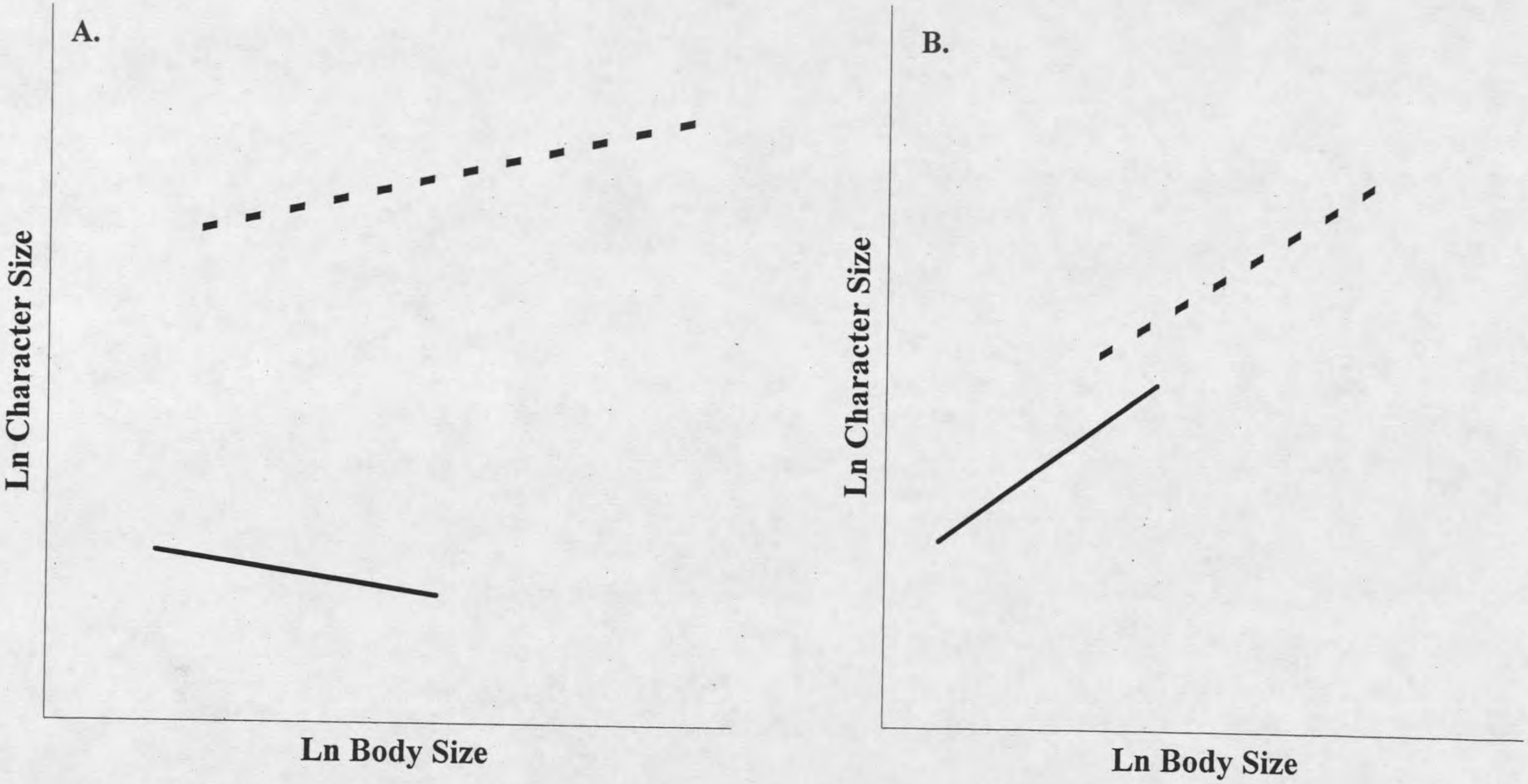
The hydropsychid caddisflies (Trichoptera: Hydropsychidae) are an interesting group in which to examine sexual dimorphism. Qualitative information from the taxonomic literature suggests that different species show either one of two possible patterns of sexual dimorphism: females larger than males and males larger than females; or alternatively, no dimorphism (Betten 1934, Ross 1944; Jannot unpub. data). Several characters, including antennal length, middle tibial width and length, and eye width, have been reported to be sexually dimorphic in a number of caddisfly species, including hydropsychids (Betten 1934, Ross 1967, Solem 1976, Malicky 1977, Deutsch 1985, Solem and Solem 1991). These differences among species in characters that are dimorphic and direction of dimorphism suggest that different types of selection may be operating concurrently. In the example above, ecological selection may be responsible for sexually dimorphic leg characters, whereas sexual selection may be responsible for sexually dimorphic eyes. In addition, flight differences between the sexes (male swarming vs. female oviposition flights) may select for different wing shape in the two sexes (Ross 1967).

One way to examine sexual dimorphism within a species is to simply compare the mean character size of males and females. This method is appropriate when the overall body size of males and females is similar (Figure 3.1 A). However, if one sex is larger than the other, the interpretation can become obscured. Morphological characters typically scale with body size. Therefore, if one sex has a larger body, it may also have larger morphological characters (Figure 3.1 B). The question is then: is selection operating on body size or on character size? By simply comparing the mean character size of the sexes, the data would suggest that there is sexual dimorphism in character size when, in fact, selection may be only operating on overall body size and character differences between the sexes are not important. One useful way around this problem is to use allometry– that is, how a trait(s) changes with body size (Shine 1988, Ernst and Wilgenbusch 1998, Tseng and Rowe 1999). By examining allometric relationships for the two sexes we can determine the true nature of the character dimorphism, while, in effect, controlling for the confounding factor of body size.

In this study, I examined sexual dimorphism in antennae, mesotibiae, eyes, and wings in adult Hydropsychidae. The purpose of this study was to:

1) use allometric relationships to quantify sexual dimorphism in adult hydropsychid caddisflies and;

2) to provide a framework for posing hypotheses about adult hydropsychid behavior.



Sexual dimorphism: character scales differently in the sexes, body sizes overlap.

Size-mediated sexual dimorphism: character scales the same in the sexes, one sex is larger than the other.

Figure 3.1 Examples of different allometric relationships, representing two forms of sexual dimorphism in character size. Lines represent the two sexes. Slopes of lines may vary.

Methods

In North America, the family Hydropsychidae contains 11 genera with 144 species (Wiggins 1996). I examined a total of 27 species within 10 genera, representing almost 20% of the described North American species (Appendix B).

Species were randomly chosen (within the constraints of availability) within genera in proportion to the number of species each contained. I chose one or two species from each of the seven genera that have relatively few species (between one and seven). The other three genera, *Cheumatopsyche*, *Ceratopsyche*, and *Hydropsyche* have 109 species combined, and represent 76% of the total North American species (Wiggins 1996). Of the 27 species examined, 16 were from these genera (60%). Specimens were borrowed from various museums and collections in the United States and Canada (Appendix B).

Body length was used as an estimator of overall body size. Body length (BL) was measured from the center of the head between the eyes to the posterior margin of the 8th sternite to exclude genitalia. Body length was measured along the organism's left side. In addition, I measured the following morphological characters on each individual: wing length (WL), wing width (WW), antennal length (AL), ocular width (EW), mesotibial length (MTL) and width (MTW). I measured WL as a straight line from the base to the apex of the fore wing. I measured WW as a straight line at the widest point on the fore wing, perpendicular to WL. Antennal length was measured from the base of the scape to the antennal tip. The apical antennal segment has a distinctive shape, and antennae were not measured if this segment was missing. I measured the straight line distance between the outer edge of the eye and where the eye joined the head when the specimen was viewed dorsally. Both eyes were measured and EW was the average of the two values. I measured MTL from the femur-tibia joint to the tibia- tarsus joint on the mesothoracic leg. I measured the width of the tibia of the mesothoracic leg just dorsal to the 1st pair of tibial spurs and just dorsal to the 2nd pair of tibial spurs. The two measurements were averaged together to obtain MTW.

Whenever possible, I measured 20 individuals of each sex, limited occasionally by damaged specimens and availability (Appendix B). With two exceptions (*Diplectrona modesta, Leptonema albovirens*), only specimens that could be scored for all characters were used.

All measurements and sex determinations were made with a zoom stereoscopic microscope (Leica MZ6; BL, BW, WL, WW, AL mag.=8x; EW, MTL, MTW mag.= 12.5x) with a high powered fiber-optic light source (Volpi Cold Light Source NCL 150). Length and width measurements were made using an ocular micrometer (Leica) calibrated with a 5.000 mm stage micrometer (Leica).

Each character was regressed against BL. The relationship between a morphological character and body size can be described by an allometric equation of the form:

$$Y=\alpha X^{\beta}$$

where X is a measure of body size, and Y is the structure of interest. The natural log yields:

$$\ln Y = \ln \alpha + \beta \ln X,$$

where α is a constant and represents the y-intercept when $X = 0$, and β is the slope of the line. Differences between the sexes in the slopes and intercepts suggests sexual dimorphism in the structure. The regression equations were solved simultaneously for both males and females using analysis of covariance and the slopes and intercepts were compared. Since the equations for each sex were solved simultaneously, there is only one r^2 value for each character-species regression. Regression statistics were obtained from SAS version 7.0 for Windows®, using Ordinary Least Squares (OLS) regression on natural log transformed data (SAS Institute 1998).

For each character, each species was categorized based on three criteria: visual inspection of the graphs, the p-value for the scaling relationship for each sex (i.e. does character size change systematically with body size, slope of line $p \leq 0.05$), and the p-value for the differences in slopes, intercepts or both between the sexes ($p \leq 0.05$). In other words, character size, body size, the scaling relationship, and the positions of the lines were all taken into account when placing a species into one of the two categories in Figure 3.1. The first category, *sexual dimorphism*, occurs when either slopes, intercepts, or both differ between the sexes (Figure 3.1A). In this case, species are clearly sexually dimorphic for the character. *Size-mediated sexual dimorphism*, the second category, occurred when one sex had a larger body size and a larger character size than the other and I detected no differences in the scaling relationships (slopes) between the sexes (Figure 3.1B). In this case, it is not clear if the sexual dimorphism is a result of selection on the character, or simply selection on body size producing a correlated increase in character size. In the absence of other information, I assume that, because of correlations between size and morphology, the sexual dimorphism is caused by the size differences. Therefore, the term size-mediated sexual dimorphism is coined. Any species not conforming to either of the above categories was not included in the results or discussion.

Results

Of the 27 species examined, 13 different species (48%) exhibited clear sexual dimorphism for at least one character (Table 3.1). Of those 13 species, five species (*Ch. gracilis*, *Ce. alternans*, *Ce. morosa*, *H. scalaris*, *M. zebratum*) were sexually dimorphic for more than one character, with *M. zebratum* sexually dimorphic for four of the six characters studied. The other four species were all sexually dimorphic for only two of the six characters. Seven other species (*A. grandis*, *A. irrorata*, *Pa. elsis*, *D. modesta*, *Ch. harwoodi*, *Ch. minuscula*, *S. dispar*) exhibited size mediated sexual dimorphism. Four of these species (*A. grandis*, *A. irrorata*, *Pa. elsis*, *D. modesta*) exhibited size-mediated dimorphism in three or four of the six characters examined. In all other species examined, there was no sexual dimorphism.

Wing Length

There were four species that exhibited true sexual dimorphism for WL (Figure 3.2). In *Ce. alternans*, *H. betteni*, and *H. elissoma*, the female WL was greater than the males (slopes and intercepts $p<0.05$; Table 3.1; Figure 3.3). In contrast, *M. zebratum* male WL was greater than females (slope and intercept $p\leq0.05$; Table 3.1; Figure 3.3).

Table 3.1 Regression statistics for species and characters that were sexually dimorphic. Values are for intercepts and slopes for each sex and species. int = intercept, slp = slope. | = the two values (above and below) are not significantly different (p<0.05).

Subfamily	**S**	**Wing**		**Wing**		**Antennal**		**Mesotibial**		**Mesotibial**	
Genus	**e**	**Length**		**Width**		**Length**		**Length**		**Width**	
species	**x**	int	slp	int	slp	int	slp	int	slp	int	slp
Hydropsychinae											
Cheumatopsyche	M					1.8	|.21	-.11	.29		
gracilis	F					.95	|.64	-1.1	.85		
Ceratopsyche	M	2.1	.04			1.9	.16				
alternans	F	.98	.65			.76	.69				
Ceratopsyche	M					2.5	-.09				
cockerelli	F					1.6	.27				
Ceratopsyche	M			.002	.51			.04	.32		
morosa	F			.91	.008			-.63	.65		
Ceratopsyche	M									-1.1	-.20
oslari	F									-2.3	.55
Ceratopsyche	M					1.6	|.36				
sparna	F					.64	|.80				
Hydropsyche	M	1.1	.53								
betteni	F	2.9	-.23								
Hydropsyche	M							.25	.15		
confusa	F							-.42	.53		
Hydropsyche	M	1.0	.60								
elissoma	F	1.9	.16								
Hydropsyche	M					3.7	-.48			-3.1	.78
scalaris	F					1.2	.55			-.33	-.38
Macronematinae											
Macrostemum	M									-.64	-.35
carolina	F									-2.0	.50
Macrostemum	M	2.0	.31	.84	.23	3.0	|.35	.18	.42		
zebratum	F	1.0	.65	-.37	.72	1.6	|.53	-1.0	.84		
Leptonema	M									-7.1	2.6
albovirens	F									-.99	-.07

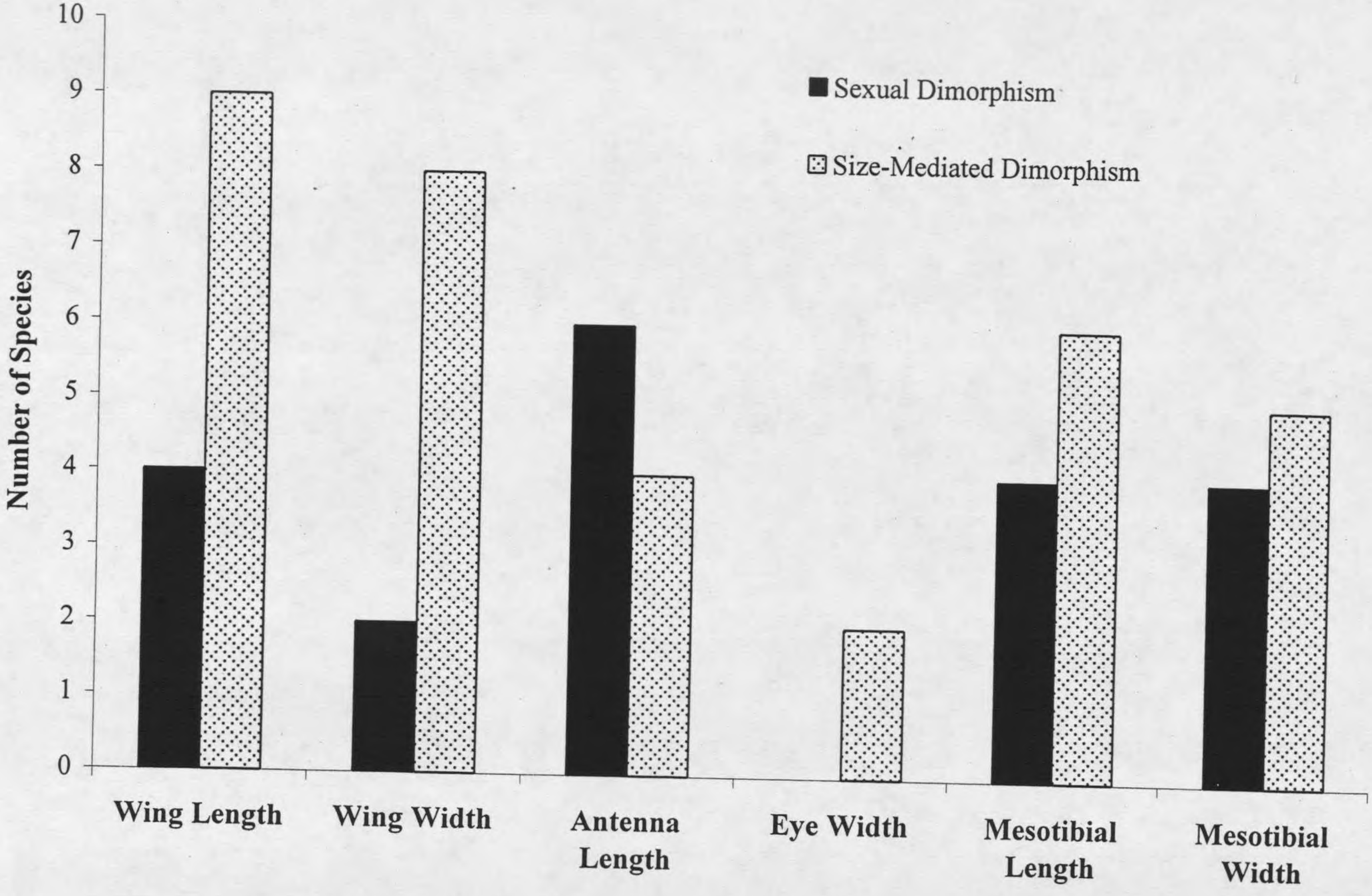


Figure 3.2 Number of species that exhibited sexual dimorphism for allometric relationships for each character. See text for description of relationships.

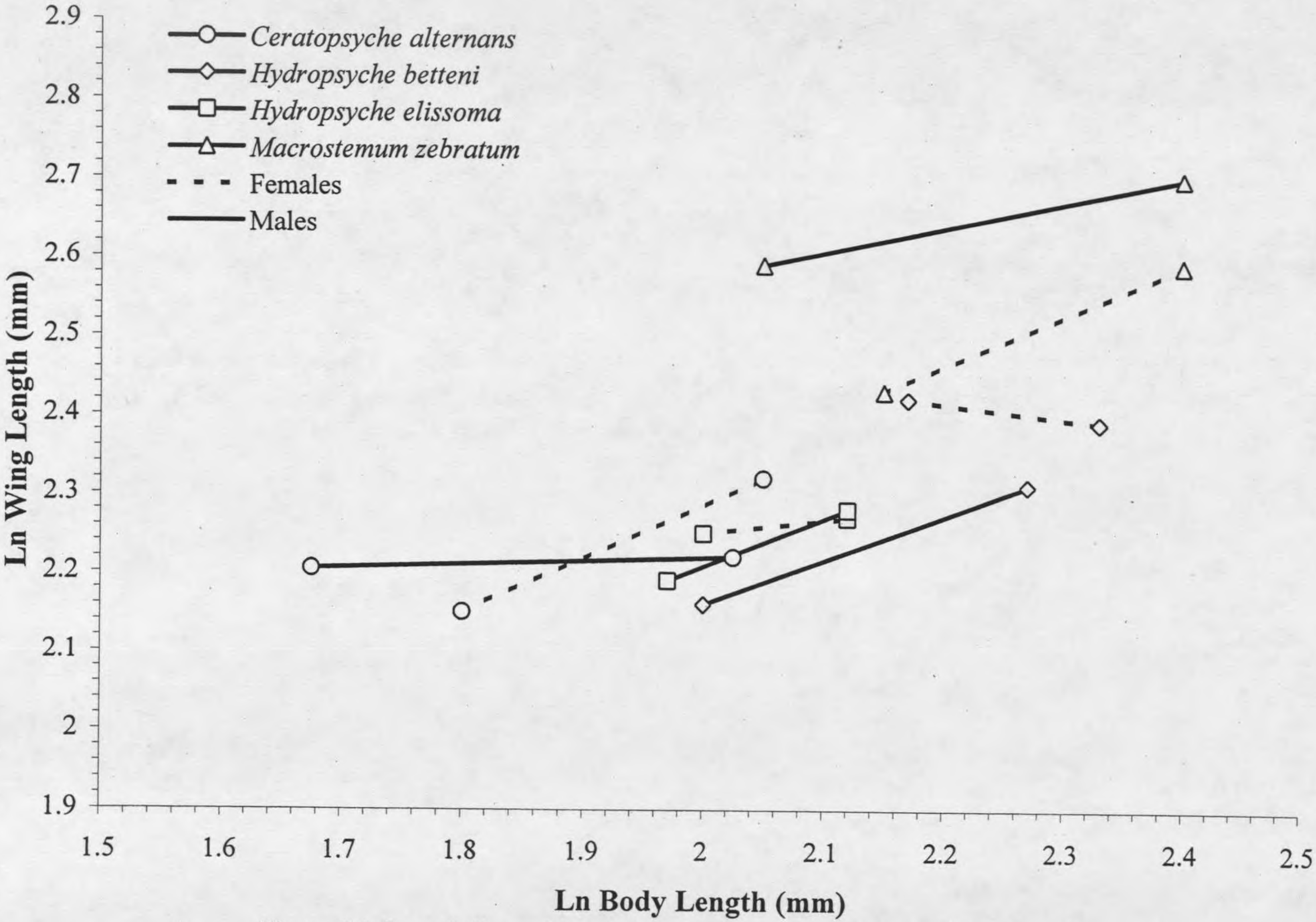


Figure 3.3 Sexual dimorphism in wing length as a function of body length. Males are solid lines, females are dashed lines.

In nine other species (*A. grandis*, *A. irrorata*, *Pa. elsis*, *D. modesta*, *Ch. minuscula*, *Ce. oslari*, *H. confusa*, *S. dispar*, *L. albovirens*), females had longer wings than males. However, females had larger bodies than males and both sexes followed similar scaling relationships (♂ intercept range: 0.46 to 2.3, slope range: 0.14 to 0.96; ♀ intercept range: 0.71 to 2.2, slope range: 0.31 to 0.88; slopes and intercepts, $p>0.05$). Wing dimorphism cannot be separated from body size dimorphism in these nine species.

Wing Width

Two species were clearly sexually dimorphic for WW (Figure 3.2). *Ce. morosa* females had wider wings than males (slope and intercept, $p< 0.05$; Table 3.1; Figure 3.4), whereas *M. zebratum* males had wider wings than females (slope and intercept $p\leq0.05$; Table 3.1; Figure 3.4).

In *A. grandis*, *A. irrorata*, *Pa. elsis*, *Ch. minuscula*, *Ce. oslari*, *H. betteni*, *H. confusa*, and *L. albovirens*, females had wider wings than males. However, females had larger bodies than males and the relationship between WW and BL was similar for both sexes (♂ intercept range: -0.49 to 1.6, slope range: 0.05 to 0.93; ♀ intercept range: -0.36 to 1.9, slope range: 0.04 to 0.82; slopes and intercepts, $p>0.05$). Wing dimorphism cannot be separated from size dimorphism in these eight species.

Antennal Length

Six species (*Ch. gracilis*, *Ce. alternans*, *Ce. cockerelli*, *Ce. sparna*, *H. scalaris*, *M. zebratum*) were sexually dimorphic for antennae length. In all cases, males had longer antennae than females (slopes and intercepts $p\leq0.05$; Table 3.1; Figure 3.2, 3.5).

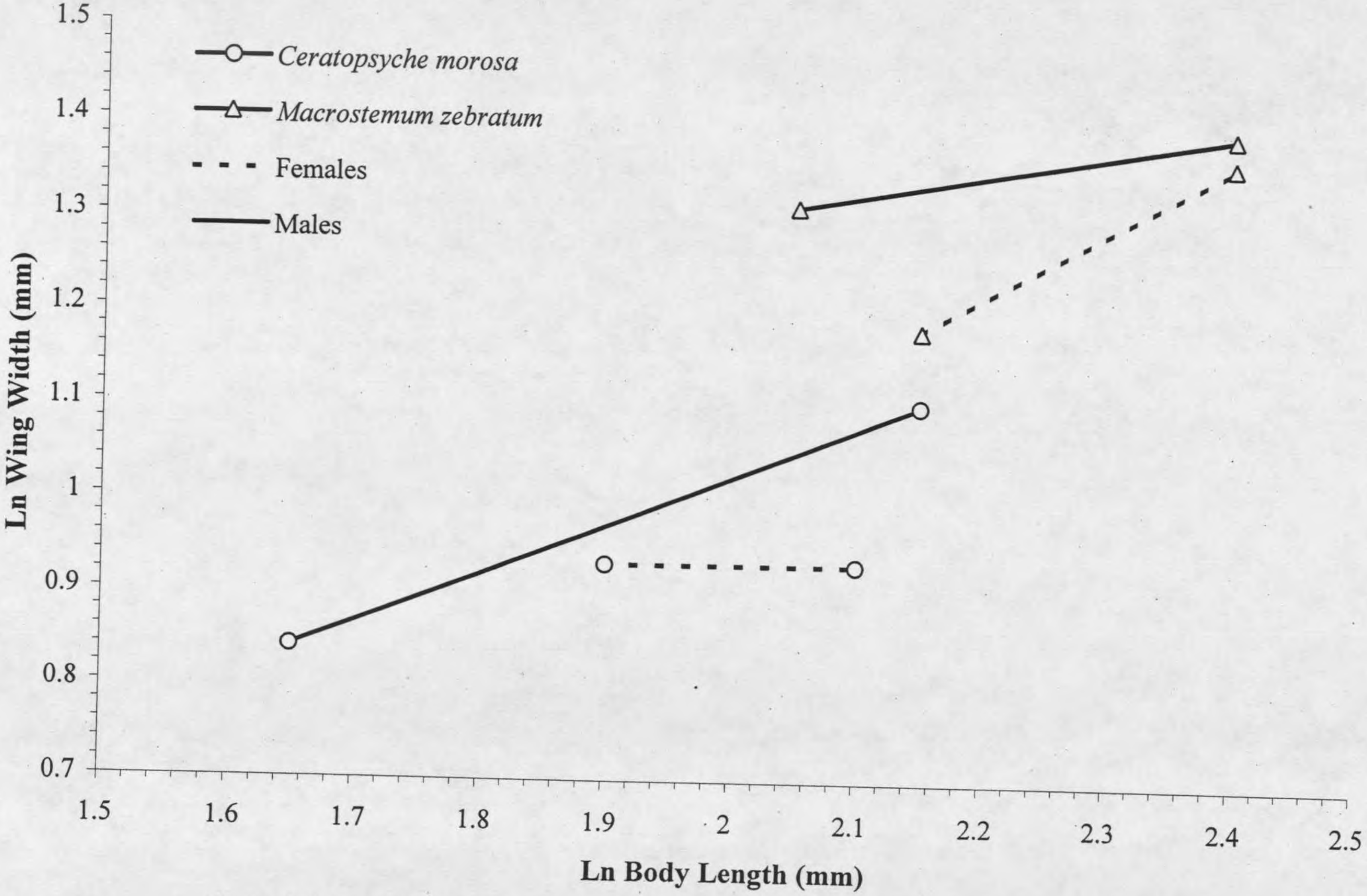


Figure 3.4 Sexual dimorphism in wing width, represented as a function of body length. Males are solid lines, females are dashed lines.

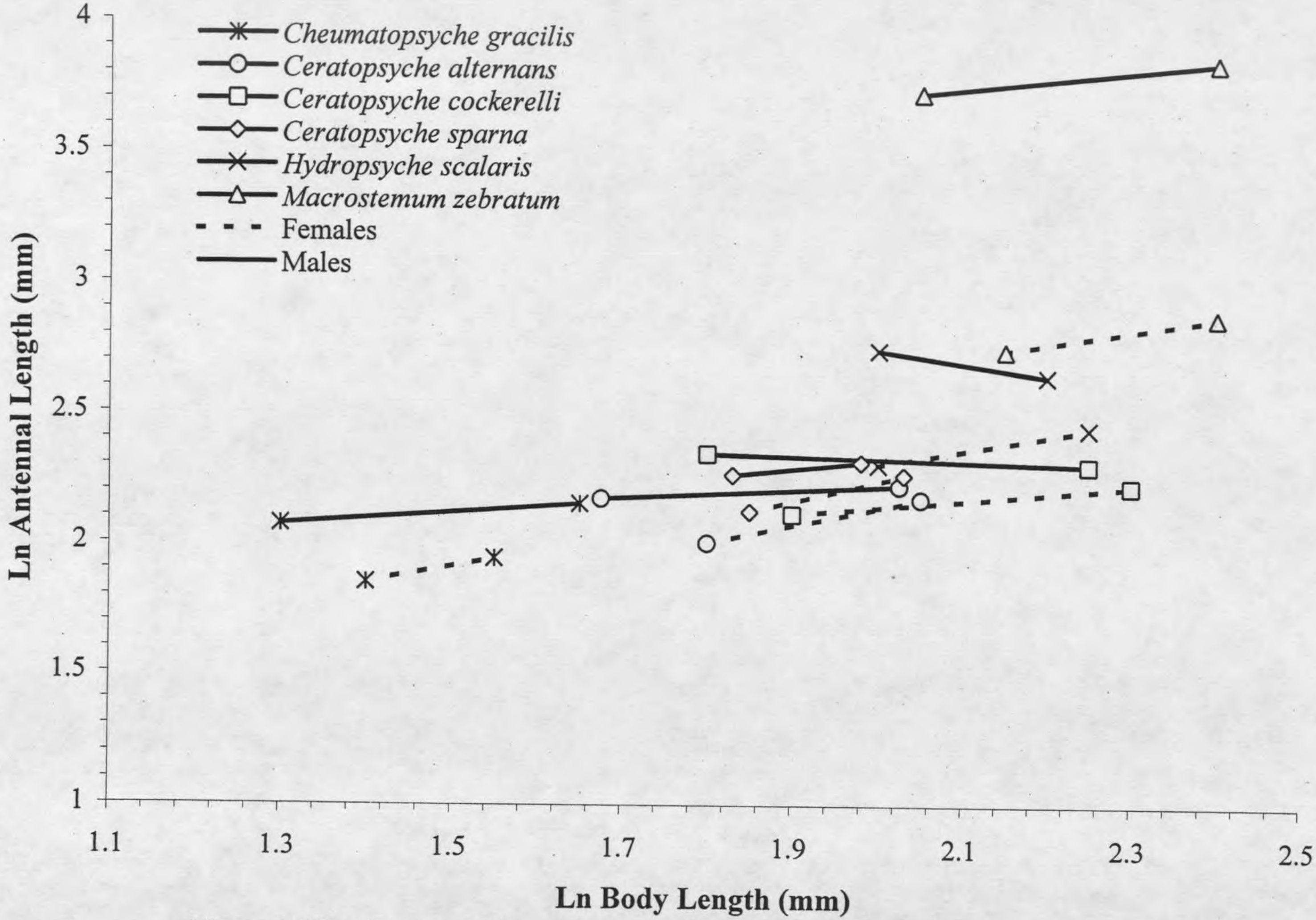


Figure 3.5 Sexual dimorphism for antennal length, represnted as a function of body length. Males are solid lines, females are dashed lines.

In four other species (*Pa. elsis*, *D. modesta*, *H. betteni*, *H. confusa*) female AL was greater than male AL. However, females had larger bodies than males and the relationship between AL and BL was the same in both sexes (♂ intercept range: 1.0 to 2.0, slope range: 0.21 to 0.54; ♀ intercept range: 1.2 to 2.8, slope range: -0.16 to 0.52; slopes and intercepts, $p>0.05$). Antennal length dimorphism cannot be separated from size dimorphism in these four species.

Eye Width

There was no true EW sexual dimorphism in any species (Figure 3.2). However, in *Ce. oslari* and *H. confusa*, EW and body length were larger in females. Both sexes had similar slopes relating EW to BL (♂ intercepts: -2.4, -1.3; slopes: 0.69, 0.14 respectively; ♀ intercepts: -2.6, -1.7; slopes 0.80, 0.35 respectively; slopes and intercepts, $p>0.05$). In these species, EW dimorphism could not be separated from size dimorphism.

Mesotibial Length

There were four species sexually dimorphic for MTL (Table 3.1; Figure 3.2). In *Ce. morosa* and *H. confusa*, females had longer middle tibiae than the males (slopes and intercepts $p\leq 0.05$; Table 3.1; Figure 3.6). In *Ch. gracilis* and *M. zebratum* males had longer middle tibiae than the females (slope and intercept or intercept only $p<0.05$; Table 3.1; Figure 3.6).

In six other species (*A. grandis*, *A. irrorata*, *Pa. elsis*, *D. modesta*, *Ch. harwoodi*, *Ce. oslari*), females had longer middle tibiae than the males, but female body size was

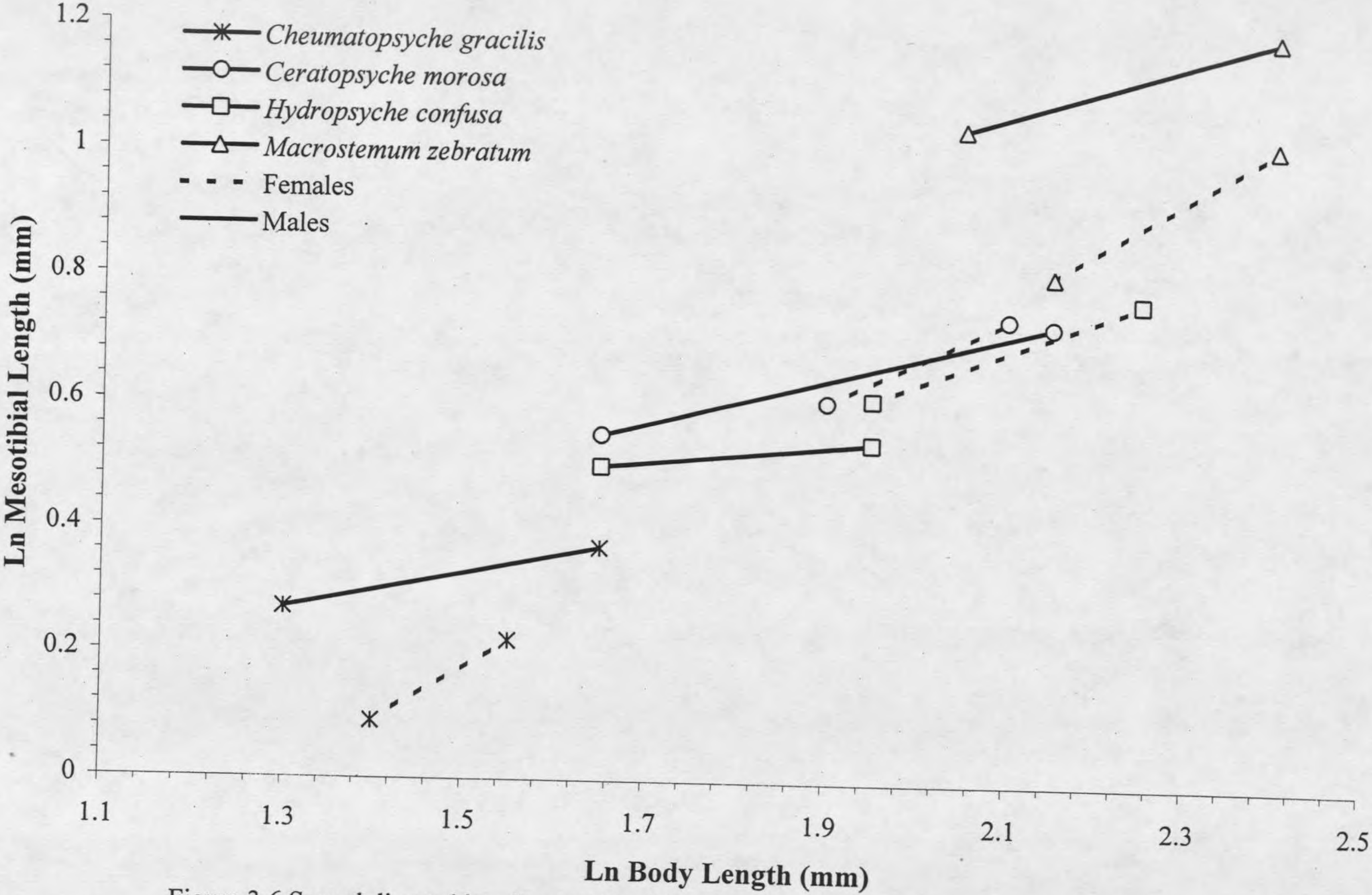


Figure 3.6 Sexual dimorphism in mesotibial length, represented as a function of body length. Males are solid lines, females are dashed lines.

also larger (♂ intercept range: -0.42 to 1.1, slope range: 0.05 to 0.59; ♀ intercept range: -0.78 to 1.5, slope range: -0.05 to 0.78; slopes and intercepts, $p>0.05$). Therefore, in these species, overall size dimorphism cannot be separated from MTL dimorphism.

Mesotibial Width

Four species were sexually dimorphic for MTW (Table 3.1; Figure 3.2). In *Ce. oslari*, *H. scalaris*, *L. albovirens*, and *M. carolina*, females had wider tibiae than males (♂ intercept range: -3.4 to -2.1, slope range: 0.36 to 0.77; ♀ intercept range: -3.3 to -1.2, slope range: -0.02 to 0.96; slopes and intercepts, $p<0.05$; Table 3.1; Figure 3.7).

A. grandis, *D. modesta*, *Ch. harwoodi*, *H. betteni*, and *H. confusa* females had wider tibiae than the males, but were also generally larger than the males (slopes and intercepts, $p>0.05$). Therefore, in these species, size dimorphism cannot be separated from MTW dimorphism.

Overall, for all species that were sexually dimorphic for WL, WW and AL, the general pattern was for females to have longer or wider wings, whereas, males had longer antennae. The exception to this pattern was *M. zebratum*, where males, in addition to having longer antennae, also had longer and wider wings than females. In all species sexually dimorphic for MTW, females had wider mesotibiae than males. However, in species where MTL was sexually dimorphic, there were two species where females had longer mesotibiae and two species where males had longer mesotibiae.

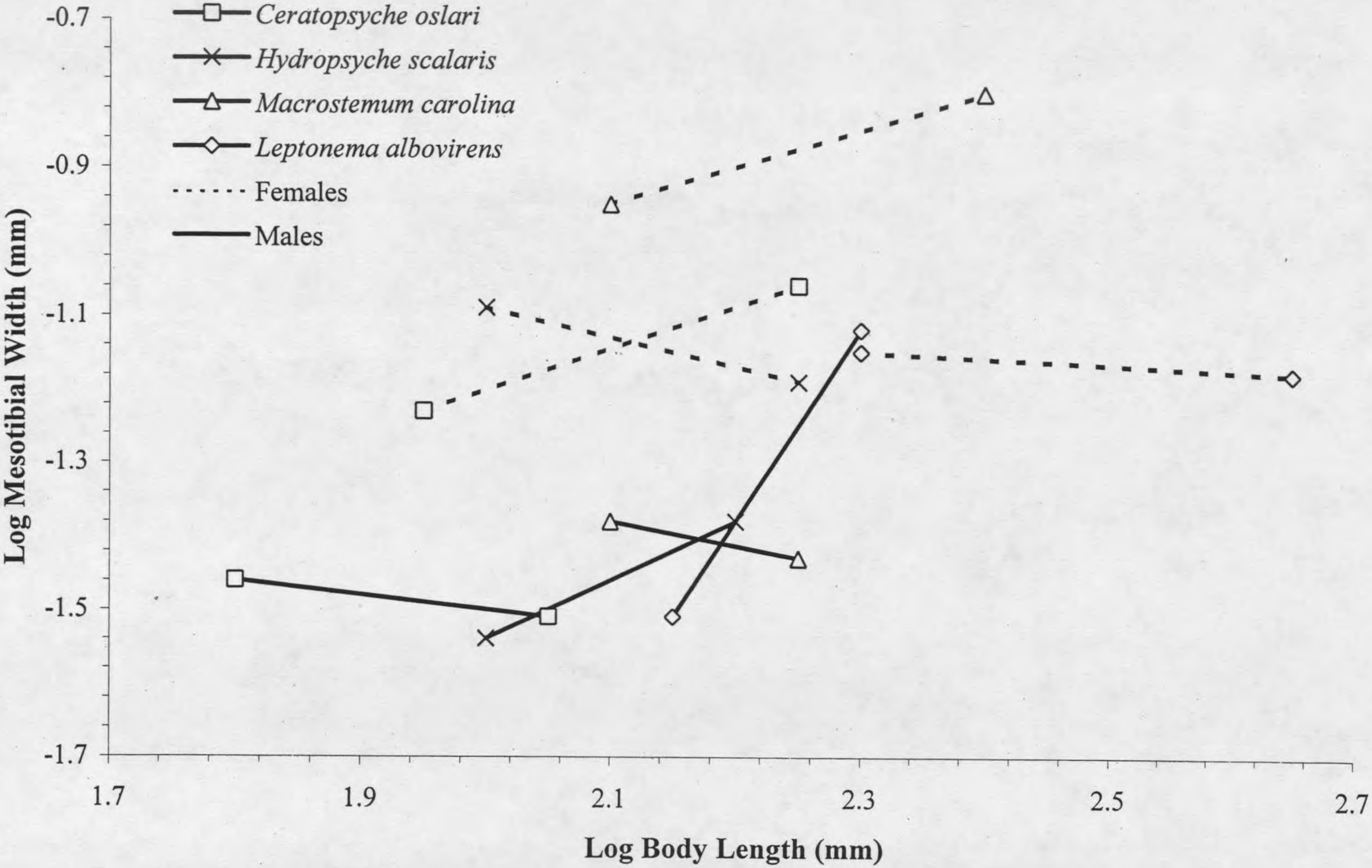


Figure 3.7 Sexual dimorphism in mesotibial width, represented as a function of body size. Males are solid lines, females are dashed lines.

Discussion

Qualitative information from the taxonomic literature suggests that species of Hydropsychidae have a wide variety of characters that are sexually dimorphic and that the patterns of dimorphism (males larger than females and vice versa) are variable among species (Betten 1934, Ross 1944). The qualitative nature of this information is such that it is often conflicting, based on small sample sizes (a few individuals from each species), does not control for body size and, more often than not, is anecdotal (Betten 1934, Ross 1944, Smith 1968, Flint 1974, 1982, 1987). This study has contributed two pieces of information to our understanding of sexual dimorphism in adult hydropsychid caddisflies of North America. First, by using allometric relationships to explicitly quantify sexual dimorphism, the confounding effects of body size have been removed and cases where males and females differ only in *character* size have been identified. Second, this study points to the variable nature of sexual dimorphism within the hydropsychids. Differences in characters and patterns of sexual dimorphism among species suggests that the reproductive biology and mating systems might also differ among species. Even though there is a considerable amount of information available about the ecology and behavior of larval hydropsychids (Wallace 1975, Alstad 1978, Mackay 1979, Miller 1984, Thorp et al. 1986, Downes and Jordan 1993, Merritt and Cummins 1995, Englund et al. 1997), much less is known about the reproductive behavior and ecology of the adults (Badcock 1953, Mori and Matubani 1953, Fremling 1960, Deutsch 1984, 1985, Lofstedt et al. 1994). These variable patterns can be used to pose testable hypotheses about adult behaviors, especially reproductive behavior and mating strategies, in adult Hydropsychidae.

The patterns of sexual dimorphism in this study were highly variable, in terms of the characters, direction (male biased vs. female biased), and species involved. This study reaffirms antennal length and mesotibial length and width as characters that are sexually dimorphic in some hydropsychids. In addition, wing length and width were added to the list of characters that are sexually dimorphic in some species of Hydropsychidae. Contrary to previous reports on eye size in hydropsychids both in the U.S. (Ross 1944) and in Europe (Malicky 1977), none of the species in this study were sexually dimorphic for eye size. Below I discuss the patterns of sexual dimorphism for each character and pose some hypotheses concerning the selective pressures that produced these dimorphisms.

Females generally had longer and wider wings than the males. There are several hypotheses that could account for larger wing size in female hydropsychids. These hypotheses could be studied independently, however, a stronger case could be made for the adaptive function of female wings if these hypotheses are examined in conjunction with each other, as alternative hypotheses.

First, fecundity selection is one hypothesis for species whose females had larger wings. The reproductive output (number of eggs) of females is often positively correlated with body size in insects (usually abdominal size) (Shine 1988, Wickman and Karlsson 1989, Honek 1993, Leather 1995). Selection on female body size to increase fecundity could produce an increase in wing size to preserve the function of carrying the female during flight. This hypothesis predicts direct correlations between wing size, body size, and fecundity.

An alternative hypothesis is that, female wing size may respond to selection on the type of flight that is important to females. For example, long, narrow fore wings, such as those seen in female *Ce. alternans*, *H. betteni*, and *H. elissoma*, are associated with rapid flight (Ross 1967). Females that must fly long distances to find oviposition sites or mates may be under selective pressure to develop longer wings for rapid, long distance flights. This hypothesis would predict that female wing size is correlated with either flight time and distance, sex ratio, or both. In contrast, Ross (1967) has suggested that wider front wings are associated with hovering flight. Hovering flight is often associated with mate searching and swarming (Svensson 1997). Some species of hydropsychid caddisflies are known to form swarms, although, these are thought to consist primarily of males (Mori and Matubani 1953, Fremling 1960). However, sex-role reversed insects have been documented (belostomatid waterbugs; Alcock and Gwynne 1991, Kight and Kruse 1992), and some females insects form swarms (Svensson and Petersson 1992, Svensson 1997, Funk and Tallamy 2000). Therefore, one hypothesis for the wider wings in female *Ce. morosa* is that they provide some advantage during swarming to attract males. This hypothesis predicts that females with wider wings have greater access to matings or resources that the male might provide. Behavioral observations of female *Ce. morosa*, coupled with studies on the relationship between wing size and frequency of mating, could be useful in determining if sex-role reversal occurs in hydropsychid caddisflies.

M. zebratum was the only species where males had longer and wider wings than the females. Sexual selection is one hypothesis for larger wings in this species (Andersson 1994, Andersson and Iwasa 1996). This hypothesis predicts that male access to females (and therefore mating opportunity) is dependent on wing size. In other insects, including other caddisflies, there is a high correlation between swarming, flight ability, and wing size in males. Males with larger wings in are more agile fliers in swarms and therefore, intercept more females during swarming leading to increased mating opportunities (Sullivan 1981, Petersson 1989, Neems et al. 1992, Gullefors and Petersson 1993, McLachlan and Neems 1995, Takamura 1999). Since swarming male hydropsychids have been documented in the literature (Mori and Matubani 1953, Fremling 1960, Sullivan 1981), it seems likely that these processes may also be operating in *M. zebratum*. If male *M. zebratum* are subject to sexual selection on wing size, then males with larger wings should have more frequent matings than males with smaller wings. Mating behavior in the North American hydropsychids is virtually unknown. *Macrostemum zebratum* is predicted to be an interesting species to examine the relationship between male swarming (if present), wing size, and sexual selection.

An alternative hypothesis for males with larger wings is that some component of male behavior, other than direct mate acquisition, is selecting for wing size. For example, large wing size may be necessary for foraging flights or flights that gather resources that are passed on to females during or prior to copulation (Boggs 1995, Karlsson 1998, Rooney and Lewis 1999). Foraging flights seem unlikely in *M. zebratum* since it is thought that most caddisflies, including hydropsychids, are relatively short lived and feed very little as adults (Hoffman , Jackson and Resh , Nozaki , Betten 1934, Ross 1944, Ross 1967, Burti et al. 1986, Merritt and Cummins 1995). However, the males of many insects, including butterflies, collect nutritionally rich resources which are then presented to the female just prior to copulation, or introduced into the reproductive tract during mating (Boggs 1995, Karlsson 1998, Rooney and Lewis 1999). Often these nuptial gifts require the adult male to go search for and collect these gifts (Boggs 1995). Although I have never seen this hypothesis suggested in the literature, it seems possible that long or complex search flights for these gifts, especially those that may require special aerial abilities (i.e. capture of flying prey) could select for larger wings in males.

In all species examined that were sexually dimorphic for antennal length, males always had longer antennae than females. One hypothesis for this is sexual selection, which predicts that males with longer antennae have access to more females or more matings (Andersson 1994, Andersson and Iwasa 1996). Since mating success is directly dependent on the ability of one sex to find the other, sexual selection should act on sensory structures, such as antennae, in the abundant sex (often males) to maximize the probability of locating the less abundant sex (often females) (Andersson 1994, Andersson and Iwasa 1996, Endler and Basolo 1998). I hypothesize that males of these species had longer antennae because: a) antennae are used to chemically detect conspecifics during mating; b) antennae are used in male-male contests for access to females; or c) females prefer to mate with males that have longer antennae (Thornhill and Alcock 1983, McLachlan and Neems 1995, Andersson and Iwasa 1996).

Male location of females prior to mating is aided in many insects, including butterflies (close relatives of caddisflies), by elaborate antennae that detect sex pheromones (Rutowski 1991, Rutowski 1997). If antennae are used by male hydropsychids to chemically detect sex pheromones, then females must produce pheromones that are attractive to males. Interestingly, in this study, *M. zebratum* males had longer antennae and both sexes had a gland on the V abdominal sternite (Jannot, unpub. data). Glands on the IV and V abdominal sternite have been suggested as sites of pheromone production in North American Hydropsychidae (Flint 1974) and are known to contain volatile compounds that elicit electrical responses in the male antennae of one European species (*H. augustipennis*) (Lofstedt et al. 1994), as well as caddisfly species from other families (Cummings 1914, Solem 1985, Solem and Petersson 1987). Longer antennae might have more sensilla and therefore be better equipped to rapidly detect pheromones produced by abdominal glands of female *M. zebratum*.

Besides *M. zebratum*, there were five other species whose males had longer antennae than the females. The females of these species did not have abdominal glands (Jannot, unpub. data). However, the “sensilla maximization” hypothesis may still be in operation in these species. Females of these species may have other, undetected pheromone production sites (Riek 1970). Pheromone production and the chemical ecology of caddisflies is in it’s infancy but studies in this field could provide valuable information about the mating behavior of these organisms.

An alternative to the “sensilla maximization” hypothesis is the hypothesis that males of these caddisfly species use their long antennae as “weapons” during male-male competition. In other insects it is known that males use their antennae during male-male competitive interactions (Hanks et al. 1996). Antennae in these species could be used in male-male competitive interactions for access to females. Alternatively, females may choose to mate with males with longer antennae because long antennae are an external signal of "good genes" (Krebs and Davies 1993, Blackenhorn et al. 1998) or of male ability to provide resources (McLain 1998). For example, in the stink bug *Nezara viridula* L., females choose males with longer antennae because antennae length is an indicator of a male's ability to transfer nutritive sperm produced by special glands in the male's reproductive tract (McLain 1998). To my knowledge, there is only one study on spermatophore production in Trichoptera. This study suggests that there is a protein mass that is transferred with the sperm during copulation and that this mass may be a nutritive contribution to the female (Khalifa 1949). Khalifa (1949) did not include hydropsychids in this study, however, males of closely related families (Polycentropodidae, Psychomyiidae) in this study delivered free sperm, not enclosed in any spermatophore. An investigation into hydropsychid spermatophore production, quality, and the relationship to external morphological characters such as antennae, could provide insight into sexual dimorphism in these species.

Females had longer mesotibiae in *Ce. morosa* and *H. confusa*, whereas male *Ch. gracilis* and *M. zebratum* had longer mesotibiae than females. One hypothesis for longer mesotibiae in these species is that one sex may use their legs to carry the other during mating flights (Gullefors and Petersson 1993). Male caddisflies of the genera and *Ceraclea* (family Leptoceridae), carry the female during copulation (Gullefors and Petersson 1993). It is unknown if these species have sexually dimorphic leg characters, however, this behavior could select for modified legs, creating sexual dimorphism. Observations of pre-copulatory behavior in *Ch. gracilis* and *M. zebratum* are necessary to shed light on MTL dimorphism.

Sexual dimorphism in leg width has been previously examined in several species of adult hydropsychid caddisflies (Deutsch 1985). This study confirms wider female tibiae in *Ce. oslari*, as reported earlier by Deutsch (1985; Table 3.3). Deutsch (1985) also reported females had larger tibiae in *A. grandis*, *Ce. cockerelli*, *Ce. morosa*, *H. occidentalis*, and *M. zebratum*, findings this study does not support. Deutsch and others have proposed that wider tibiae in females aids swimming during underwater oviposition (Badcock 1953, Deutsch 1984, Deutsch 1985). Since females always had wider tibiae than males in this study, I predict that underwater oviposition occurs in *Ce. oslari*, *H. scalaris*, *L. albovirens* and *M. carolina.* Direct observation is necessary to confirm underwater oviposition in these species.

In conclusion, the patterns of sexual dimorphism in caddisflies of the family Hydropsychidae appear to be consistent with patterns of sexual dimorphism in other caddisflies that have been previously examined (i.e. Leptoceridae; Petersson 1989, Gullefors and Petersson 1993) as well as other insects such as Lepidoptera (Rutowski 1991, Rutowski 1997), Coleoptera (Goldsmith et al. 1996, Hanks et al. 1996, Kawano 2000) Hemiptera (Weigensberg and Fairbairn 1996, McLain 1998). However, a better understanding of sexual dimorphism in adult hydropsychid caddisflies will only be possible when behavioral observations and experiments are undertaken. Information on swarming, mate locating, mate choice, pre-copulatory behavior, male-male competition, and oviposition behavior will provide a clearer understanding of the mechanisms that shape patterns of sexual dimorphism in this family. The adult portion of the life cycle in most aquatic insects has been severely neglected in most studies (dragonflies are the exception). An understanding of the role of aquatic insects in ecosystem function and the connections between aquatic and terrestrial systems cannot be attained until the adult stages are better understood. Since adult aquatic insects spend the majority of their time dispersing, in reproductive activity, and ovipositing (Merritt and Cummins 1995), it seems that an understanding of reproductive behavior is critical to achieving a better understanding of aquatic systems. The information in this study and the hypotheses presented above provide a jumping off point for such investigations.

Literature Cited

Alcock, J. 1993. The effects of male body size on territorial and mating success in the landmark-defending fly *Hermetia comstocki* (Stratiomyidae). *Ecological Entomology*, 18:1-6.

Alcock, J. and D. T. Gwynne. 1991. Evolution of insect mating systems: The impact of individual selectionist thinking. In W. J. Bailey and J. Ridsdill-Smith (eds.), *Reproductive Behavior of Insects: Individuals and Populations*, pp. 10-41. Chapman Hall, New York.

Alstad, D. N. 1978. Distributional and community ecology of filtering caddisflies (Trichoptera: Hydropsychidae). Dissertation thesis, University of Utah, Salt Lake City.

Andersen, N. M. 1994. The evolution of sexual size dimorphism and mating systems in water striders (Hemiptera: Gerridae) : A phylogenetic approach. *Ecoscience*, 1:208-214.

Andersen, N. M. 1997. A phylogenetic analysis of the evolution of sexual dimorphism and mating systems in water striders (Hemiptera: Gerridae). *Biological Journal of the Linnean Society*, 61:345-368.

Andersson, M. 1994. *Sexual Selection.* Princeton University Press, Princeton NJ.

Andersson, M. and Y. Iwasa . 1996. Sexual selection. *Trends in Ecology and Evolution*, 11:53-58.

Badcock, R. 1953. Observations of the oviposition underwater of the aerial insect *Hydropsyche augustipennis* (Curtis) (Trichoptera). *Hydrobiologia*, 5:222-225.

Bailey, W. J. and H. Romer. 1991. Sexual differences in auditory sensitivity: Mismatch of hearing threshold and call frequency in a Tettigoniid (Orthoptera, Tettigoniidae: Zaprochilinae). *Journal of Comparative Physiology*, 169:349-353.

Betten, C. 1934. The caddisflies of New York. *New York Museum Bulletin*, 292:1-576.

Bjorklund, M. 1990. A phylogenetic interpretation of sexual dimorphism in body size and ornament in relation to mating system in birds. *Journal of Evolutionary Biology*, 3:171-183.

Blackenhorn, W. U., T. Reusch and C. Muhlhauser. 1998. Fluctuating asymmetry, body size and sexual selection in the dung fly *Sepsis cynipsea*- Testing the Good Genes assumptions and predictions. *Journal of Evolutionary Biology*, 11:735-753.

Boggs, C. L. 1995. Male nuptial gifts: Phenotypic consequences and evolutionary implications. In S. R. a. J. H. Leather (ed.), *Insect Reproduction*, pp. 215-242. CRC Press, Boca Raton, FL.

Burti, E. T., R. J. O. Perry and A. J. McLachlan. 1986. Feeding and sexual dimorphism in adult midges (Diptera: Chironomidae). *Holarctic Ecology*, 9:27-32.

Calder, W. A. I. 1984. *Size, Function and Life History*. Harvard University Press, Cambridge and London.

Cummings, B. F. 1914. Scent organs in Trichoptera. *"Proceedings of the Zoological Society, London"*, 2:459-474.

Darwin, C. 1859. *The Origin of the Species by Natural Selection*. Penguin Books, Middlesex, UK.

Deutsch, W. G. 1984. Oviposition of Hydropsychidae (Trichoptera) in a large river. *Canadian Journal of Zoology*, 62:1988-1994.

Deutsch, W. G. 1985. Swimming modifications of adult female Hydropsychidae compared with other Trichoptera. *Freshwater Invertebrate Biology*, 4:35-40.

Downes, B. J. and J. Jordan. 1993. Effects of stone topography on abundance of net-building caddisfly larvae and arthropod diversity in an upland stream. *Hydrobiologia*, 252:163-174.

Endler, J. A. and A. L. Basolo. 1998. Sensory ecology receiver bias and sexual selection. *Trends in Ecology and Evolution*, 13:415-420.

Englund, G., B. Malmqvist and Y. Zhang. 1997. Using predictive models to estimate effects of flow regulation on net-spinning caddis larvae in north Swedish streams. *Freshwater Biology*, 37:687-697.

Ernst, C. H. and J. C. Wilgenbusch. 1998. Growth allometry and sexual dimorphism in the Florida box turtle. *Herpetological Journal*, 8:72-78.

Fairbairn, D. J. 1990. Factors influencing sexual size dimorphism in temperate waterstriders. *American Naturalist*, 136:61-86.

Flint, O. S. 1974. Studies of neotropical caddisflies, XVIII: The Genus *Smicridea* from North America and Central America (Trichoptera: Hydropsychidae). *Smithsonian Contributions to Zoology*, 167:1-65.

Flint, O. S., jr. and J. Bueno-Soria. 1982. Studies of neotropical caddisflies XXXII: The immature stages of *Macronema variipenne* Flint and Bueno, with the division of *Macronema* by the resurrection of *Macrostemum* (Trichoptera: Hydropsychidae). *Proceedings of the Biological Society of Washington*, 95:358-370.

Flint, O. S., J. F. McAlpine and H. H. Ross. 1987. A revision of the genus *Leptonema* Guerin (Trichoptera: Hydropsychidae: Macronematinae). *Smithsonian Contributions to Zoology*, 450:1-193.

Fremling, C. R. 1960. Biology and possible control of nuisance caddisflies of the upper Mississippi River. *Iowa State University Science and Technical Research Bulletin*, 483:856-879.

Funk, D. H. and D. W. Tallamy. 2000. Courtship role reversal and deceptive signals in the long-tailed dance fly, *Rhamphomyia longicauda*. *Animal behaviour*, 59:411.

Goldsmith, S. K., Z. Stewart, S. Adams and A. Trimble. 1996. Body size, male aggression, and male mating success in the cottonwood borer, *Plectrodera scalator* (Coleoptera: Cerambycidae). *Journal of Insect Behavior*, 9.

Gullefors, B. and E. Petersson. 1993. Sexual dimorphism in relation to swarming and pair formation patterns in Leptocerid caddisflies (Trichoptera: Leptoceridae). *Journal of Insect Behavior*, 6:563-577.

Hanks, L. M., J. G. Millar and T. D. Paine. 1996. Body size influences mating success of the eucalyptus longhorned borer (Coleoptera: Cerambycidae). *Journal of Insect Behavior*, 9:369-382.

Hedrick, A. V. and E. J. Temeles. 1989. The evolution of sexual dimorphism in animals: Hypotheses and tests. *Trends in Ecology and Evolution*, 4:136-138.

Hoffman, A. 1997. Adult feeding and reproduction in *Lasiocephala basalis* (Kol.) females (Trichoptera: Lepidostmatidae), *Proceedings of the 8th International Symposium on Trichoptera*, pp. 145-149.

Honek, A. 1993. Intraspecific variation in body size and fecundity in insects - A general relationship. *Oikos*, 66:483-492.

Jackson, J. K. and V. H. Resh. 1989. Activities and ecological roles of adult insects in the riparian zone, *Proceedings of the California riparian systems conference: protection management and restoration*, Vol. General Technical Report psw-110, pp. 342-345. Pacific Southwest Forest and Range Experimental Station, Forest Service, USDA, Berkeley, CA.

Karlsson, B. 1998. Nuptial gifts resource budgets and reproductive output in a polyandrous butterfly. *Ecology*, 79:2931-2940.

Kawano, K. 2000. Genera and allometry in the stag beetle family Lucanidae, Coleoptera. *Annals of the Entomological Society of America*, 93:198-207.

Khalifa, A. 1949. Spermatophore production in Trichoptera and some other insects. *Transactions of the Royal Entomological Society of London*, 100:449-471.

Kight, S. L. and K. C. Kruse. 1992. Factors affecting the allocation of paternal care in waterbugs. *Behavioral Ecology and Sociobiology*, 30:409-414.

Krebs, J. R. and N. B. Davies. 1993. *An Introduction to Behavioral Ecology*. Blackwell Scientific, Oxford.

Leather, S. R. 1995. Factors affecting fecundity, fertility, oviposition and larviposition in insects. In S. R. Leather and J. Hardie (eds.), *Insect Reproduction,* pp. 143-174. CRC Press, Boca Raton, FL.

Lofstedt, C., B. S. Hansson, E. Petersson, P. Valeur and A. Richards. 1994. Pheromonal secretions from glands on the 5th abdominal sternite of hydropsychid and rhyacophilid caddisflies (Trichoptera). *Journal of Chemical Ecology,* 20:153-170.

Mackay, R. J. 1979. Life history patterns of some species of *Hydropsyche* (Trichoptera: Hydropsychidae) in southern Ontario. *Canadian Journal of Zoology,* 57:963-975.

Malicky, H. 1977. The taxonomic significance of eye proportions in adult caddisflies, *Proceedings of the 2nd International Symposium on Trichoptera,* pp. 155-156.

Malmgren, J. C. and M. Thollesson. 1999. Sexual size and shape dimorphism in two species of newts, *Triturus cristatus* and *T. vulgaris* (Caudata: Salamandridae). *Journal of Zoology (London),* 249:127.

McLachlan, A. and R. Neems. 1995. Swarm-based mating systems. In S. R. Leather and J. Hardie (eds.), *Insect Reproduction,* pp. 199-213. CRC Press Inc., Boca Raton, FL.

McLain, D. K. 1993. Copes rules, sexual selection, and the loss of ecological plasticity. *Oikos,* 68:490-500.

McLain, D. K. 1998. Non-genetic benefits of mate choice: Fecundity enhancement and sexy sons. *Animal-Behaviour,* 55:1191-1201.

Merritt, R. W. and K. W. Cummins. 1995. An Introduction to the Aquatic Insects of North America, pp. 862. Kendall/Hunt Publishing Company, Dubuque, Iowa.

Miller, J. C. 1984. Competition predation and catchnet differentiation among net-spinning caddisflies (Trichoptera). *Oikos,* 43:117-120.

Moore, A. J. and P. Wilson. 1993. The evolution of sexually dimorphic earwig forceps - Social interactions among adults of the toothed earwig, *Vostox apicedentatus. Behavioral Ecology,* 4:40-48.

Mori, S. and K. Matubani. 1953. Daily swarming of some caddisfly adults and their habitat segregations. *Zoology Magazine (Tokyo),* 62:191-198.

Neems, R. M., J. Lazarus and A. J. McLachlan. 1992. Swarming behavior in male chironomid midges: A cost-benefit analysis. *Behavioral Ecology,* 3:285-290.

Nozaki, T. and T. Shimada. 1997. Nectar feeding by adults of *Nothopsyche ruficollis* (Ulmer) (Trichoptera: Limnephilidae) and its effects on their reproduction, *Proceedings of the 8th International Symposium on Trichoptera*, pp. 379-386.

Owen-Smith, N. 1993. Comparative mortality rates of male and female kudus - The costs of sexual size dimorphism. *Journal of Animal Ecology*, 62:428-440.

Petersson, E. 1989. Mating in swarming caddisflies (Trichoptera: Leptoceridae). Dissertation thesis, Acta Universitatis Upsaliensis, Uppsala.

Poulin, R. 1997. Covariation of sexual size dimorphism and adult sex ratio in parasitic nematodes. *Biological Journal of the Linnean Society*, 62:567-580.

Preziosi, R. F. and D. J. Fairbairn. 1996. Sexual size dimorphism and selection in the wild waterstrider *Aquarius remigis*: Body size, components of body size, and male mating success. *Journal of Evolutionary Biology*, 9:317-336.

Radhika, M., A. K. A. Nazar and K. Nellaiappan. 1998. Sex-linked differences in phenol oxidase in the fairy shrimp *Streptocephalus dichotomus* Baird and their possible role (Crustacea: Anostraca). *Hydrobiologia*, 377:161-164.

Reiss, M. J. 1989. *The Allometry of Growth and Reproduction.* Cambridge University Press, Cambridge.

Riek, E. F. 1970. Trichoptera, *The Insects of Australia.* C.I.S.R.O., pp. 1029. Melbourne University Press, Canberra.

Roelke, D. L. and S. M. Sogard. 1993. Gender-based differences in habitat selection and activity level in the northern pipefish (*Syngnathus fuscus*). *Copeia*, 2:528-532.

Roff, D. A. and D. J. Fairbairn. 1993. The evolution of alternate morphologies: Fitness and wing morphology in male sand crickets. *Evolution*, 47:1572-1584.

Rooney, J. and S. M. Lewis. 1999. Differential allocation of male-derived nutrients in two lampyrid beetles with contrasting life-histories. *Behavioral Ecology*, 10:97-104.

Ross, H. H. 1944. The caddis flies, or Trichoptera, of Illinois. *Bulletin of the Illinois Natural History Survey*, 23:1-326.

Ross, H. H. 1967. The evolution and past dispersal of the Trichoptera. *Annual Review of Entomology*, 12:169-206.

Rutowski, R. L. 1991. The evolution of mate-locating behavior in butterflies. *American Naturalist*, 138:1121-1139.

Rutowski, R. L. 1997. Sexual dimorphism, mating and ecology in butterflies. In J. C. Choe and B. J. Crespi (eds.), *Evolution of Mating Systems in Insects and Arachnids*. Cambridge University Press.

Shine, R. 1988. The evolution of large body size in females: A critique of Darwin's Fecundity Advantage Model. *American Naturalist*, 131:124-131.

Shine, R. 1989. Ecological causes for the evolution of sexual dimorphism: A review of the evidence. *Quarterly Review of Biology*, 64:419-461.

Shuster, S. M. 1992. The reproductive behavior of alpha, beta and gamma male morphs in *Paracerceis sculpta*, a marine isopod crustacean. *Behavior*, 121:231-258.

Slatkin, M. 1984. Ecological causes of sexual dimorphism. *Evolution*, 38:622-630.

Smith, S. D. 1968. The Arctopsychinae of Idaho (Trichoptera: Hydropsychidae). *Pan Pacific Entomologist*, 44:102-112.

Solem, J. O. 1976. Studies on the behavior of adults of *Phryganea bipunctata* and *Agrypnia obsoleta* (Trichoptera). *Norwegian Journal of Entomology*, 23:23-28.

Solem, J. O. 1985. Female sex pheromones in *Rhyacophila nublia* (Zetterstedt) (Trichoptera: Rhyacophilidae) and arrival pattern to sticky traps. *Fauna norvegica, Series B*, 32:80-82.

Solem, J. O. and E. Petersson. 1987. Demonstration of female sex pheromones and adult behavior in *Molanna angustata* (Trichoptera). *Entomologica generalis*, 12:115-118.

Solem, J. O. and T. Solem. 1991. Mate location and pre-mating behaviour in *Apatania fimbriata* Pictet (Trichoptera, Limnephilidae). *Aquatic Insects*, 13:1-8.

St. Clair, R. C. 1998. Patterns of growth and sexual size dimorphism in two species of box turtles with environmental sex determination. *Oecologia*, 115:501-507.

Sullivan, R. T. 1981. Insect swarming and mating. *Florida Entomologist*, 64:44-65.

Svensson, B. G. 1997. Swarming behavior sexual dimorphism and female reproductive status in the sex-role reversed dance-fly species *Rhamphomyia marginata*. *Journal of Insect Behavior*, 10:783-804.

Svensson, B. G. and E. Petersson. 1992. Why insects swarm: Testing the models for lek mating systems on swarming *Emphis borealis* females. *Behavioral Ecology and Sociobiology*, 31:253-261.

Takamura, K. 1999. Wing length and asymmetry of male *Tokunagayusurika akamusi* chironomid midges using alternative mating tactics. *Behavioral Ecology*, 10:498-503.

Thornhill, R. and J. Alcock. 1983. *The Evolution of Insect Mating Systems*. Harvard University Press, Cambridge, MA.

Thorp, J. H., J. B. Wallace and T. J. Georgian . 1986. Untangling the web of caddisfly evolution and distribution. *Oikos*, 47:253-256.

Tseng, M. and L. Rowe. 1999. Sexual dimorphism and allometry in the giant water strider *Gigantometra gigas*: *Canadian Journal of Zoology*, 77:923-929.

Wallace, J. B. 1975. Food partitioning in net-spinning Trichoptera larvae *Hydropsyche venularis*, *Cheumatopsyche etrona*, and *Macronema zebratum* (Hydropsychidae). *Annals of the Entomological Society of America*, 68:463-472.

Weigensberg, I. and D. J. Fairbairn. 1996. The sexual arms race and phenotypic correlates of mating success in the water strider, *Aquarius remigis*. *J. Insect behavior*, 9:307-319.

Wickman, P.-O. and B. Karlsson. 1989. Abdomen size, body size and the reproductive effort of insects. *Oikos*, 56:209-214.

Wiggins, G. B. 1996. *Larvae of the North American Caddisfly Genera (Trichoptera)*. 2nd ed. University of Toronto Press, Toronto and Buffalo.

SUMMARY

Body size and shape impacts biological processes--from metabolic rates to the outcome of interspecific interactions. At least since Darwin, researchers have noticed that males and females of a single species can be different sizes or shapes. These morphological differences are called sexual dimorphism, or, in the case of body size, sexual size dimorphism (SSD). Sexual dimorphism often reflects mating and reproductive behaviors. Anecdotal reports of adult hydropsychid caddisflies (Hydropsychidae: Trichoptera) indicate some species may be sexually dimorphic. Reports indicate sexual dimorphism in a variety of characters and that species show wide variability in patterns (females larger; males larger; no dimorphism). However, sexual dimorphism has not been quantified within the Hydropsychidae. I used the comparative method to examine how phylogenetic constraints and allometry influence body size, SSD, and sexual dimorphism in the adults of 29 species of Hydropsychidae and 12 species of closely related families (outgroups). I examined the distribution of body size and SSD, and the correlation between these two variables (Rensch's rule) within the Hydropsychidae and among the outgroups. I also used allometry to quantify sexual dimorphism in seven morphological characters: wing length and width; antennal length; eye width; and mesotibial length and width. Relatively closely related genera had very different body sizes suggesting that body size among genera was not constrained by phylogenetic history. However, SSD did not vary among genera and may have been constrained. Most of the variation in SSD was attributable to differences among species

within genera (nested ANOVA, 41%) and among families within the suborder Annulipalpia (59%), indicating that SSD was not constrained among these groups. There was no correlation between SSD and body size within the hydropsychids. Among the outgroups, SSD declined with increasing body size. Allometric regressions revealed that, in general, females had longer or wider wings, and wider mesotibiae, whereas, males had longer antennae. The exception to this pattern was *M. zebratum*, where males had longer and wider wings than females. These results support currently accepted hypotheses about the evolution of the Hydropsychidae and can be used to develop testable hypotheses about selective pressures operating on adult hydropsychids.

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Dipseudopsidae		*Phylocentropus*	*lucidus*	5.56	6.79	1.98	6.92	0.20	1.95	0.16	F	MA
		Phylocentropus	*lucidus*	5.68	7.41	2.59	7.53	0.27	1.95	0.16	F	VA
		Phylocentropus	*lucidus*	5.19	6.55	2.22	6.79	0.22	1.72	0.10	F	VA
		Phylocentropus	*lucidus*	5.56	6.55	2.35	7.04	0.23	1.79	0.16	F	VA
		Phylocentropus	*lucidus*	5.43	6.05	2.22	7.16	0.23	1.79	0.16	F	VA
		Phylocentropus	*lucidus*	5.68	7.78	2.47	7.78	0.23	2.03	0.16	F	VA
		Phylocentropus	*lucidus*	5.43	8.03	2.59	7.16	0.25	1.95	0.16	F	NC
		Phylocentropus	*lucidus*	5.19	6.42	2.22	7.04	0.23	1.79	0.16	F	VA
		Phylocentropus	*lucidus*	4.20	5.56	2.10	6.79	0.27	1.56	0.14	M	NY
		Phylocentropus	*lucidus*	5.31	6.18	2.22	7.16	0.27	1.64	0.16	M	NY
		Phylocentropus	*lucidus*	4.69	6.42	2.10	6.67	0.23	1.79	0.09	M	MA
		Phylocentropus	*lucidus*	4.94	6.30	1.98	7.78	0.23	1.56	0.12	M	MA
		Phylocentropus	*lucidus*	4.82	6.79	2.22	7.04	0.23	1.79	0.16	M	MA
		Phylocentropus	*lucidus*	4.69	7.16	2.47	8.27	0.31	1.95	0.14	M	MA
		Phylocentropus	*lucidus*	4.69	6.92	2.35	7.90	0.31	1.95	0.14	M	MA
		Phylocentropus	*lucidus*	4.57	6.42	2.35	7.04	0.27	1.79	0.09	M	MA
		Phylocentropus	*lucidus*	4.94	6.79	2.47	8.40	0.34	1.95	0.14	M	VA
		Phylocentropus	*lucidus*	4.69	6.05	2.10	7.29	0.23	1.64	0.16	M	VA
		Phylocentropus	*lucidus*	4.32	6.18	2.22	7.41	0.23	1.72	0.13	M	VA
		Phylocentropus	*lucidus*	3.71	5.06	1.85	6.30	0.23	1.72	0.12	M	VA
		Phylocentropus	*lucidus*	5.43	7.78	2.84	8.89	0.31	1.95	0.14	M	NC
		Phylocentropus	*lucidus*	4.82	6.55	2.47	8.03	0.27	1.72	0.08	M	NC
		Phylocentropus	*placidus*	10.13	11.49	3.09	8.15	0.35	2.96	0.27	F	ON
		Phylocentropus	*placidus*	11.61	10.87	3.09	7.53	0.43	2.50	0.30	F	ON
		Phylocentropus	*placidus*	10.25	10.87	3.33	7.53	0.35	2.81	0.31	F	ON
		Phylocentropus	*placidus*	12.10	11.73	3.46	8.40	0.43	3.04	0.37	F	ON
		Phylocentropus	*placidus*	10.00	11.24	3.58	9.02	0.41	2.89	0.31	F	ON
		Phylocentropus	*placidus*	8.89	11.61	3.09	8.15	0.39	2.65	0.31	F	ON
		Phylocentropus	*placidus*	11.49	11.24		9.02	0.35	2.96	0.31	F	ON
		Phylocentropus	*placidus*	9.02	11.73	3.21	8.77	0.35	2.89	0.27	F	ON
		Phylocentropus	*placidus*	11.98	10.74	3.09	7.41	0.35	2.73	0.27	F	ON
		Phylocentropus	*placidus*	7.53	9.76	3.33	7.53	0.34	2.57	0.31	F	AR
		Phylocentropus	*placidus*	8.03	9.51	3.33	8.52	0.35	2.50	0.23	F	AR
		Phylocentropus	*placidus*	9.88	8.15	3.21	9.02	0.39	2.57	0.23	F	AR
		Phylocentropus	*placidus*	7.04	9.26	3.09	8.03	0.35	2.18	0.27	F	AR
		Phylocentropus	*placidus*	9.14	10.13	3.09	8.65	0.39	3.04	0.27	F	QB
		Phylocentropus	*placidus*	6.67	10.50	2.47	7.41	0.31	2.73	0.26	F	QB
		Phylocentropus	*placidus*	6.42	9.26	2.47	6.42	0.34	2.50	0.22	F	QB
Dipseudopsidae		*Phylocentropus*	*placidus*	8.27	11.73	3.46	8.89	0.39	2.73	0.31	F	VA
		Phylocentropus	*placidus*	6.92	9.63	2.47	7.41	0.35	2.65	0.23	F	OH
		Phylocentropus	*placidus*	7.04	8.77	2.47	7.41	0.31	2.42	0.23	F	OH
		Phylocentropus	*placidus*	5.80	8.40	2.72	10.87	0.31	2.34	0.20	M	ON

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Phylocentropus	*placidus*	5.80	8.03	2.72	10.87	0.31	2.34	0.18	M	ON
		Phylocentropus	*placidus*	6.42	8.77	2.96	11.73	0.39	2.34	0.23	M	ON
		Phylocentropus	*placidus*	6.79	8.65	2.96	10.50	0.35	2.42	0.20	M	ON
		Phylocentropus	*placidus*	6.18	8.40	2.59	10.37	0.31	2.26	0.16	M	ON
		Phylocentropus	*placidus*	6.18	8.40	2.59	9.76	0.35	2.18	0.16	M	ON
		Phylocentropus	*placidus*	7.16	9.63	2.96	10.87	0.35	2.65	0.23	M	ON
		Phylocentropus	*placidus*	7.04	8.89	2.72	9.76	0.31	2.57	0.16	M	ON
		Phylocentropus	*placidus*	7.41	9.76	2.72	10.25	0.39			M	ON
		Phylocentropus	*placidus*	6.42	9.14	2.59	10.50	0.39	2.50	0.16	M	ON
		Phylocentropus	*placidus*	5.80	7.66	2.59	8.77	0.35	2.26	0.18	M	ON
		Phylocentropus	*placidus*	5.93	7.41	2.47	8.89	0.31	2.26	0.18	M	ON
		Phylocentropus	*placidus*	6.55	7.53	2.35	8.89	0.39	1.95	0.23	M	ON
		Phylocentropus	*placidus*	5.43	6.42	2.47	9.14	0.39	1.95	0.16	M	AR
		Phylocentropus	*placidus*	6.18	9.02	2.59	9.51	0.31	2.50	0.23	M	QB
		Phylocentropus	*placidus*	6.05	7.90	2.22	8.89	0.35	2.89	0.16	M	QB
		Phylocentropus	*placidus*	5.80	7.29	2.22	7.53	0.35	2.34	0.16	M	QB
		Phylocentropus	*placidus*	6.55	9.26	2.35	8.03	0.34	2.73	0.17	M	QB
		Phylocentropus	*placidus*	6.67	9.39	2.72	10.13	0.35	2.73	0.23	M	QB
		Phylocentropus	*placidus*	6.05	8.89	2.22	10.25	0.35	2.73	0.20	M	QB
		Phylocentropus	*placidus*	6.79	8.03	2.59	10.00	0.31	2.34	0.16	M	QB
		Phylocentropus	*placidus*	6.79	7.78	2.35	8.27	0.39	2.42	0.16	M	QB
		Phylocentropus	*placidus*	5.93	8.15	2.47	9.26	0.35	2.50	0.16	M	QB
Hydropsychidae	Arctopsychinae	*Arctopsyche*	*grandis*	11.61	16.43	6.18	11.86	0.47	3.28	0.55	F	MT
		Arctopsyche	*grandis*	11.98	21.00	6.92	13.21	0.39	3.35	0.62	F	MT
		Arctopsyche	*grandis*	12.35	17.91	6.79	11.61	0.55	3.35	0.55	F	MT
		Arctopsyche	*grandis*	12.60	18.40	6.42	11.36	0.47	3.35	0.62	F	MT
		Arctopsyche	*grandis*	13.21	20.38	6.67	12.60	0.51	3.67	0.62	F	MT
		Arctopsyche	*grandis*	14.20	20.50	6.42	12.23	0.47	3.51	0.59	F	MT
		Arctopsyche	*grandis*	11.73	16.18	5.43	10.74	0.44	2.96	0.47	F	MT
		Arctopsyche	*grandis*	12.10	16.92	6.05	12.35	0.47	3.35	0.62	F	MT
		Arctopsyche	*grandis*	12.47	19.27	5.93	10.87	0.43	3.20	0.62	F	MT
		Arctopsyche	*grandis*	13.34	18.28	5.68	10.74	0.49	3.35	0.62	F	MT
		Arctopsyche	*grandis*	11.36	15.81	5.19	9.14	0.44	2.89	0.55	F	MT
		Arctopsyche	*grandis*	13.09	18.65	6.30	11.36	0.55	3.43	0.62	F	MT
Hydropsychidae	Arctopsychinae	*Arctopsyche*	*grandis*	12.35	19.27	6.42	12.47	0.51	3.28	0.70	F	MT
		Arctopsyche	*grandis*	13.34	17.78	5.93	10.25	0.39	3.04	0.66	F	MT
		Arctopsyche	*grandis*	11.98	18.77	5.80	11.61	0.55	3.28	0.55	F	MT
		Arctopsyche	*grandis*	11.86	20.01	6.79	12.97	0.55	3.28	0.62	F	MT
		Arctopsyche	*grandis*	11.61	17.41	5.68	11.86	0.47	3.20	0.55	F	MT
		Arctopsyche	*grandis*	15.44	18.53	6.18	10.74	0.47	3.35	0.70	F	MT
		Arctopsyche	*grandis*	11.98	18.65	6.79	11.98	0.47	3.12	0.55	F	MT
		Arctopsyche	*grandis*	12.35	19.76	6.30	11.73	0.43	3.43	0.70	F	MT

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Arctopsyche	*grandis*	9.88	14.20	5.19	14.20	0.51	3.12	0.31	M	MT
		Arctopsyche	*grandis*	9.14	14.33	5.56	12.97	0.55	3.12	0.23	M	MT
		Arctopsyche	*grandis*	8.15	14.33	5.43	12.35	0.51	3.20	0.27	M	MT
		Arctopsyche	*grandis*	9.02	14.08	5.06	13.09	0.59	3.20	0.26	M	MT
		Arctopsyche	*grandis*	8.40	13.09	5.06	12.60	0.51	2.81	0.26	M	MT
		Arctopsyche	*grandis*	11.98	13.71	5.19	14.94	0.47	3.28	0.35	M	MT
		Arctopsyche	*grandis*	11.49	15.93	4.94	14.94	0.55	3.82	0.31	M	MT
		Arctopsyche	*grandis*	8.03	16.06	5.56	14.94	0.59	3.35	0.31	M	MT
		Arctopsyche	*grandis*	10.37	14.45	5.68	14.82	0.51	3.28	0.27	M	MT
		Arctopsyche	*grandis*	10.50	14.57	5.43	14.20	0.51	3.35	0.31	M	MT
		Arctopsyche	*grandis*	9.39	13.21	4.94	13.09	0.39	3.04	0.29	M	MT
		Arctopsyche	*grandis*	9.14	13.83	4.69	13.21	0.39	3.12	0.23	M	MT
		Arctopsyche	*grandis*	8.40	13.34	4.94	13.83	0.47	3.04	0.31	M	MT
		Arctopsyche	*grandis*	9.39	13.96	4.94	13.96	0.51	3.04	0.27	M	MT
		Arctopsyche	*grandis*	9.88	14.20	4.94	13.59	0.55	3.35	0.27	M	MT
		Arctopsyche	*grandis*	9.51	13.83	5.56	11.86	0.51	3.04	0.27	M	MT
		Arctopsyche	*grandis*	9.51	14.57	5.31	13.34	0.55	3.12	0.35	M	MT
		Arctopsyche	*grandis*	11.24	15.44	5.56	14.82	0.55	3.20	0.26	M	MT
		Arctopsyche	*grandis*	9.02	13.96	5.31	13.59	0.59	3.12	0.23	M	MT
		Arctopsyche	*grandis*	10.13	15.07	5.93	14.57	0.45	3.67	0.30	M	MT
		Arctopsyche	*irrorata*	15.80	20.50	7.20	12.80	0.62	3.70	0.68	F	SC
		Arctopsyche	*irrorata*	13.50	20.00	7.30	13.00	0.55	3.80	0.63	F	SC
		Arctopsyche	*irrorata*	13.50	21.00	7.30	13.00	0.66	3.80	0.66	F	SC
		Arctopsyche	*irrorata*	13.70	20.50	7.10	14.20	0.45	3.80	0.62	F	SC
		Arctopsyche	*irrorata*	14.80	21.00	7.30	14.20	0.59	4.00	0.61	F	SC
		Arctopsyche	*irrorata*	15.30	22.90	7.40	14.60	0.66	3.80	0.63	F	SC
		Arctopsyche	*irrorata*	12.40	13.30	5.90	15.10	0.62	3.20	0.42	M	SC
		Arctopsyche	*irrorata*	12.00	15.60	5.40	13.80	0.66	3.20	0.37	M	SC
		Arctopsyche	*irrorata*	13.80	15.10	5.60	14.40	0.66	3.30	0.38	M	SC
		Arctopsyche	*irrorata*	12.00	13.80	5.10	13.30	0.59	2.90	0.37	M	SC
Hydropsychidae	Arctopsychinae	*Arctopsyche*	*irrorata*	12.50	15.00	5.50	14.70	0.62	3.20	0.42	M	SC
		Arctopsyche	*irrorata*	14.40	14.70	5.80	14.60	0.62	3.20	0.39	M	SC
		Arctopsyche	*irrorata*	12.80	16.00	5.80	13.70	0.66	3.20	0.45	M	SC
		Arctopsyche	*irrorata*	12.30	15.70	5.80	14.20	0.45	3.20	0.39	M	SC
		Arctopsyche	*irrorata*	12.30	14.00	5.80	14.80	0.55	3.30	0.37	M	SC
		Arctopsyche	*irrorata*	12.50	14.20	5.70	14.10	0.51	3.00	0.42	M	SC
		Arctopsyche	*irrorata*	13.50	15.60	6.00	15.70	0.41	3.60	0.47	M	SC
		Arctopsyche	*irrorata*	12.60	14.50	5.90	13.60	0.55	3.20	0.37	M	SC
		Arctopsyche	*irrorata*	11.70	15.40	6.00	14.30	0.51	3.10	0.45	M	SC
		Arctopsyche	*irrorata*	12.60	13.90	5.70	14.60	0.41	3.10	0.43	M	SC
		Arctopsyche	*irrorata*	12.20	16.00	6.00	13.70	0.55	3.20	0.42	M	SC
		Arctopsyche	*irrorata*	11.90	14.30	6.00	14.30	0.62	3.20	0.43	M	SC

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Arctopsyche	*irrorata*	12.90	17.00	6.00	15.70	0.48	3.50	0.43	M	SC
		Arctopsyche	*irrorata*	13.40	15.70	6.00	14.70	0.51	3.50	0.49	M	SC
		Arctopsyche	*irrorata*	12.00	14.70	5.60	14.30	0.66	2.90	0.41	M	SC
		Arctopsyche	*irrorata*	12.80	15.60	6.10	15.60	0.55	3.60	0.39	M	SC
Hydropsychidae	Arctopsychinae	*Parapsyche*	*elsis*	10.25	17.04	6.30	13.83	0.51	3.98	0.39	F	OR
		Parapsyche	*elsis*	11.98	18.53	6.55	14.57	0.51	4.13	0.39	F	OR
		Parapsyche	*elsis*	12.35	16.43	6.55	14.33	0.43	3.90	0.31	F	OR
		Parapsyche	*elsis*	11.98	17.91	6.18	13.34	0.43	4.13	0.39	F	OR
		Parapsyche	*elsis*	10.74	14.45	5.06	10.87	0.47	3.35	0.31	F	UT
		Parapsyche	*elsis*	12.10	17.91	5.93	12.60	0.45	4.06	0.31	F	MT
		Parapsyche	*elsis*	11.73	20.01	6.55	12.84	0.62	4.13	0.39	F	MT
		Parapsyche	*elsis*	13.34	20.13	7.04	16.18	0.43	4.13	0.31	F	OR
		Parapsyche	*elsis*	11.36	16.67	6.05	11.24	0.43	3.51	0.27	F	UT
		Parapsyche	*elsis*	11.98	18.53	6.55	15.19	0.51	4.29	0.35	F	OR
		Parapsyche	*elsis*	13.71	20.75	6.79	13.96	0.47	4.52	0.39	F	WY
		Parapsyche	*elsis*	13.71	19.88	6.79	12.84	0.51	4.21	0.39	F	WY
		Parapsyche	*elsis*	12.60	18.03	5.43	12.72	0.47	3.51	0.39	F	WY
		Parapsyche	*elsis*	11.73	18.15	6.55	13.71	0.45	3.90	0.31	F	WY
		Parapsyche	*elsis*	12.72	20.62	6.18	13.83	0.48	3.98	0.37	F	WY
		Parapsyche	*elsis*	9.88	14.20	5.06	12.35	0.51	3.28	0.27	M	MT
		Parapsyche	*elsis*	10.25	14.70	5.06	12.47	0.55	3.59	0.31	M	MT
		Parapsyche	*elsis*	10.00	14.45	4.82	12.60	0.55	3.43	0.27	M	MT
		Parapsyche	*elsis*	9.26	13.59	5.31	12.47	0.51	3.51	0.23	M	MT
		Parapsyche	*elsis*	10.13	15.07	5.19	13.09	0.51	3.51	0.31	M	MT
		Parapsyche	*elsis*	9.88	15.31	5.31	12.72	0.43	3.51	0.31	M	MT
		Parapsyche	*elsis*	9.63	14.70	5.06	11.98	0.47	3.51	0.31	M	MT
Hydropsychidae	Arctopsychinae	*Parapsyche*	*elsis*	10.00	14.45	4.94	11.73	0.55	3.51	0.31	M	MT
		Parapsyche	*elsis*	9.63	15.44	5.31	12.35	0.55	3.59	0.31	M	MT
		Parapsyche	*elsis*	9.63	15.31	5.06	13.21	0.59	3.74	0.31	M	MT
		Parapsyche	*elsis*	8.65	13.34	4.69	11.61	0.47	3.51	0.31	M	MT
		Parapsyche	*elsis*	10.00	15.44		12.97	0.55	3.67	0.31	M	MT
		Parapsyche	*elsis*	11.12	15.31	5.43	12.84	0.51	3.59	0.31	M	MT
		Parapsyche	*elsis*	9.76	15.44	5.31	12.10	0.47	3.12	0.31	M	MT
		Parapsyche	*elsis*	10.00	15.68	5.19	11.86	0.47	3.51	0.31	M	MT
		Parapsyche	*elsis*	9.26	13.83	4.69	11.98	0.51	3.35	0.31	M	MT
		Parapsyche	*elsis*	9.26	14.82	5.43	12.72	0.39	3.51	0.23	M	UT
		Parapsyche	*elsis*	9.51	14.20	4.82	12.60	0.43	3.35	0.23	M	UT
		Parapsyche	*elsis*	11.24	15.68	5.56	12.60	0.43	3.35	0.31	M	OR
		Parapsyche	*elsis*	9.39	13.71	5.19	12.72	0.55	3.28	0.31	M	UT
Hydropsychidae	Diplectroninae	*Diplectrona*	*modesta*	8.20	8.90		9.30	0.38	2.40	0.16	F	SC
		Diplectrona	*modesta*	7.10	8.60		9.70	0.45	2.30	0.16	F	SC
		Diplectrona	*modesta*	9.70	9.80		10.10	0.38	2.40	0.18	F	SC

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Diplectrona	*modesta*	8.70	8.70		8.50	0.38	2.20	0.21	F	SC
		Diplectrona	*modesta*	8.20	9.30		9.20	0.38	2.40	0.14	F	SC
		Diplectrona	*modesta*	7.60	7.90		8.20	0.38	2.20	0.16	F	SC
		Diplectrona	*modesta*	9.20	9.90		10.00	0.34	2.50	0.19	F	SC
		Diplectrona	*modesta*	9.70	9.10		9.60	0.45	2.40	0.21	F	SC
		Diplectrona	*modesta*	8.00	10.60		8.60	0.41	2.70	0.20	F	SC
		Diplectrona	*modesta*	7.90	8.00		8.50	0.38	2.20	0.16	F	SC
		Diplectrona	*modesta*	7.20	8.20		8.70	0.34	2.20	0.16	F	SC
		Diplectrona	*modesta*	7.50	8.60		8.60	0.38	2.30	0.16	F	SC
		Diplectrona	*modesta*	9.20	9.00		9.30	0.41	2.30	0.16	F	SC
		Diplectrona	*modesta*	10.00	11.70		10.00	0.38	2.50	0.21	F	SC
		Diplectrona	*modesta*	8.30	9.00		9.70	0.33	2.40	0.16	F	SC
		Diplectrona	*modesta*	8.80	10.20		10.10	0.38	2.50	0.18	F	SC
		Diplectrona	*modesta*	8.00	9.40		9.20	0.38	2.30	0.17	F	SC
		Diplectrona	*modesta*	8.70	9.90		10.10	0.34	2.60	0.17	F	SC
		Diplectrona	*modesta*	8.70	10.80		10.20	0.38	2.70	0.18	F	SC
		Diplectrona	*modesta*	7.80	8.60		7.70	0.38	2.20	0.16	F	SC
		Diplectrona	*modesta*	6.60	9.20		9.30	0.38	2.40	0.16	M	SC
		Diplectrona	*modesta*	8.00	8.10		9.30	0.48	2.30	0.16	M	SC
		Diplectrona	*modesta*	6.90	7.50		7.20	0.41	1.90	0.14	M	SC
		Diplectrona	*modesta*	6.80	7.70		7.10	0.64	2.00	0.16	M	SC
		Diplectrona	*modesta*	7.20	7.40		7.00	0.34	2.10	0.16	M	SC
Hydropsychidae	Diplectroninae	*Diplectrona*	*modesta*	7.80	8.70		9.10	0.41	2.40	0.16	M	SC
		Diplectrona	*modesta*	7.50	8.10		8.20	0.38	2.20	0.16	M	SC
		Diplectrona	*modesta*	6.50	8.30		8.80	0.38	2.30	0.16	M	SC
		Diplectrona	*modesta*	6.40	9.00		7.10	0.38	2.40	0.16	M	SC
		Diplectrona	*modesta*	7.90	9.00		9.20	0.38	2.30	0.16	M	SC
		Diplectrona	*modesta*	7.20	7.10		7.40	0.38	2.10	0.16	M	SC
		Diplectrona	*modesta*	7.30	7.70		8.50	0.41	2.20	0.16	M	SC
		Diplectrona	*modesta*	7.50	8.50		9.10	0.45	2.30	0.18	M	SC
		Diplectrona	*modesta*	8.40	9.20		9.10	0.52	2.40	0.16	M	SC
		Diplectrona	*modesta*	7.40	8.50		8.00	0.45	2.40	0.16	M	SC
		Diplectrona	*modesta*	7.20	7.20		6.80	0.45	2.10	0.13	M	SC
		Diplectrona	*modesta*	6.30	7.50		8.30	0.52	2.10	0.14	M	SC
		Diplectrona	*modesta*	7.50	8.20		8.30	0.43	2.30	0.16	M	SC
		Diplectrona	*modesta*	6.20	7.70		8.10	0.48	2.20	0.11	M	SC
		Diplectrona	*modesta*	6.50	7.00		7.20	0.41	1.80	0.16	M	SC
Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*alternans*	7.41	11.61	3.33	9.26	0.27	2.11	0.39	F	MN
		Ceratopsyche	*alternans*	6.79	9.26	2.72	7.66	0.39	1.87	0.23	F	AB
		Ceratopsyche	*alternans*	7.16	8.89	3.09	8.27	0.39	1.95	0.31	F	AB
		Ceratopsyche	*alternans*	7.29	9.51	2.96	7.53	0.35	1.87	0.23	F	AB
		Ceratopsyche	*alternans*	7.53	9.02	2.72	9.39	0.35	1.87	0.27	F	AB

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*alternans*	7.04	9.51	2.84	8.27	0.35	1.95	0.23	F	AB
		Ceratopsyche	*alternans*	5.68	7.90	2.59	6.79	0.35	1.87	0.20	F	AB
		Ceratopsyche	*alternans*	7.04	8.89	2.96	7.66	0.39	1.72	0.23	F	AB
		Ceratopsyche	*alternans*	7.29	9.51	2.72	7.90	0.39	1.87	0.27	F	AB
		Ceratopsyche	*alternans*	5.93	9.26	2.96	7.78	0.35	1.87	0.31	F	AB
		Ceratopsyche	*alternans*	6.92	9.14	2.84	8.03	0.35	1.95	0.30	F	AB
		Ceratopsyche	*alternans*	7.04	10.50	3.71	9.51	0.39	1.95	0.23	F	AB
		Ceratopsyche	*alternans*	8.03	10.50	3.33	8.65	0.39	1.95	0.31	F	AB
		Ceratopsyche	*alternans*	7.90	10.87	3.46	9.26	0.39	1.79	0.27	F	AB
		Ceratopsyche	*alternans*	6.55	9.26	2.84	8.03	0.39	1.87	0.23	F	AB
		Ceratopsyche	*alternans*	6.79	9.02	2.84	8.15	0.39	1.95	0.23	F	AB
		Ceratopsyche	*alternans*	6.79	10.99	3.33	9.02	0.35	2.11	0.31	F	NY
		Ceratopsyche	*alternans*	6.55	8.77	2.59	7.53	0.39	1.79	0.27	F	AB
		Ceratopsyche	*alternans*	6.92	9.02	2.72	8.27	0.31	1.72	0.23	F	AB
		Ceratopsyche	*alternans*	7.04	8.52	2.47	7.53	0.39	1.64	0.23	F	AB
		Ceratopsyche	*alternans*	6.18	8.89	2.84	9.02	0.35	1.72	0.23	M	ON
		Ceratopsyche	*alternans*	5.06	9.39	2.84	8.89	0.23	1.87	0.16	M	MN
		Ceratopsyche	*alternans*	5.43	9.26	2.84	9.02	0.35	1.79	0.23	M	MN
		Ceratopsyche	*alternans*	6.18	9.88	3.21	9.26	0.27	2.11	0.20	M	MN
		Ceratopsyche	*alternans*	6.18	9.76	2.72	9.14	0.31	1.87	0.20	M	MN
		Ceratopsyche	*alternans*	6.18	10.37	3.21	8.77	0.27	2.03	0.20	M	MN
		Ceratopsyche	*alternans*	6.18	8.65	2.96	8.03	0.35	2.18	0.12	M	VA
		Ceratopsyche	*alternans*	6.30	9.02	2.84	9.51	0.35	1.79	0.22	M	ON
		Ceratopsyche	*alternans*	6.42	9.63	2.72	10.00	0.35	2.03	0.20	M	NY
		Ceratopsyche	*alternans*	5.31	8.52	2.72	8.52	0.27	1.79	0.16	M	ON
		Ceratopsyche	*alternans*	7.41	9.26	3.09	9.26	0.39	1.95	0.23	M	ON
		Ceratopsyche	*alternans*	7.66	9.26	2.84	10.25	0.39	1.95	0.16	M	ON
		Ceratopsyche	*alternans*	7.78	9.02	2.72	7.78	0.35	1.87	0.22	M	ON
		Ceratopsyche	*alternans*	6.55	8.65	2.84	9.26	0.31	1.87	0.20	M	ON
		Ceratopsyche	*alternans*	6.42	9.26	2.96	9.88	0.35	1.95	0.23	M	ON
		Ceratopsyche	*alternans*	7.66	8.77	3.33	10.13	0.35	1.79	0.23	M	ON
		Ceratopsyche	*alternans*	6.67	9.02	2.72	9.39	0.35	1.87	0.23	M	ON
		Ceratopsyche	*alternans*	6.55	9.02	2.84	9.14	0.35	1.95	0.16	M	ON
		Ceratopsyche	*alternans*	5.43	8.03	2.72	8.89	0.39	1.87	0.23	M	ON
		Ceratopsyche	*alternans*	6.42	9.39	2.84	10.37	0.35	2.03	0.23	M	ON
		Ceratopsyche	*cockerelli*	9.26	12.10	3.95	9.39	0.27	2.03	0.37	F	ID
		Ceratopsyche	*cockerelli*	10.74	12.84	3.95	9.39	0.35	2.34	0.43	F	ID
		Ceratopsyche	*cockerelli*	9.14	10.87	3.21	9.02	0.27	2.03	0.39	F	MT
		Ceratopsyche	*cockerelli*	9.88	11.61	3.58	9.14	0.31	2.26	0.39	F	ID
		Ceratopsyche	*cockerelli*	9.76	11.98	3.46	9.14	0.27	2.18	0.39	F	ID
		Ceratopsyche	*cockerelli*	7.78	10.37	3.09	7.53	0.30	2.03	0.35	F	MT
		Ceratopsyche	*cockerelli*	6.92	11.12	3.46	8.40	0.31	2.26	0.35	F	MT

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*cockerelli*	7.53	10.87	3.21	8.15	0.27	2.03	0.31	F	MT
		Ceratopsyche	*cockerelli*	6.79	10.50	3.21	10.00	0.30	2.03	0.30	F	ID
		Ceratopsyche	*cockerelli*	6.67	9.39	2.72	7.41	0.31	1.79	0.27	F	MT
		Ceratopsyche	*cockerelli*	7.78	12.10	3.71	9.14	0.35	2.11	0.35	F	MT
		Ceratopsyche	*cockerelli*	6.67	10.87	2.96	7.90	0.31	2.11	0.35	F	MT
		Ceratopsyche	*cockerelli*	7.78	11.73	3.33	10.62	0.35	2.03	0.35	F	MT
		Ceratopsyche	*cockerelli*	8.52	11.12	3.21	9.14	0.35	2.03	0.35	F	MT
		Ceratopsyche	*cockerelli*	9.14	11.49	3.46	9.14	0.35	2.26	0.35	F	MT
		Ceratopsyche	*cockerelli*	5.93	10.00	2.96	10.13	0.27	1.87	0.16	M	OR
		Ceratopsyche	*cockerelli*	7.04	8.89	2.84	10.13	0.35	1.95	0.22	M	MT
		Ceratopsyche	*cockerelli*	7.04	9.88	2.84	9.88	0.27	1.95	0.23	M	MT
		Ceratopsyche	*cockerelli*	7.29	9.88	2.84	10.25	0.35	2.11	0.23	M	MT
		Ceratopsyche	*cockerelli*	7.04	10.13	3.09	10.50	0.31	1.95	0.23	M	MT
		Ceratopsyche	*cockerelli*	6.55	9.51	2.84	9.14	0.27	1.95	0.23	M	MT
		Ceratopsyche	*cockerelli*	6.55	10.13	3.09	10.37	0.35	1.87	0.27	M	MT
		Ceratopsyche	*cockerelli*	6.42	9.51	2.96	8.89	0.31	1.79	0.22	M	MT
		Ceratopsyche	*cockerelli*	6.05	9.14	2.84	8.89	0.30	1.95	0.27	M	MT
		Ceratopsyche	*cockerelli*	6.42	10.37	2.96	10.00	0.31	2.11	0.23	M	MT
		Ceratopsyche	*cockerelli*	6.18	10.00	3.09	9.88	0.27	2.03	0.23	M	MT
		Ceratopsyche	*cockerelli*	8.40	9.14	2.84	9.14	0.31	1.95	0.23	M	ID
		Ceratopsyche	*cockerelli*	9.26	10.13	3.21	10.00	0.23	1.95	0.23	M	ID
		Ceratopsyche	*cockerelli*	8.52	9.88	3.09	9.39	0.27	1.95	0.23	M	ID
		Ceratopsyche	*cockerelli*	9.02	10.50	3.21	9.26	0.31	1.87	0.23	M	ID
		Ceratopsyche	*cockerelli*	7.78	10.00	3.09	9.63	0.27	1.95	0.23	M	ID
		Ceratopsyche	*cockerelli*	9.26	11.86	3.58	8.77	0.31	2.18	0.35	M	ID
		Ceratopsyche	*cockerelli*	7.90	9.39	2.72	9.02	0.33	2.03	0.23	M	ID
		Ceratopsyche	*cockerelli*	8.77	10.00	3.09	9.51	0.31	2.03	0.23	M	ID
		Ceratopsyche	*cockerelli*	9.63	10.25	3.09	9.51	0.31	2.03	0.23	M	ID
		Ceratopsyche	*morosa*	7.66	10.13	3.09	8.65	0.35	1.95	0.23	F	CO
		Ceratopsyche	*morosa*	6.67	8.52	2.35	7.53	0.35	1.95	0.23	F	OK
		Ceratopsyche	*morosa*	8.77	10.00	3.09	7.53	0.39	2.18	0.30	F	OK
		Ceratopsyche	*morosa*	7.41	8.52	2.84	8.15	0.39	2.03	0.31	F	OK
		Ceratopsyche	*morosa*	7.53	8.77	2.72	7.29	0.35	1.87	0.31	F	OK
		Ceratopsyche	*morosa*	7.66	8.52	2.84	7.16	0.35	1.95	0.27	F	OK
		Ceratopsyche	*morosa*	7.53	8.65	2.84	7.29	0.39	1.87	0.27	F	OK
		Ceratopsyche	*morosa*	7.53	8.77	2.72	7.66	0.39	2.03	0.25	F	OK
		Ceratopsyche	*morosa*	7.29	9.02	2.59	8.27	0.35	2.03	0.25	F	OK
		Ceratopsyche	*morosa*	8.03	9.76	3.09	8.15	0.39	2.11	0.31	F	OK
		Ceratopsyche	*morosa*	7.78	9.26	3.09	8.40	0.43	2.11	0.29	F	OK
		Ceratopsyche	*morosa*	6.92	8.40	2.59	7.16	0.39	1.79	0.25	F	OK
		Ceratopsyche	*morosa*	8.77	10.00	2.96	8.27	0.39	2.18	0.27	F	OK
		Ceratopsyche	*morosa*	8.27	9.39	2.84	8.15	0.39	2.03	0.31	F	OK

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Ceratopsyche	*morosa*	8.27	9.39	2.59	8.03	0.39	2.03	0.27	F	OK
		Ceratopsyche	*morosa*	6.79	9.76	2.72	9.76	0.39	1.95	0.27	F	ON
		Ceratopsyche	*morosa*	6.79	9.63	2.84	9.02	0.39	1.72	0.27	F	ON
		Ceratopsyche	*morosa*	6.92	9.39	2.72	8.52	0.35	1.79	0.23	F	ON
		Ceratopsyche	*morosa*	7.41	8.03	2.84	7.41	0.39	1.79	0.25	F	OK
		Ceratopsyche	*morosa*	6.92	8.77	2.72	6.79	0.39	1.79	0.23	F	OK
		Ceratopsyche	*morosa*	5.31	8.03	2.59	9.02	0.35	1.72	0.16	M	CO
		Ceratopsyche	*morosa*	6.18	8.89	2.72	9.88	0.35	1.95	0.16	M	MN
		Ceratopsyche	*morosa*	5.56	8.40	2.72	9.26	0.35	1.95	0.16	M	CO
		Ceratopsyche	*morosa*	5.68	7.78	2.72	9.02	0.39	1.87	0.16	M	CO
Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*morosa*	4.94	6.30	2.10	7.66	0.31	1.64	0.16	M	CO
		Ceratopsyche	*morosa*	5.43	8.65	2.59	9.02	0.39	1.79	0.16	M	CO
		Ceratopsyche	*morosa*	5.31	9.39	2.72	9.63	0.39	1.87	0.16	M	CO
		Ceratopsyche	*morosa*	5.93	8.03	2.47	9.51	0.35	1.87	0.16	M	CO
		Ceratopsyche	*morosa*	5.68	7.90	2.72	9.14	0.31	1.95	0.16	M	CO
		Ceratopsyche	*morosa*	5.68	7.90	2.35	8.77	0.35	1.79	0.16	M	CO
		Ceratopsyche	*morosa*	5.43	7.53	2.10	8.15	0.39	1.64	0.16	M	CO
		Ceratopsyche	*morosa*	6.30	8.77	2.59	10.00	0.39	1.79	0.16	M	CO
		Ceratopsyche	*morosa*	6.67	8.52	2.72	8.77	0.35	2.03	0.16	M	CO
		Ceratopsyche	*morosa*	8.52	8.77	2.47	10.25	0.39	2.18	0.20	M	MN
		Ceratopsyche	*morosa*	9.02	8.65	2.47	10.50	0.39	2.11	0.20	M	MN
		Ceratopsyche	*morosa*	7.41	8.77	2.47	9.76	0.39	1.95	0.16	M	MN
		Ceratopsyche	*morosa*	7.78	8.15	2.35	9.39	0.39	1.95	0.16	M	MN
		Ceratopsyche	*morosa*	8.27	8.65	2.59	10.13	0.35	1.95	0.16	M	MN
		Ceratopsyche	*morosa*	8.77	8.89	2.47	10.13	0.39	2.11	0.17	M	MN
		Ceratopsyche	*morosa*	6.30	8.77	2.59	9.14	0.39	1.95	0.16	M	MN
		Ceratopsyche	*oslari*	9.63	12.84	3.71	11.73	0.43	2.65	0.31	F	AZ
		Ceratopsyche	*oslari*	6.55	10.25	3.09	9.88	0.35	2.18	0.23	F	AZ
		Ceratopsyche	*oslari*	7.78	10.25	2.84	9.14	0.35	2.26	0.31	F	CO
		Ceratopsyche	*oslari*	7.53	10.50	3.33	9.39	0.35	2.11	0.25	F	CO
		Ceratopsyche	*oslari*	8.40	11.36	3.58	10.62	0.39	2.26	0.31	F	CO
		Ceratopsyche	*oslari*	7.66	10.13	2.96	9.88	0.35	2.11	0.29	F	CO
		Ceratopsyche	*oslari*	7.66	10.62	2.96	10.00	0.35	2.18	0.31	F	CO
		Ceratopsyche	*oslari*	9.26	11.73	3.46	11.98	0.45	2.65	0.33	F	AZ
		Ceratopsyche	*oslari*	8.89	12.72	3.95	12.47	0.43	2.73	0.31	F	AZ
		Ceratopsyche	*oslari*	9.26	12.35	3.46	11.73	0.47	2.50	0.31	F	AZ
		Ceratopsyche	*oslari*	8.52	11.98	3.83	11.98	0.39	2.57	0.31	F	AZ
		Ceratopsyche	*oslari*	8.40	12.72	3.46	11.49	0.43	2.42	0.35	F	AZ
		Ceratopsyche	*oslari*	8.40	13.09	4.08	11.86	0.37	2.57	0.31	F	AZ
		Ceratopsyche	*oslari*	8.77	12.47	4.20	12.23	0.39	2.81	0.33	F	AZ
		Ceratopsyche	*oslari*	8.89	12.10	3.21	11.86	0.43	2.50	0.31	F	AZ
		Ceratopsyche	*oslari*	8.40	11.36	3.33	11.73	0.35	2.65	0.31	F	AZ

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Ceratopsyche	*oslari*	8.77	12.60	3.33	12.60	0.39	2.50	0.31	F	AZ
		Ceratopsyche	*oslari*	8.15	11.73	3.21	12.10	0.39	2.26	0.31	F	AZ
		Ceratopsyche	*oslari*	8.27	10.99	3.71	10.13	0.39	2.34	0.35	F	CO
		Ceratopsyche	*oslari*	7.04	10.62	3.21	9.14	0.35	2.11	0.34	F	CO
		Ceratopsyche	*oslari*	6.18	8.77	2.59	10.00	0.35	2.03	0.23	M	CO
		Ceratopsyche	*oslari*	5.80	8.89	2.59	10.00	0.31	2.03	0.22	M	CO
Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*oslari*	5.93	8.77	2.96	10.74	0.35	2.11	0.23	M	CO
		Ceratopsyche	*oslari*	6.42	9.39	2.96	10.99	0.35	1.95	0.23	M	CO
		Ceratopsyche	*oslari*	6.18	9.14	2.72	10.74	0.27	1.95	0.23	M	CO
		Ceratopsyche	*oslari*	6.30	9.14	2.84	10.00	0.35	1.95	0.23	M	CO
		Ceratopsyche	*oslari*	6.67	10.25	3.33	11.36	0.35	2.26	0.23	M	CO
		Ceratopsyche	*oslari*	6.79	10.00	3.09	11.86	0.35	2.11	0.23	M	CO
		Ceratopsyche	*oslari*	6.55	10.25	3.21	11.86	0.31	2.18	0.23	M	CO
		Ceratopsyche	*oslari*	6.18	9.26	2.84	10.25	0.27	2.18	0.22	M	CO
		Ceratopsyche	*oslari*	6.79	9.88	3.09	11.12	0.35	2.26	0.23	M	CO
		Ceratopsyche	*oslari*	6.30	9.88	3.09	11.36	0.35	2.11	0.23	M	CO
		Ceratopsyche	*oslari*	8.15	11.61	3.46	12.47	0.39	2.42	0.21	M	AZ
		Ceratopsyche	*oslari*	6.67	11.12	3.21	11.73	0.39	2.34	0.21	M	AZ
		Ceratopsyche	*oslari*	7.78	11.73	3.46	13.09	0.37	2.34	0.21	M	AZ
		Ceratopsyche	*oslari*	6.67	11.61	3.46	12.35	0.35	2.34	0.23	M	AZ
		Ceratopsyche	*oslari*	6.30	9.76	2.84	10.74	0.31	2.18	0.23	M	CO
		Ceratopsyche	*slossonae*	8.77	11.12	3.83	9.02	0.43	2.42	0.32	F	MN
		Ceratopsyche	*slossonae*	8.40	9.76	3.09	9.76	0.35	1.95	0.27	F	MN
		Ceratopsyche	*slossonae*	8.15	10.13	3.09	8.27	0.43	1.95	0.23	F	MN
		Ceratopsyche	*slossonae*	7.90	10.74	3.21	10.00	0.31	2.11	0.31	F	MN
		Ceratopsyche	*slossonae*	9.76	11.12	3.33	10.50	0.39	2.50	0.30	F	MN
		Ceratopsyche	*slossonae*	8.70	9.00	4.50	9.10	0.38	2.70	0.23	F	PA
		Ceratopsyche	*slossonae*	8.20	9.10	3.40	8.80	0.41	2.60	0.24	F	PA
		Ceratopsyche	*slossonae*	7.00	8.70	2.90	8.60	0.34	1.80	0.25	F	PA
		Ceratopsyche	*slossonae*	9.14	11.12	3.83	8.77	0.39	2.34	0.31	F	MN
		Ceratopsyche	*slossonae*	9.02	11.61	3.83	10.62	0.47	2.18	0.33	F	MN
		Ceratopsyche	*slossonae*	7.78	9.39	2.84	8.40	0.35	1.79	0.27	F	MN
		Ceratopsyche	*slossonae*	8.20	9.00	3.30	8.30	0.38	1.90	0.26	F	PA
		Ceratopsyche	*slossonae*	9.10	9.70	3.30	9.60	0.45	2.10	0.29	F	PA
		Ceratopsyche	*slossonae*	8.15	10.37	3.09	9.14	0.32	1.95	0.23	F	MN
		Ceratopsyche	*slossonae*	7.29	9.88	2.96	9.26	0.35	1.87	0.23	F	MN
		Ceratopsyche	*slossonae*	6.40	8.50	3.40	9.40	0.41	1.90	0.21	F	PA
		Ceratopsyche	*slossonae*	9.20	9.50	3.40	9.90	0.41	2.10	0.26	F	PA
		Ceratopsyche	*slossonae*	7.50	9.10	3.30	9.60	0.34	2.00	0.26	F	PA
		Ceratopsyche	*slossonae*	8.20	10.50	3.50	9.90	0.41	2.10	0.30	F	PA
		Ceratopsyche	*slossonae*	9.39	11.86	3.09	12.35	0.39	1.48	0.16	M	NC
		Ceratopsyche	*slossonae*	9.02	11.98	3.46	11.86	0.43	2.42	0.20	M	NC

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Ceratopsyche	*slossonae*	8.40	11.61	3.33	11.86	0.43	2.42	0.23	M	NC
		Ceratopsyche	*slossonae*	9.63	12.10	3.09	12.10	0.43	2.42	0.21	M	NC
Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*slossonae*	7.41	9.76	3.21	11.24	0.39	2.26	0.23	M	MN
		Ceratopsyche	*slossonae*	7.16	9.26	3.09	10.50	0.43	2.18	0.23	M	MN
		Ceratopsyche	*slossonae*	6.79	9.02	2.96	9.76	0.43	2.03	0.23	M	MN
		Ceratopsyche	*slossonae*	7.16	9.51	2.96	10.25	0.39	2.11	0.23	M	MN
		Ceratopsyche	*slossonae*	7.78	9.51	3.09	10.37	0.43	2.11	0.22	M	MN
		Ceratopsyche	*slossonae*	5.90	8.30	3.00	9.30	0.34	1.90	0.16	M	PA
		Ceratopsyche	*slossonae*	7.70	8.90	3.20	10.00	0.38	2.10	0.16	M	PA
		Ceratopsyche	*slossonae*	6.90	8.90	3.00	10.10	0.38	2.10	0.20	M	PA
		Ceratopsyche	*slossonae*	7.16	9.39	2.72	10.00	0.35	2.18	0.22	M	MN
		Ceratopsyche	*slossonae*	7.53	9.76	3.21	11.12	0.35	1.95	0.23	M	MN
		Ceratopsyche	*slossonae*	6.80	8.90	3.20	10.20	0.38	2.10	0.20	M	PA
		Ceratopsyche	*slossonae*	8.65	10.74	3.09	10.00	0.31	2.18	0.23	M	MN
		Ceratopsyche	*slossonae*	8.65	9.76	2.96	9.51	0.43	1.95	0.22	M	MN
		Ceratopsyche	*slossonae*	7.20	9.00	3.10	8.20	0.38	2.00	0.17	M	PA
		Ceratopsyche	*sparna*	7.30	9.20	2.90	9.10	0.34	1.80	0.21	F	SC
		Ceratopsyche	*sparna*	6.40	8.50	2.70	9.00	0.31	1.80	0.24	F	SC
		Ceratopsyche	*sparna*	6.50	9.50	2.90	8.70	0.34	1.80	0.24	F	SC
		Ceratopsyche	*sparna*	7.30	8.80	3.00	9.20	0.31	1.90	0.26	F	SC
		Ceratopsyche	*sparna*	6.50	9.30	3.10	8.70	0.31	1.80	0.22	F	SC
		Ceratopsyche	*sparna*	7.20	9.70	3.10	9.30	0.24	1.80	0.29	F	SC
		Ceratopsyche	*sparna*	7.70	9.80	3.10	9.50	0.34	2.10	0.24	F	SC
		Ceratopsyche	*sparna*	7.10	8.30	2.80	8.30	0.38	1.80	0.26	F	SC
		Ceratopsyche	*sparna*	7.00	8.20	2.70	9.10	0.34	1.70	0.22	F	SC
		Ceratopsyche	*sparna*	6.50	8.50	2.70	7.70	0.26	1.80	0.21	F	SC
		Ceratopsyche	*sparna*	7.40	10.70	3.20	9.80	0.31	2.10	0.26	F	SC
		Ceratopsyche	*sparna*	7.10	9.50	3.20	10.10	0.34	1.90	0.24	F	SC
		Ceratopsyche	*sparna*	7.60	9.30	3.10	9.50	0.28	1.90	0.26	F	SC
		Ceratopsyche	*sparna*	6.70	8.30	2.70	8.30	0.28	1.80	0.26	F	SC
		Ceratopsyche	*sparna*	6.70	8.50	2.80	8.30	0.31	1.80	0.21	F	SC
		Ceratopsyche	*sparna*	7.90	9.70	3.20	9.80	0.31	1.90	0.26	F	SC
		Ceratopsyche	*sparna*	6.40	8.40	2.70	8.30	0.31	1.80	0.26	F	SC
		Ceratopsyche	*sparna*	6.10	8.40	2.70	7.90	0.24	1.70	0.21	F	SC
		Ceratopsyche	*sparna*	7.20	9.00	2.90	9.10	0.34	1.90	0.26	F	SC
		Ceratopsyche	*sparna*	7.40	9.60	3.30	9.20	0.28	2.00	0.25	F	SC
		Ceratopsyche	*sparna*	6.60	8.50	2.60	8.70	0.31	1.70	0.16	M	SC
		Ceratopsyche	*sparna*	6.60	9.50	2.60	9.50	0.34	1.80	0.16	M	SC
		Ceratopsyche	*sparna*	6.10	7.40	2.60	9.30	0.28	2.20	0.16	M	SC
		Ceratopsyche	*sparna*	6.70	9.50	3.00	9.50	0.31	2.00	0.18	M	SC
Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*sparna*	7.40	9.50	3.00	10.20	0.34	1.90	0.18	M	SC
		Ceratopsyche	*sparna*	7.00	9.00	2.80	9.90	0.31	1.90	0.20	M	SC

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Ceratopsyche	*sparna*	6.90	9.30	3.00	9.60	0.31	2.10	0.21	M	SC
		Ceratopsyche	*sparna*	6.90	9.00	2.80	9.90	0.20	1.80	0.20	M	SC
		Ceratopsyche	*sparna*	7.10	9.70	2.90	10.30	0.34	2.00	0.18	M	SC
		Ceratopsyche	*sparna*	6.30	9.20	2.90	9.70	0.28	1.70	0.16	M	SC
		Ceratopsyche	*sparna*	7.20	9.90	3.00	10.40	0.31	2.10	0.21	M	SC
		Ceratopsyche	*sparna*	7.30	9.00	2.80	10.20	0.28	1.80	0.18	M	SC
		Ceratopsyche	*sparna*	7.00	9.30	2.80	9.10	0.31	1.80	0.16	M	SC
		Ceratopsyche	*sparna*	6.70	9.20	2.80	10.10	0.29	1.90	0.16	M	SC
		Ceratopsyche	*sparna*	7.30	9.50	3.10	10.20	0.29	1.80	0.21	M	SC
		Ceratopsyche	*sparna*	6.30	8.20	2.60	9.00	0.34	1.70	0.16	M	SC
		Ceratopsyche	*sparna*	6.80	9.30	2.90	10.10	0.34	1.90	0.16	M	SC
		Ceratopsyche	*sparna*	6.80	7.70	2.80	9.20	0.34	1.80	0.16	M	SC
		Ceratopsyche	*sparna*	6.60	9.40	2.80	10.60	0.26	1.80	0.18	M	SC
		Ceratopsyche	*sparna*	6.00	9.00	3.00	10.10	0.34	1.60	0.16	M	SC
Hydropsychidae	Hydropsychinae	*Cheumatopsyche*	*aphanta*	4.69	6.05	1.85	6.42	0.23	1.25	0.16	F	AR
		Cheumatopsyche	*aphanta*	4.20	5.80	1.73	5.93	0.17	1.09	0.16	F	AR
		Cheumatopsyche	*aphanta*	4.08	6.05	1.85	6.55	0.20	1.17	0.14	F	AR
		Cheumatopsyche	*aphanta*	4.20	5.56	1.61	5.43	0.23	1.17	0.16	F	AR
		Cheumatopsyche	*aphanta*	3.71	6.42	1.73	6.67	0.22	1.17	0.17	F	AR
		Cheumatopsyche	*aphanta*	4.69	6.18	1.61	5.80	0.23	1.25	0.16	F	AR
		Cheumatopsyche	*aphanta*	3.71	6.05	1.73	6.55	0.23	1.17	0.14	F	AR
		Cheumatopsyche	*aphanta*	4.08	5.93	1.85	6.18	0.20	1.01	0.16	F	AR
		Cheumatopsyche	*aphanta*	4.32	5.68	1.61	6.05	0.22	1.17	0.16	F	AR
		Cheumatopsyche	*aphanta*	3.71	6.05	1.73	6.18	0.23	1.09	0.16	F	AR
		Cheumatopsyche	*aphanta*	3.95	6.05	1.61	5.43	0.22	0.94	0.16	F	AR
		Cheumatopsyche	*aphanta*	4.08	5.68	1.61	6.30	0.23	1.17	0.16	F	AR
		Cheumatopsyche	*aphanta*	4.20	6.30	1.73	6.05	0.20	1.17	0.16	F	AR
		Cheumatopsyche	*aphanta*	4.08	5.56	1.61	5.56	0.23	1.17	0.16	F	AR
		Cheumatopsyche	*aphanta*	3.95	5.56	1.61	6.05	0.22	1.09	0.16	F	AR
		Cheumatopsyche	*aphanta*	4.69	5.93	1.61	7.41	0.23	1.17	0.08	M	OH
		Cheumatopsyche	*aphanta*	4.57	5.80	1.61		0.20	1.17	0.08	M	OH
		Cheumatopsyche	*aphanta*	3.83	6.42	1.85	7.90	0.23	1.33	0.10	M	AR
		Cheumatopsyche	*aphanta*	4.08	5.80	1.85	7.16	0.20	1.17	0.14	M	AR
		Cheumatopsyche	*aphanta*	3.21	5.31	1.61	6.30	0.22	1.17	0.08	M	AR
		Cheumatopsyche	*aphanta*	4.20	5.56	1.85	7.16	0.20	1.25	0.12	M	AR
		Cheumatopsyche	*aphanta*	3.83	5.93	1.73	7.53	0.23	1.17	0.08	M	AR
Hydropsychidae	Hydropsychinae	*Cheumatopsyche*	*aphanta*	3.71	5.56	1.85	7.16	0.23	1.17	0.09	M	AR
		Cheumatopsyche	*aphanta*	3.46	6.05	1.85	7.53	0.20	1.33	0.08	M	AR
		Cheumatopsyche	*aphanta*	3.71	5.80	1.73	6.67	0.20	1.17	0.09	M	AR
		Cheumatopsyche	*aphanta*	3.46	6.18	1.85	7.41	0.20	1.17	0.16	M	AR
		Cheumatopsyche	*aphanta*	3.71	5.93	1.85	7.04	0.20	1.01	0.12	M	AR
		Cheumatopsyche	*aphanta*	3.83	6.30	1.85	7.78	0.20	1.33	0.10	M	AR

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Cheumatopsyche	*aphanta*	3.71	5.68	1.73	6.79	0.20	1.17	0.12	M	AR
		Cheumatopsyche	*aphanta*	3.95	5.56	1.85	7.16	0.21	1.17	0.16	M	AR
		Cheumatopsyche	*aphanta*	3.95	5.93	1.73	7.53	0.22	1.17	0.12	M	AR
		Cheumatopsyche	*aphanta*	3.71	5.68	1.73	7.16	0.23	1.17	0.10	M	AR
		Cheumatopsyche	*aphanta*	4.20	5.93	1.98	7.16	0.23	1.17	0.16	M	AR
		Cheumatopsyche	*aphanta*	3.21	5.43	1.61	6.79	0.20	1.01	0.14	M	AR
		Cheumatopsyche	*gracilis*	4.08	5.93	1.85	5.93	0.22	1.01	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.57	6.92	2.10	6.55	0.23	1.17	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.08	5.93	2.10	6.92	0.23	1.25	0.16	F	WY
		Cheumatopsyche	*gracilis*	4.08	5.93	1.85	6.18	0.23	1.09	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.20	6.42	1.98	6.30	0.27	1.25	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.57	7.04	2.22	6.67	0.23	1.33	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.69	6.92	2.10	6.92	0.23	1.33	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.82	6.79	2.10	7.04	0.22	1.25	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.57	6.92	2.10	7.29	0.23	1.33	0.20	F	AB
		Cheumatopsyche	*gracilis*	4.08	6.05	1.73	5.68	0.22	1.01	0.14	F	AB
		Cheumatopsyche	*gracilis*	4.69	6.67	2.22	7.04	0.23	1.33	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.20	6.30	1.85	6.30	0.17	1.25	0.14	F	AB
		Cheumatopsyche	*gracilis*	4.20	6.42	1.98	7.16	0.27	1.25	0.16	F	AB
		Cheumatopsyche	*gracilis*	3.95	6.18	1.85	6.30	0.23	1.17	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.08	6.92	2.10	6.79	0.23	1.17	0.17	F	AB
		Cheumatopsyche	*gracilis*	4.32	6.42	1.98	6.30	0.23	1.25	0.17	F	AB
		Cheumatopsyche	*gracilis*	4.57	6.79	2.10	6.67	0.23	1.25	0.17	F	AB
		Cheumatopsyche	*gracilis*	4.32	6.67	1.85	6.79	0.22	1.17	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.32	7.04	2.22	6.18	0.22	1.25	0.17	F	AB
		Cheumatopsyche	*gracilis*	4.32	6.67	1.98	6.30	0.23	1.25	0.16	F	AB
		Cheumatopsyche	*gracilis*	4.57	7.29	2.22	8.40	0.27	1.48	0.16	M	WY
		Cheumatopsyche	*gracilis*	4.08	6.55	1.85	7.53	0.23	1.25	0.08	M	AB
		Cheumatopsyche	*gracilis*	3.71	6.30	1.85	6.92	0.23	1.17	0.12	M	WY
		Cheumatopsyche	*gracilis*	3.95	6.42	1.73	8.27	0.23	1.25	0.12	M	NY
		Cheumatopsyche	*gracilis*	3.83	5.80	1.73	7.66	0.31	1.33	0.13	M	NY
		Cheumatopsyche	*gracilis*	3.83	6.18	1.85	7.78	0.20	1.33	0.13	M	NY
Hydropsychidae	Hydropsychinae	*Cheumatopsyche*	*gracilis*	5.06	7.16	1.98	8.77	0.23	1.40	0.09	M	CO
		Cheumatopsyche	*gracilis*	5.06	7.41	2.22	8.40	0.24	1.33	0.09	M	CO
		Cheumatopsyche	*gracilis*	5.31	7.04	2.10	8.15	0.26	1.40	0.09	M	CO
		Cheumatopsyche	*gracilis*	5.19	7.16	2.10	8.03	0.23	1.33	0.12	M	ON
		Cheumatopsyche	*gracilis*	3.95	6.79	2.10	8.03	0.27	1.33	0.10	M	ON
		Cheumatopsyche	*gracilis*	4.32	6.79	1.98	8.52	0.23	1.40	0.12	M	ON
		Cheumatopsyche	*gracilis*	4.45	7.04	2.10	8.77	0.23	1.48	0.09	M	ON
		Cheumatopsyche	*gracilis*	4.08	6.79	2.10	8.89	0.25	1.48	0.16	M	ON
		Cheumatopsyche	*gracilis*	4.94	7.29	1.98	8.52	0.25	1.48	0.13	M	ON
		Cheumatopsyche	*gracilis*	4.45	7.16	1.98	8.77	0.27	1.40	0.10	M	ON

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Hydropsychidae	Hydropsychinae	*Cheumatopsyche*	*gracilis*	4.32	6.67	2.10	8.65	0.23	1.25	0.09	M	ON
		Cheumatopsyche	*gracilis*	4.69	7.53	2.22	9.39	0.30	1.56	0.12	M	ON
		Cheumatopsyche	*gracilis*	4.57	6.79	2.22	7.78	0.25	1.40	0.16	M	ON
		Cheumatopsyche	*gracilis*	4.45	7.29	2.22	8.89	0.27	1.48	0.16	M	ON
		Cheumatopsyche	*gracilis*	3.95	7.29	2.22	8.40	0.27	1.40	0.09	M	ON
		Cheumatopsyche	*gracilis*	3.95	6.55	1.98	8.89	0.27	1.25	0.12	M	ON
		Cheumatopsyche	*gracilis*	3.95	7.53	2.22	9.02	0.28	1.56	0.14	M	ON
		Cheumatopsyche	*gracilis*	4.20	6.79	2.10	8.15	0.30	1.40	0.12	M	ON
		Cheumatopsyche	*gracilis*	4.20	6.55	1.85	7.53	0.31	1.25	0.09	M	ON
		Cheumatopsyche	*gracilis*	4.08	6.55	1.98		0.25	1.25	0.12	M	AB
		Cheumatopsyche	*harwoodi*	5.06	6.92	1.98	6.92	0.23	1.25	0.16	F	VA
		Cheumatopsyche	*harwoodi*	6.42	7.78	2.35	6.55	0.23	1.33	0.23	F	NC
		Cheumatopsyche	*harwoodi*	7.29	8.27	2.47	7.66	0.27	1.56	0.23	F	NC
		Cheumatopsyche	*harwoodi*	6.67	8.15	2.35	7.53	0.27	1.56	0.23	F	NC
		Cheumatopsyche	*harwoodi*	6.55	7.78	2.47	6.42	0.27	1.56	0.23	F	NC
		Cheumatopsyche	*harwoodi*	5.93	6.79	2.22	7.04	0.23	1.33	0.22	F	NC
		Cheumatopsyche	*harwoodi*	5.68	6.18	1.85	5.80	0.23	1.25	0.16	F	VA
		Cheumatopsyche	*harwoodi*	4.69	5.80	1.85	6.42	0.23	1.25	0.16	F	VA
		Cheumatopsyche	*harwoodi*	4.32	7.04	1.98	7.29	0.23	1.25	0.16	F	VA
		Cheumatopsyche	*harwoodi*	4.82	6.55	1.85	6.42	0.20	1.25	0.18	F	VA
		Cheumatopsyche	*harwoodi*	4.57	6.18	1.85	7.04	0.22	1.09	0.16	F	VA
		Cheumatopsyche	*harwoodi*	4.45	6.79	2.10	7.04	0.22	1.33	0.16	F	VA
		Cheumatopsyche	*harwoodi*	5.06	6.92	1.98	7.78	0.23	1.40	0.12	M	NC
		Cheumatopsyche	*harwoodi*	4.94	6.67	1.85	7.78	0.23	1.25	0.14	M	VA
		Cheumatopsyche	*harwoodi*	4.57	6.30	1.98	7.90	0.22	1.17	0.12	M	VA
		Cheumatopsyche	*harwoodi*	5.56	7.41	2.47	8.03	0.22	1.40	0.14	M	NC
		Cheumatopsyche	*harwoodi*	5.56	6.79	2.10	7.66	0.23	1.40	0.16	M	NC
		Cheumatopsyche	*harwoodi*	4.32	6.79	1.85	8.03	0.25	1.33	0.16	M	VA
		Cheumatopsyche	*harwoodi*	4.08	6.18	1.85	7.16	0.20	1.17	0.12	M	VA
		Cheumatopsyche	*harwoodi*	5.56	7.41	2.10	8.03	0.23	1.40	0.16	M	NC
		Cheumatopsyche	*harwoodi*	4.45	6.79	1.98	7.53	0.23	1.40	0.14	M	VA
		Cheumatopsyche	*harwoodi*	4.94	7.04	1.98	8.77	0.22	1.17	0.12	M	VA
		Cheumatopsyche	*harwoodi*	4.82	6.67	1.98	8.27	0.20	1.25	0.14	M	VA
		Cheumatopsyche	*harwoodi*	4.94	7.41	2.10	8.77	0.23	1.25	0.16	M	VA
		Cheumatopsyche	*harwoodi*	4.45	6.42	1.98	8.15	0.23	1.25	0.14	M	VA
		Cheumatopsyche	*harwoodi*	4.69	6.42	1.85	7.41	0.23	1.25	0.14	M	VA
		Cheumatopsyche	*minuscula*	4.45	7.16	2.10	6.92	0.31	1.25	0.23	F	ON
		Cheumatopsyche	*minuscula*	6.18	8.15	2.47	7.78	0.27	1.33	0.20	F	ON
		Cheumatopsyche	*minuscula*	5.68	7.78	2.22	7.90	0.27	1.40	0.20	F	ON
		Cheumatopsyche	*minuscula*	5.31	7.53	2.22	7.41	0.31	1.48	0.23	F	ON
		Cheumatopsyche	*minuscula*	5.19	7.41	2.35	7.41	0.27	1.48	0.20	F	ON
		Cheumatopsyche	*minuscula*	4.82	7.16	1.85	7.04	0.27	1.40	0.16	F	ON

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Cheumatopsyche	*minuscula*	6.18	8.27	2.47	8.40	0.27	1.56	0.22	F	ON
		Cheumatopsyche	*minuscula*	5.19	8.03	2.22	7.66	0.23	1.56	0.20	F	ON
		Cheumatopsyche	*minuscula*	5.56	8.03	2.59	7.90	0.27	1.64	0.23	F	ON
		Cheumatopsyche	*minuscula*	5.31	7.66	2.35	7.53	0.35	1.40	0.23	F	ON
		Cheumatopsyche	*minuscula*	5.06	8.27	2.35	8.03	0.27	1.56	0.22	F	ON
		Cheumatopsyche	*minuscula*	5.19	7.66	2.22	7.78	0.27	1.25	0.22	F	ON
		Cheumatopsyche	*minuscula*	5.56	8.27	2.47	7.16	0.27	1.40	0.23	F	ON
		Cheumatopsyche	*minuscula*	6.05	7.41	2.35	7.53	0.27	1.56	0.23	F	ON
		Cheumatopsyche	*minuscula*	5.93	8.03	2.47	7.66	0.30	1.56	0.22	F	ON
		Cheumatopsyche	*minuscula*	5.43	7.41	2.35	7.66	0.27	1.48	0.16	F	ON
		Cheumatopsyche	*minuscula*	5.06	7.53	2.22	7.16	0.27	1.56	0.22	F	ON
		Cheumatopsyche	*minuscula*	5.56	7.78	2.47	7.90	0.23	1.56	0.20	F	ON
		Cheumatopsyche	*minuscula*	5.56	8.40	2.59	7.66	0.31	1.56	0.20	F	ON
		Cheumatopsyche	*minuscula*	4.69	6.92	2.22	7.53	0.27	1.48	0.12	F	ON
		Cheumatopsyche	*minuscula*	4.94	7.41	2.22	7.41	0.27	1.40	0.18	F	ON
		Cheumatopsyche	*minuscula*	3.95	5.31	1.61	5.19	0.23	1.17	0.08	M	AR
		Cheumatopsyche	*minuscula*	4.82	6.55	2.10	7.04	0.27	1.40	0.16	M	ON
		Cheumatopsyche	*minuscula*	4.57	7.41	2.22	8.03	0.30	1.56	0.12	M	ON
		Cheumatopsyche	*minuscula*	5.06	6.92	2.22	7.53	0.27	1.40	0.14	M	ON
		Cheumatopsyche	*minuscula*	5.06	7.53	2.47	6.67	0.30	1.48	0.14	M	ON
		Cheumatopsyche	*minuscula*	4.45	7.29	2.22	8.40	0.31	1.64	0.16	M	ON
		Cheumatopsyche	*minuscula*	4.45	6.92	2.10	6.55	0.30	1.48	0.10	M	ON
		Cheumatopsyche	*minuscula*	5.06	7.41	2.47	7.66	0.25	1.40	0.14	M	ON
		Cheumatopsyche	*minuscula*	5.06	7.41	2.35	8.03	0.30	1.48	0.14	M	ON
Hydropsychidae	Hydropsychinae	*Cheumatopsyche*	*minuscula*	4.69	6.79	2.10	7.78	0.31	1.40	0.12	M	ON
		Cheumatopsyche	*minuscula*	4.82	6.67	2.10	5.93	0.27	1.40	0.16	M	ON
		Cheumatopsyche	*minuscula*	4.82	7.16	2.22	7.41	0.31	1.56	0.16	M	ON
		Cheumatopsyche	*pettiti*	6.10	6.20	3.00	6.70	0.21	1.30	0.16	F	SC
		Cheumatopsyche	*pettiti*	6.50	7.00	2.10	7.20	0.24	1.40	0.21	F	SC
		Cheumatopsyche	*pettiti*	5.40	6.10	2.00	7.00	0.24	1.30	0.16	F	SC
		Cheumatopsyche	*pettiti*	5.20	6.30	1.90	6.30	0.31	1.20	0.16	F	SC
		Cheumatopsyche	*pettiti*	6.10	6.50	1.90	7.20	0.24	1.40	0.22	F	SC
		Cheumatopsyche	*pettiti*	6.80	6.60	2.10	7.20	0.21	1.30	0.16	F	SC
		Cheumatopsyche	*pettiti*	6.70	6.60	2.00	7.20	0.21	1.40	0.21	F	SC
		Cheumatopsyche	*pettiti*	6.30	7.00	2.20	6.80	0.24	1.50	0.21	F	SC
		Cheumatopsyche	*pettiti*	6.60	6.60	2.10	7.60	0.24	1.50	0.21	F	SC
		Cheumatopsyche	*pettiti*	6.40	6.70	2.00	7.20	0.21	1.40	0.16	F	SC
		Cheumatopsyche	*pettiti*	5.10	6.50	2.00	6.50	0.28	1.40	0.18	F	SC
		Cheumatopsyche	*pettiti*	6.30	6.30	2.00	6.80	0.24	1.30	0.18	F	SC
		Cheumatopsyche	*pettiti*	5.70	6.20	2.10	7.20	0.21	1.30	0.18	F	SC
		Cheumatopsyche	*pettiti*	6.60	6.70	1.90	7.40	0.28	1.60	0.21	F	SC
		Cheumatopsyche	*pettiti*	5.20	6.10	2.00	6.40	0.21	1.30	0.21	F	SC

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Cheumatopsyche	*pettiti*	7.00	6.70	1.90	7.30	0.24	1.50	0.21	F	SC
		Cheumatopsyche	*pettiti*	6.80	6.70	2.10	7.40	0.24	1.40	0.21	F	SC
		Cheumatopsyche	*pettiti*	7.30	7.10	2.20	7.10	0.24	1.40	0.16	F	SC
		Cheumatopsyche	*pettiti*	6.80	6.90	2.10	7.20	0.24	1.40	0.21	F	SC
		Cheumatopsyche	*pettiti*	6.00	6.70	2.00	7.20	0.24	1.50	0.21	F	SC
		Cheumatopsyche	*pettiti*	6.50	6.10	1.90	6.90	0.24	1.20	0.20	F	SC
		Cheumatopsyche	*pettiti*	5.40	6.50	1.90	8.30	0.21	1.50	0.13	M	SC
		Cheumatopsyche	*pettiti*	6.10	6.60	1.90	8.20	0.24	1.50	0.16	M	SC
		Cheumatopsyche	*pettiti*	5.60	6.50	2.00	7.60	0.24	1.40	0.16	M	SC
		Cheumatopsyche	*pettiti*	6.30	6.50	2.00	7.90	0.24	1.50	0.16	M	SC
		Cheumatopsyche	*pettiti*	5.90	6.20	2.00	7.90	0.21	1.50	0.16	M	SC
		Cheumatopsyche	*pettiti*	5.00	6.50	1.90	7.20	0.24	1.40	0.16	M	SC
		Cheumatopsyche	*pettiti*	6.20	6.80	2.00	7.50	0.24	1.50	0.16	M	SC
		Cheumatopsyche	*pettiti*	5.60	6.80	1.90	8.60	0.24	1.50	0.16	M	SC
		Cheumatopsyche	*pettiti*	5.20	6.30	2.00	7.20	0.21	1.40	0.16	M	SC
		Cheumatopsyche	*pettiti*	6.40	7.50	2.10	7.50	0.24	1.50	0.16	M	SC
		Cheumatopsyche	*pettiti*	5.40	6.70	2.00	8.20	0.24	1.30	0.14	M	SC
		Cheumatopsyche	*pettiti*	5.30	6.20	1.90	8.30	0.21	1.50	0.14	M	SC
		Cheumatopsyche	*pettiti*	6.50	6.50	2.20	8.50	0.24	1.40	0.14	M	SC
		Cheumatopsyche	*pettiti*	5.00	6.10	1.90	7.50	0.21	1.30	0.14	M	SC
Hydropsychidae	Hydropsychinae	*Cheumatopsyche*	*pettiti*	5.60	6.70	1.90	8.70	0.28	1.50	0.14	M	SC
		Cheumatopsyche	*pettiti*	6.00	6.10	2.10	8.10	0.21	1.30	0.13	M	SC
		Cheumatopsyche	*pettiti*	6.40	6.70	2.10	8.60	0.21	1.40	0.16	M	SC
		Cheumatopsyche	*pettiti*	6.10	6.20	1.80	8.30	0.24	1.40	0.16	M	SC
		Cheumatopsyche	*pettiti*	6.00	6.80	2.00	8.40	0.22	1.40	0.11	M	SC
		Cheumatopsyche	*pettiti*	5.90	6.50	1.90	7.90	0.21	1.20	0.14	M	SC
		Cheumatopsyche	*speciosa*	4.57	5.93	1.61	5.31	0.20	1.17	0.18	F	MT
		Cheumatopsyche	*speciosa*	5.43	6.05	1.73	5.68	0.27	1.17	0.16	F	CO
		Cheumatopsyche	*speciosa*	3.83	5.93	1.85	5.80	0.20	1.09	0.18	F	MT
		Cheumatopsyche	*speciosa*	4.45	6.55	1.73	5.80	0.23	1.25	0.16	F	MT
		Cheumatopsyche	*speciosa*	2.84	4.94	1.36	5.06	0.23	1.01	0.08	M	MT
		Cheumatopsyche	*speciosa*	3.83	5.31	1.36	5.06	0.27	1.09	0.12	M	MT
		Cheumatopsyche	*speciosa*	3.09	5.19	1.36	5.31	0.23	1.01	0.08	M	MT
		Cheumatopsyche	*speciosa*	3.83	6.30	1.48	6.30	0.30	1.17	0.10	M	MT
		Cheumatopsyche	*speciosa*	3.71	5.56	1.48	5.93	0.27	1.17	0.12	M	MT
		Cheumatopsyche	*speciosa*	3.46	5.68	1.73	5.68	0.27	1.09	0.08	M	MT
		Cheumatopsyche	*speciosa*	4.69	5.68	1.24	5.31	0.20	1.09	0.09	M	CO
		Cheumatopsyche	*speciosa*	5.31	5.56	1.24	5.19	0.27	1.09	0.08	M	CO
		Cheumatopsyche	*speciosa*	5.06	5.80	1.61	5.31	0.23	1.09	0.08	M	CO
Hydropsychidae	Hydropsychinae	*Hydropsyche*	*betteni*	9.10	11.60	3.80	11.20	0.45	2.40	0.34	F	NC
		Hydropsyche	*betteni*	9.30	12.70	3.80	12.80	0.41	2.60	0.34	F	NC
		Hydropsyche	*betteni*	8.70	11.10	3.80	13.00	0.41	2.30	0.29	F	NC

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Hydropsyche	*betteni*	8.90	11.40	3.70	11.50	0.38	2.60	0.26	F	NC
		Hydropsyche	*betteni*	9.10	11.10	3.20	11.90	0.52	2.40	0.26	F	NC
		Hydropsyche	*betteni*	9.10	11.70	3.30	10.40	0.41	2.30	0.32	F	SC
		Hydropsyche	*betteni*	10.30	11.30	3.80	10.10	0.41	2.40	0.32	F	SC
		Hydropsyche	*betteni*	9.90	12.30	3.90	12.60	0.45	2.60	0.34	F	SC
		Hydropsyche	*betteni*	9.20	10.70	3.80	11.00	0.41	2.50	0.29	F	SC
		Hydropsyche	*betteni*	10.00	10.90	3.50	11.40	0.38	2.50	0.29	F	SC
		Hydropsyche	*betteni*	9.70	11.00	3.80	12.00	0.45	2.60	0.34	F	SC
		Hydropsyche	*betteni*	9.50	9.70	3.30	10.80	0.38	2.20	0.29	F	SC
		Hydropsyche	*betteni*	9.40	11.10	3.30	11.70	0.38	2.50	0.26	F	SC
		Hydropsyche	*betteni*	9.20	11.30	3.20	10.30	0.38	2.40	0.32	F	SC
		Hydropsyche	*betteni*	9.90	10.60	3.20	10.60	0.38	2.30	0.26	F	SC
		Hydropsyche	*betteni*	9.90	11.00	3.60	11.90	0.38	2.40	0.26	F	SC
		Hydropsyche	*betteni*	10.00	10.50	3.90	12.20	0.38	2.40	0.32	F	SC
		Hydropsyche	*betteni*	10.10	11.20	3.50	11.60	0.38	2.40	0.29	F	SC
		Hydropsyche	*betteni*	10.30	10.70	3.80	11.60	0.41	2.60	0.26	F	SC
Hydropsychidae	Hydropsychinae	*Hydropsyche*	*betteni*	9.50	10.10	3.50	10.50	0.45	2.40	0.26	F	SC
		Hydropsyche	*betteni*	8.50	11.60	3.90	13.80	0.48	2.90	0.16	M	GA
		Hydropsyche	*betteni*	8.30	8.00	2.80	10.10	0.45	1.90	0.16	M	SC
		Hydropsyche	*betteni*	8.00	9.80	3.30	11.00	0.42	2.30	0.21	M	SC
		Hydropsyche	*betteni*	8.50	9.00	2.90	10.70	0.41	2.20	0.17	M	SC
		Hydropsyche	*betteni*	7.30	8.40	2.80	10.30	0.38	2.20	0.16	M	SC
		Hydropsyche	*betteni*	8.30	8.70	3.10	11.00	0.41	2.20	0.20	M	SC
		Hydropsyche	*betteni*	9.00	9.50	2.90	11.20	0.45	2.20	0.22	M	SC
		Hydropsyche	*betteni*	8.20	9.00	2.80	10.50	0.41	2.10	0.16	M	SC
		Hydropsyche	*betteni*	7.30	8.90	2.70	10.40	0.45	2.10	0.18	M	SC
		Hydropsyche	*betteni*	8.30	8.70	2.90	10.30	0.41	2.10	0.16	M	SC
		Hydropsyche	*betteni*	8.30	9.30	3.20	10.50	0.41	2.10	0.16	M	SC
		Hydropsyche	*betteni*	7.80	9.40	3.10	11.60	0.45	2.20	0.18	M	SC
		Hydropsyche	*betteni*	9.10	9.90	3.30	11.80	0.45	2.00	0.18	M	SC
		Hydropsyche	*betteni*	8.40	8.80	2.90	10.00	0.38	2.50	0.16	M	SC
		Hydropsyche	*betteni*	9.10	9.80	3.00	10.80	0.34	2.20	0.21	M	SC
		Hydropsyche	*betteni*	9.00	9.20	3.40	12.10	0.38	2.30	0.20	M	SC
		Hydropsyche	*betteni*	8.60	9.40	3.80	11.10	0.38	2.30	0.21	M	SC
		Hydropsyche	*betteni*	9.10	9.80	3.00	10.30	0.41	2.10	0.18	M	SC
		Hydropsyche	*betteni*	9.90	10.40	3.10	12.60	0.41	2.40	0.21	M	SC
		Hydropsyche	*betteni*	7.50	8.80	2.80	10.00	0.34	2.00	0.16	M	SC
		Hydropsyche	*betteni*	8.20	9.40	2.50	10.30	0.41	1.60	0.16	M	NC
		Hydropsyche	*confusa*	8.27	10.99	3.09	9.76	0.39	2.11	0.33	F	MT
		Hydropsyche	*confusa*	8.40	11.12	2.96	9.26	0.35	2.11	0.35	F	MT
		Hydropsyche	*confusa*	8.65	11.12	3.21	10.00	0.35	2.11	0.35	F	MT
		Hydropsyche	*confusa*	8.15	10.50	3.09	9.88	0.35	2.11	0.31	F	MT

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Hydropsychidae	Hydropsychinae	*Hydropsyche*	*confusa*	7.29	10.25	2.84	9.14	0.35	1.95	0.31	F	MT
		Hydropsyche	*confusa*	9.14	11.86	3.33	10.62	0.43	2.11	0.39	F	MT
		Hydropsyche	*confusa*	8.65	9.63	3.21	9.26	0.35	2.03	0.35	F	MT
		Hydropsyche	*confusa*	8.03	10.50	3.09	8.65	0.31	2.11	0.33	F	MT
		Hydropsyche	*confusa*	8.65	10.99	2.59	10.00	0.39	2.18	0.35	F	MT
		Hydropsyche	*confusa*	9.76	11.12	2.96	10.13	0.43	2.26	0.37	F	MT
		Hydropsyche	*confusa*	9.02	10.62	3.09	9.02	0.39	2.03	0.39	F	MT
		Hydropsyche	*confusa*	7.90	9.76	2.72	9.76	0.39	1.95	0.31	F	MT
		Hydropsyche	*confusa*	7.53	9.02	2.59	8.77	0.35	1.87	0.31	F	MT
		Hydropsyche	*confusa*	7.78	9.39	2.59	8.77	0.35	1.95	0.31	F	MT
		Hydropsyche	*confusa*	8.27	10.37	2.96	10.13	0.35	1.95	0.31	F	MT
		Hydropsyche	*confusa*	6.92	9.14	2.47	8.89	0.35	1.79	0.31	F	MT
		Hydropsyche	*confusa*	6.55	9.39	2.59	9.02	0.39	1.79	0.27	F	MT
		Hydropsyche	*confusa*	8.03	9.51	2.72	8.89	0.39	1.87	0.31	F	MT
		Hydropsyche	*confusa*	8.40	9.39	2.59	8.65	0.39	1.79	0.31	F	MT
		Hydropsyche	*confusa*	7.53	10.87	2.96	10.00	0.35	1.95	0.31	F	MT
		Hydropsyche	*confusa*	5.06	7.66	2.10	8.77	0.35	1.56	0.17	M	MT
		Hydropsyche	*confusa*	7.04	8.40	2.22	9.14	0.39	1.79	0.16	M	MT
		Hydropsyche	*confusa*	5.31	8.03	2.22	8.77	0.35	1.72	0.16	M	MT
		Hydropsyche	*confusa*	6.30	7.53	2.10	8.40	0.35	1.56	0.16	M	MT
		Hydropsyche	*confusa*	6.18	8.15	2.10	8.52	0.35	1.64	0.16	M	MT
		Hydropsyche	*confusa*	6.79	8.40	2.22	9.39	0.37	1.87	0.17	M	MT
		Hydropsyche	*confusa*	5.68	7.41	2.10	8.03	0.35	1.64	0.16	M	MT
		Hydropsyche	*confusa*	6.18	9.63	2.59	10.00	0.35	1.64	0.23	M	MT
		Hydropsyche	*confusa*	6.67	10.37	2.59	10.25	0.31	1.64	0.17	M	MT
		Hydropsyche	*confusa*	5.56	8.15	2.10	8.77	0.31	1.72	0.16	M	MT
		Hydropsyche	*confusa*	8.03	8.89	2.47	10.00	0.35	1.79	0.23	M	MT
		Hydropsyche	*confusa*	5.06	8.15	2.22	8.77	0.35	1.72	0.16	M	MT
		Hydropsyche	*confusa*	6.18	8.15	2.35	8.77	0.35	1.72	0.20	M	MT
		Hydropsyche	*confusa*	5.43	8.27	2.22	8.77	0.35	1.72	0.16	M	MT
		Hydropsyche	*confusa*	5.56	8.40	2.22	9.26	0.37	1.72	0.16	M	MT
		Hydropsyche	*confusa*	5.31	8.52	2.22	8.65	0.31	1.72	0.16	M	MT
		Hydropsyche	*confusa*	5.19	7.78	2.22	8.77	0.35	1.72	0.17	M	MT
		Hydropsyche	*confusa*	5.43	8.15	2.10	8.40	0.33	1.64	0.16	M	MT
		Hydropsyche	*confusa*	5.31	7.66	2.22	9.26	0.31	1.72	0.16	M	MT
		Hydropsyche	*confusa*	5.06	7.90	2.10	8.40	0.35	1.56	0.16	M	MT
		Hydropsyche	*elissoma*	9.63	9.63	2.59	9.39	0.27	2.11	0.23	F	SC
		Hydropsyche	*elissoma*	7.29	9.39	2.47	8.03	0.39	1.95	0.29	F	SC
		Hydropsyche	*elissoma*	7.66	9.14	2.35	8.65	0.35	1.79	0.29	F	SC
		Hydropsyche	*elissoma*	7.78	10.13	2.72	9.76	0.35	2.11	0.23	F	SC
		Hydropsyche	*elissoma*	7.78	9.63	2.59	9.14	0.35	1.95	0.27	F	SC
		Hydropsyche	*elissoma*	7.29	8.89	2.47	8.77	0.31	2.03	0.23	F	SC

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
Hydropsychidae	Hydropsychinae	*Hydropsyche*	*elissoma*	7.29	9.88	2.96	9.14	0.30	2.03	0.27	F	SC
		Hydropsyche	*elissoma*	7.78	9.14	2.72	9.02	0.35	1.79	0.23	F	SC
		Hydropsyche	*elissoma*	8.65	9.63	2.84	9.39	0.35	1.95	0.23	F	SC
		Hydropsyche	*elissoma*	7.78	9.39	2.72	8.65	0.35	1.95	0.23	F	SC
		Hydropsyche	*elissoma*	7.66	9.39	2.59	9.02	0.39	1.79	0.31	F	SC
		Hydropsyche	*elissoma*	7.90	9.51	2.59	9.63	0.35	2.03	0.31	F	SC
		Hydropsyche	*elissoma*	7.53	10.00	2.72	7.53	0.31	1.95	0.27	F	SC
		Hydropsyche	*elissoma*	8.27	10.37	2.72	9.39	0.37	2.18	0.31	F	SC
		Hydropsyche	*elissoma*	7.66	9.26	2.22	8.89	0.35	1.87	0.23	F	SC
		Hydropsyche	*elissoma*	7.53	9.63	2.72	9.26	0.27	1.64	0.23	F	SC
		Hydropsyche	*elissoma*	8.40	9.76	2.10	8.65	0.29	2.03	0.23	F	SC
		Hydropsyche	*elissoma*	7.16	9.39	2.47	8.52	0.31	1.79	0.23	F	SC
		Hydropsyche	*elissoma*	7.29	9.51	2.72	8.40	0.34	1.87	0.31	F	SC
		Hydropsyche	*elissoma*	7.53	9.26	2.35	8.27	0.39	1.79	0.20	F	SC
		Hydropsyche	*elissoma*	7.66	10.00	2.72	8.77	0.35	2.18	0.16	M	SC
		Hydropsyche	*elissoma*	7.90	9.14	2.10	8.89	0.39	2.11	0.16	M	SC
		Hydropsyche	*elissoma*	8.15	9.51	2.47	8.89	0.43	2.18	0.16	M	SC
		Hydropsyche	*elissoma*	8.27	9.63	2.22	9.14	0.39	2.11	0.16	M	SC
		Hydropsyche	*elissoma*	7.53	8.65	2.10	8.27	0.39	1.95	0.16	M	SC
		Hydropsyche	*elissoma*	7.66	9.39	2.22	9.14	0.39	1.79	0.16	M	SC
		Hydropsyche	*elissoma*	7.78	8.89	2.47	8.65	0.41	1.95	0.16	M	SC
		Hydropsyche	*elissoma*	7.90	9.26	2.35	8.65	0.41	2.03	0.16	M	SC
		Hydropsyche	*elissoma*	7.41	8.89	2.59	9.02	0.34	2.03	0.16	M	SC
		Hydropsyche	*elissoma*	7.78	9.63	2.72	9.14	0.39	2.03	0.16	M	SC
		Hydropsyche	*elissoma*	8.27	9.76	2.47	9.14	0.35	2.18	0.16	M	SC
		Hydropsyche	*elissoma*	8.40	9.88	2.22	9.76	0.37	2.11	0.20	M	SC
		Hydropsyche	*elissoma*	8.27	10.00	2.59	9.51	0.41	2.11	0.20	M	SC
		Hydropsyche	*elissoma*	6.92	9.02	2.59	8.52	0.35	1.72	0.16	M	SC
		Hydropsyche	*elissoma*	7.78	9.02	2.47	8.89	0.35	2.03	0.23	M	SC
		Hydropsyche	*elissoma*	8.40	9.88	2.72	9.39	0.39	2.18	0.20	M	SC
		Hydropsyche	*elissoma*	8.15	9.39	2.22	8.52	0.39	2.03	0.16	M	SC
		Hydropsyche	*elissoma*	7.78	9.39	2.59	8.77	0.35	2.03	0.16	M	SC
		Hydropsyche	*elissoma*	7.66	9.39	2.72	9.02	0.39	2.03	0.16	M	SC
		Hydropsyche	*elissoma*	8.27	10.00	2.72	9.39	0.39	2.18	0.20	M	SC
		Hydropsyche	*elissoma*	7.90	9.76	2.47	8.89	0.39	2.03	0.16	M	SC
		Hydropsyche	*hageni*	6.05	10.13	2.72	8.89	0.35	1.79	0.25	F	VA
		Hydropsyche	*hageni*	9.63	12.60	3.71	11.24	0.55	2.26	0.33	F	VA
		Hydropsyche	*hageni*	9.02	11.86	3.33	11.86	0.43	2.26	0.37	F	VA
		Hydropsyche	*hageni*	8.03	10.62	3.09	10.00	0.47	1.87	0.35	F	VA
		Hydropsyche	*hageni*	9.02	12.35	3.58	11.24	0.45	2.26	0.31	F	VA
		Hydropsyche	*hageni*	9.26	13.09	3.46	11.36	0.47	2.26	0.31	F	VA
		Hydropsyche	*hageni*	7.90	10.25	2.84	10.62	0.70	1.95	0.18	M	PA

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Hydropsychidae	Hydropsychinae	*Hydropsyche*	*hageni*	7.04	10.13	2.59	9.76	0.78	1.79	0.16	M	PA
		Hydropsyche	*hageni*	8.27	9.88	3.09	9.88	0.66	1.95	0.16	M	KY
		Hydropsyche	*hageni*	8.89	10.87	3.09	10.87	0.66	2.18	0.16	M	KY
		Hydropsyche	*hageni*	8.03	10.62	3.09	9.63	0.73	1.79	0.23	M	VA
		Hydropsyche	*hageni*	7.29	11.24	3.21	10.87	0.74	2.18	0.23	M	VA
		Hydropsyche	*hageni*	7.53	10.13	3.21	10.37	0.72	2.11	0.22	M	VA
		Hydropsyche	*hageni*	7.16	10.37	3.09	11.73	0.55	2.03	0.23	M	WV
		Hydropsyche	*hageni*	7.41	9.63	2.96	10.00	0.55	1.95	0.23	M	WV
		Hydropsyche	*hageni*	6.92	9.88	3.09	9.76	0.66	1.79	0.20	M	VA
		Hydropsyche	*hageni*	6.79	10.62	3.09	10.62	0.74	2.03	0.23	M	VA
		Hydropsyche	*hageni*	7.04	10.00	2.96	10.87	0.62	1.95	0.23	M	WV
		Hydropsyche	*hageni*	6.79	9.26	2.84	10.25	0.55	2.03	0.22	M	WV
		Hydropsyche	*hageni*	6.05	9.63	2.96	10.87	0.57	2.03	0.20	M	WV
		Hydropsyche	*hageni*	7.16	9.88	2.72	10.74	0.74	2.03	0.23	M	VA
		Hydropsyche	*hageni*	7.78	10.13	2.84	10.50	0.74	2.11	0.20	M	VA
		Hydropsyche	*hageni*	7.16	10.25	3.21	10.13	0.74	1.95	0.23	M	VA
		Hydropsyche	*hageni*	6.79	9.76	2.72	10.50	0.74	1.87	0.20	M	VA
		Hydropsyche	*occidentalis*	6.92	9.02	2.84	7.66	0.33	1.79	0.27	F	MT
		Hydropsyche	*occidentalis*	5.93	8.77	2.72	11.24	0.31	1.87	0.23	F	MT
		Hydropsyche	*occidentalis*	6.55	9.63	2.59	7.78	0.31	1.95	0.25	F	MT
		Hydropsyche	*occidentalis*	6.55	9.51	2.72	7.90	0.35	1.79	0.23	F	MT
		Hydropsyche	*occidentalis*	7.16	9.39	2.59	7.66	0.31	1.87	0.27	F	MT
		Hydropsyche	*occidentalis*	6.42	10.50	2.84	7.66	0.31	2.03	0.29	F	CA
		Hydropsyche	*occidentalis*	6.18	8.40	2.47	6.30	0.35	1.72	0.23	F	MT
		Hydropsyche	*occidentalis*	6.42	9.39	2.72	7.53	0.31	1.79	0.25	F	MT
		Hydropsyche	*occidentalis*	6.30	9.02	2.59	6.92	0.31	1.72	0.23	F	MT
		Hydropsyche	*occidentalis*	5.93	8.89	2.47	8.15	0.31	1.95	0.31	F	MT
		Hydropsyche	*occidentalis*	6.42	9.14	2.84	8.15	0.30	1.79	0.30	F	MT
		Hydropsyche	*occidentalis*	5.68	8.27	2.35	7.78	0.31	1.72	0.30	F	MT
		Hydropsyche	*occidentalis*	6.42	8.27	2.47	7.53	0.31	1.72	0.23	F	MT
		Hydropsyche	*occidentalis*	6.55	9.14	2.59	7.66	0.27	1.95	0.25	F	MT
		Hydropsyche	*occidentalis*	5.93	8.27	2.47	7.66	0.27	1.72	0.23	F	MT
		Hydropsyche	*occidentalis*	7.41	9.39	2.96	9.02	0.31	1.95	0.23	F	MT
		Hydropsyche	*occidentalis*	6.30	8.89	2.72	7.90	0.31	1.72	0.27	F	MT
		Hydropsyche	*occidentalis*	6.79	8.65	2.59	8.03	0.27	1.72	0.23	F	MT
		Hydropsyche	*occidentalis*	6.18	9.02	2.59	7.53	0.27	1.72	0.23	F	MT
		Hydropsyche	*occidentalis*	6.67	8.89	2.47	8.03	0.31	1.79	0.23	F	MT
		Hydropsyche	*occidentalis*	6.55	9.88	2.72	11.36	0.35	2.03	0.23	M	CA
		Hydropsyche	*occidentalis*	7.29	10.74	3.09	12.47	0.39	2.18	0.16	M	CA
		Hydropsyche	*occidentalis*	5.93	9.51	2.59	11.73	0.31	1.95	0.16	M	CA
		Hydropsyche	*occidentalis*	6.30	9.76	2.72	11.24	0.39	1.87	0.16	M	CA
		Hydropsyche	*occidentalis*	6.30	9.63	2.72	10.50	0.39	1.95	0.18	M	CA

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Hydropsychidae	Hydropsychinae	*Hydropsyche*	*occidentalis*	6.67	10.25	2.84	11.12	0.35	2.03	0.16	M	CA
		Hydropsyche	*occidentalis*	6.42	9.51	2.72	10.99	0.39	2.11	0.18	M	CA
		Hydropsyche	*occidentalis*	6.30	9.14	2.72	10.25	0.39	1.95	0.16	M	CA
		Hydropsyche	*occidentalis*	6.05	10.25	2.84	10.25	0.31	2.11	0.16	M	CA
		Hydropsyche	*occidentalis*	5.19	10.13	3.09	9.63	0.35	1.95	0.16	M	CA
		Hydropsyche	*occidentalis*	5.80	8.65	2.35	9.51	0.31	1.79	0.20	M	MT
		Hydropsyche	*occidentalis*	5.93	9.02	2.47	10.25	0.35	1.79	0.20	M	MT
		Hydropsyche	*occidentalis*	6.18	9.51	2.47	8.65	0.27	1.72	0.17	M	MT
		Hydropsyche	*occidentalis*	5.93	8.15	2.35	9.51	0.33	1.72	0.16	M	MT
		Hydropsyche	*occidentalis*	5.56	8.65	2.47	9.88	0.31	1.79	0.16	M	MT
		Hydropsyche	*occidentalis*	6.30	9.26	2.59	11.36	0.33	1.72	0.16	M	MT
		Hydropsyche	*occidentalis*	5.68	8.65	2.59	9.26	0.33	1.79	0.20	M	MT
		Hydropsyche	*occidentalis*	5.93	8.65	2.72	10.37	0.35	1.72	0.16	M	MT
		Hydropsyche	*occidentalis*	5.56	8.52	2.47	10.13	0.31	1.72	0.17	M	MT
		Hydropsyche	*occidentalis*	4.94	8.15	2.22	9.39	0.31	1.64	0.16	M	MT
		Hydropsyche	*occidentalis*	5.56	7.66	2.10	8.40	0.27	1.56	0.16	M	MT
		Hydropsyche	*scalaris*	9.76	11.73	3.46	11.36	0.47	2.18	0.31	F	VA
		Hydropsyche	*scalaris*	7.53	11.49	3.21	10.13	0.43	2.11	0.35	F	PA
		Hydropsyche	*scalaris*	9.02	11.36	3.21	11.12	0.43	2.18	0.31	F	PA
		Hydropsyche	*scalaris*	8.03	11.73	3.33	10.13	0.43	2.18	0.31	F	PA
		Hydropsyche	*scalaris*	8.89	11.73	3.21	11.49	0.43	2.18	0.31	F	PA
		Hydropsyche	*scalaris*	7.66	10.99	3.09	13.83	0.74	2.11	0.23	M	VA
		Hydropsyche	*scalaris*	8.65	10.50	3.09	13.09	0.43	2.18	0.23	M	PA
		Hydropsyche	*scalaris*	6.18	8.27	2.72	12.60	0.31	1.64	0.16	M	TX
		Hydropsyche	*scalaris*	7.41	10.62	3.21	18.15	0.59	2.03	0.16	M	SC
		Hydropsyche	*scalaris*	9.02	11.12	3.33	14.20	0.55	2.18	0.23	M	PA
		Hydropsyche	*scalaris*	8.15	10.99	3.33	14.33	0.55	2.26	0.23	M	PA
		Hydropsyche	*scalaris*	8.40	11.12	3.21	13.96	0.49	2.11	0.23	M	PA
		Hydropsyche	*scalaris*	9.26	11.12	3.33	13.96	0.55	2.11	0.23	M	PA
		Hydropsyche	*scalaris*	7.78	10.50	3.33	14.08	0.55	2.11	0.23	M	PA
		Hydropsyche	*scalaris*	8.40	10.87	3.21	14.20	0.51	2.26	0.23	M	PA
		Hydropsyche	*scalaris*	8.40	11.36	3.09	14.20	0.51	2.11	0.23	M	PA
		Hydropsyche	*scalaris*	9.26	11.12	3.33	13.96	0.55	2.18	0.23	M	PA
		Hydropsyche	*scalaris*	8.52	10.62	3.21	13.09	0.47	2.03	0.23	M	PA
		Hydropsyche	*scalaris*	8.27	11.12	2.96	13.83	0.55	2.18	0.23	M	PA
		Hydropsyche	*scalaris*	8.40	10.99	3.21	13.96	0.51	2.11	0.23	M	PA
		Hydropsyche	*scalaris*	8.77	10.99	3.09	14.33	0.51	2.18	0.23	M	PA
		Hydropsyche	*scalaris*	9.02	11.12	3.33	14.20	0.51	2.11	0.23	M	PA
Hydropsychidae	Hydropsychinae	*Hydropsyche*	*scalaris*	8.03	10.13	3.21	13.59	0.51	1.87	0.23	M	PA
		Hydropsyche	*scalaris*	8.27	10.25	3.09	13.83	0.51	2.11	0.23	M	PA
		Hydropsyche	*scalaris*	8.65	10.50	3.21	13.83	0.51	2.11	0.23	M	PA
Hydropsychidae	Hydropsychinae	*Potamyia*	*flava*	5.06	7.90	2.10	8.77	0.31	1.40	0.31	F	FL

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Potamyia	*flava*	6.30	7.78	2.10	9.51	0.31	1.56	0.23	F	FL
		Potamyia	*flava*	5.31	7.41	1.98	9.76	0.27	1.25	0.18	F	FL
		Potamyia	*flava*	5.56	6.79	1.98	8.77	0.23	1.33	0.23	F	OK
		Potamyia	*flava*	6.79	8.27	2.35	9.26	0.31	1.56	0.31	F	TX
		Potamyia	*flava*	6.30	7.90	2.47	10.13	0.31	1.48	0.27	F	TX
		Potamyia	*flava*	6.18	7.41	1.98	8.89	0.27	1.33	0.23	F	OK
		Potamyia	*flava*	5.43	6.92	2.22	8.52	0.23	1.25	0.23	F	OK
		Potamyia	*flava*	5.80	7.29	2.10	9.26	0.25	1.40	0.23	F	MA
		Potamyia	*flava*	5.56	6.55	1.85	7.66	0.25	1.33	0.20	F	MA
		Potamyia	*flava*	5.19	6.67	2.10	8.15	0.27	1.25	0.23	F	MA
		Potamyia	*flava*	5.93	6.92	2.22	8.65	0.23	1.33	0.23	F	MA
		Potamyia	*flava*	6.42	7.41	2.10	8.89	0.30	1.33	0.23	F	MA
		Potamyia	*flava*	5.43	7.66	2.10	9.76	0.27	1.56	0.23	F	MA
		Potamyia	*flava*	5.93	8.03	2.10	9.76	0.31	1.40	0.23	F	MA
		Potamyia	*flava*	6.05	7.41	2.10	9.26	0.25	1.40	0.23	F	MA
		Potamyia	*flava*	4.69	6.55	2.10	8.40	0.25	1.33	0.22	F	MA
		Potamyia	*flava*	5.93	7.78	2.22	9.39	0.27	1.40	0.23	F	MA
		Potamyia	*flava*	5.19	7.53	2.22	15.07	0.23	1.56	0.16	M	OK
		Potamyia	*flava*	5.93	8.27	2.47	17.54	0.27	1.56	0.14	M	OK
		Potamyia	*flava*	4.57	7.41	2.22	15.19	0.33	1.40	0.12	M	FL
		Potamyia	*flava*	4.32	8.40	2.10	14.33	0.27	1.48	0.08	M	FL
		Potamyia	*flava*	4.94	7.78	2.35	16.18	0.25	1.56	0.12	M	OK
		Potamyia	*flava*	5.06	8.40	2.35	17.41	0.27	1.64	0.12	M	TX
		Potamyia	*flava*	5.31	8.27	2.35	18.77	0.27	1.48	0.10	M	TX
		Potamyia	*flava*	5.80	8.77	2.47	17.54	0.30	1.79	0.13	M	TX
		Potamyia	*flava*	5.68	9.02	2.59	19.02	0.31	1.64	0.13	M	TX
		Potamyia	*flava*	5.80	8.65	2.59	17.91	0.27	1.72	0.08	M	TX
		Potamyia	*flava*	5.93	8.89	2.59	18.77	0.29	1.48	0.14	M	TX
		Potamyia	*flava*	4.82	8.89	2.47	17.54	0.27	1.72	0.14	M	TX
		Potamyia	*flava*	4.94	8.03	2.10	15.81	0.23	1.48	0.14	M	OK
		Potamyia	*flava*	5.56	7.41	2.10	14.94	0.23	1.48	0.12	M	OK
		Potamyia	*flava*	5.43	8.03	2.22	16.18	0.23	1.56	0.12	M	TX
		Potamyia	*flava*	4.94	7.29	2.22	16.92	0.31	1.56	0.14	M	OK
		Potamyia	*flava*	5.80	8.15	2.47	16.18	0.23	1.64	0.09	M	OK
Hydropsychidae	Hydropsychinae	*Potamyia*	*flava*	5.31	8.15	2.47	15.81	0.27	1.64	0.16	M	OK
		Potamyia	*flava*	5.19	7.66	2.22	15.31	0.22	1.56	0.12	M	OK
		Potamyia	*flava*	5.68	8.65	2.22	18.90	0.27	1.64	0.12	M	MA
Hydropsychidae	Macronematinae	*Leptonema*	*albovirens*	10.50	14.45	4.69		0.47	3.28	0.31	F	CR
		Leptonema	*albovirens*	11.24	14.45	5.06		0.51	3.74	0.31	F	CR
		Leptonema	*albovirens*	11.73	14.33	5.06		0.47	3.74	0.31	F	CR
		Leptonema	*albovirens*	9.39	12.35	4.20		0.45	3.35	0.31	F	CR
		Leptonema	*albovirens*	11.12	14.82	5.19		0.47	3.82	0.31	F	CR

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Leptonema	*albovirens*	11.36	14.45	4.57		0.47	3.35	0.31	F	CR
		Leptonema	*albovirens*	10.13	14.08	4.94		0.43	3.59	0.31	F	CR
		Leptonema	*albovirens*	15.07	16.30	5.68	25.07	0.43	3.43	0.27	F	CR
		Leptonema	*albovirens*	10.87	16.18	5.43	26.68	0.55	4.21	0.31	F	MX
		Leptonema	*albovirens*	12.35	14.45	5.19	22.60	0.51	3.67	0.31	F	CR
		Leptonema	*albovirens*	11.73	14.94	4.94		0.47	3.90	0.31	F	CR
		Leptonema	*albovirens*	12.35	14.82	5.19		0.51	3.74	0.31	F	CR
		Leptonema	*albovirens*	11.73	18.40	6.55	30.63	0.55	4.68	0.31	F	MX
		Leptonema	*albovirens*	12.84	19.51	5.93	27.29	0.55	4.37	0.39	F	MX
		Leptonema	*albovirens*	9.39	13.34	4.69		0.47	3.51	0.23	M	CR
		Leptonema	*albovirens*	9.63	13.34	4.94		0.47	3.51	0.23	M	CR
		Leptonema	*albovirens*	9.26	12.23	4.45		0.43	3.12	0.23	M	CR
		Leptonema	*albovirens*	9.02	12.10	4.20		0.43	3.35	0.23	M	CR
		Leptonema	*albovirens*	9.51	11.98	3.95	25.07	0.39	2.89	0.25	M	CR
		Leptonema	*albovirens*	10.00	13.71	4.82		0.39	3.43	0.31	M	CR
		Leptonema	*albovirens*	9.88	13.71	4.57		0.44	3.51	0.31	M	CR
		Leptonema	*albovirens*	10.13	13.59	4.69		0.47	3.59	0.31	M	CR
		Leptonema	*albovirens*	8.77	11.86	4.32		0.47	3.20	0.23	M	CR
		Leptonema	*albovirens*	10.00	12.60	4.69		0.39	3.43	0.31	M	CR
Hydropsychidae	Macronematinae	*Macrostemum*	*carolina*	11.60	12.30	4.20	14.70	0.45	2.70	0.42	F	SC
		Macrostemum	*carolina*	10.10	13.60	4.60	14.30	0.52	2.90	0.51	F	SC
		Macrostemum	*carolina*	10.00	12.50	4.30	10.30	0.34	2.60	0.49	F	SC
		Macrostemum	*carolina*	10.90	13.30	4.50	13.70	0.55	2.70	0.45	F	SC
		Macrostemum	*carolina*	11.20	12.20	4.20	9.10	0.66	2.70	0.42	F	SC
		Macrostemum	*carolina*	9.30	12.50	3.90	11.10	0.59	2.50	0.43	F	SC
		Macrostemum	*carolina*	10.60	14.70	4.40	15.20	0.48	3.00	0.50	F	SC
		Macrostemum	*carolina*	9.80	12.90	4.30	14.20	0.45	2.20	0.45	F	SC
		Macrostemum	*carolina*	8.60	12.70	3.90	12.20	0.45	2.70	0.42	F	SC
		Macrostemum	*carolina*	10.10	12.70	4.00	14.10	0.45	2.70	0.47	F	SC
		Macrostemum	*carolina*	8.20	10.50	3.40	11.80	0.38	2.40	0.39	F	GA
Hydropsychidae	Macronematinae	*Macrostemum*	*carolina*	9.40	10.70	3.50	13.70	0.45	2.30	0.42	F	GA
		Macrostemum	*carolina*	10.10	11.60	4.10	13.20	0.48	2.60	0.45	F	GA
		Macrostemum	*carolina*	9.50	11.70	3.70	11.30	0.48	2.50	0.42	F	GA
		Macrostemum	*carolina*	8.00	10.30	3.50	12.80	0.41	2.30	0.42	F	GA
		Macrostemum	*carolina*	8.50	10.30	3.30	10.50	0.45	2.30	0.37	F	GA
		Macrostemum	*carolina*	8.20	10.10	3.20	12.20	0.41	2.20	0.37	F	GA
		Macrostemum	*carolina*	9.90	11.20	4.20	12.70	0.41	2.50	0.47	F	GA
		Macrostemum	*carolina*	10.00	11.70	4.00	13.10	0.45	2.70	0.46	F	GA
		Macrostemum	*carolina*	9.20	10.80	3.70	13.20	0.48	2.40	0.42	F	GA
		Macrostemum	*carolina*	8.80	10.30	3.40	22.60	0.66	1.60	0.26	M	SC
		Macrostemum	*carolina*	8.90	10.30	3.80	16.30	0.52	2.70	0.25	M	SC
		Macrostemum	*carolina*	8.60	11.10	3.80	24.30	0.45	2.70	0.25	M	SC

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Macrostemum	*carolina*	7.40	10.70	3.50	19.30	0.48	2.50	0.26	M	SC
		Macrostemum	*carolina*	8.70	10.30	3.70	21.50	0.55	2.50	0.24	M	SC
		Macrostemum	*carolina*	8.20	9.80	3.50	19.90	0.59	2.30	0.24	M	SC
		Macrostemum	*carolina*	9.00	10.40	3.90	19.50	0.41	2.80	0.24	M	SC
		Macrostemum	*carolina*	9.70	10.30	3.50	21.30	0.41	2.60	0.21	M	SC
		Macrostemum	*carolina*	9.10	10.90	3.80	23.60	0.38	2.80	0.26	M	SC
		Macrostemum	*carolina*	8.60	11.30	3.90	22.20	0.38	2.80	0.26	M	SC
		Macrostemum	*carolina*	8.50	9.90	3.50	19.70	0.45	2.50	0.22	M	SC
		Macrostemum	*carolina*	8.60	10.60	3.80	21.30	0.48	2.70	0.28	M	SC
		Macrostemum	*carolina*	9.40	11.60	4.10	25.10	0.45	2.60	0.24	M	SC
		Macrostemum	*carolina*	8.60	10.90	3.60	20.80	0.55	2.70	0.24	M	SC
		Macrostemum	*carolina*	9.30	10.90	3.80	23.30	0.55	2.80	0.24	M	SC
		Macrostemum	*carolina*	9.30	11.70	4.20	22.30	0.52	2.90	0.26	M	SC
		Macrostemum	*carolina*	9.20	11.20	3.80	26.10	0.41	2.80	0.26	M	SC
		Macrostemum	*carolina*	8.40	11.40	3.80	23.60	0.41	2.70	0.25	M	SC
		Macrostemum	*carolina*	8.30	10.70	3.80	24.70	0.45	2.70	0.26	M	SC
		Macrostemum	*carolina*	8.50	10.30	3.70	20.90	0.38	2.70	0.26	M	SC
		Macrostemum	*zebratum*	9.26	13.96	3.95	17.66	0.39	2.57	0.47	F	VA
		Macrostemum	*zebratum*	9.51	13.21	3.71	18.40	0.43	2.73	0.44	F	VA
		Macrostemum	*zebratum*	10.50	12.72	3.71	17.78	0.48	2.50	0.47	F	MD
		Macrostemum	*zebratum*	9.02	11.24	3.33	15.07	0.43	2.18	0.43	F	VA
		Macrostemum	*zebratum*	8.40	10.13	2.96	15.31	0.37	1.79	0.34	F	VA
		Macrostemum	*zebratum*	10.62	12.35	3.71	16.67	0.51	2.57	0.47	F	MD
		Macrostemum	*zebratum*	11.36	14.82	4.32	21.37	0.47	3.67	0.55	F	ON
		Macrostemum	*zebratum*	10.50	12.47	3.95	19.14	0.47	2.57	0.47	F	WI
		Macrostemum	*zebratum*	10.87	12.84	3.71	19.27	0.39	2.42	0.44	F	WI
Hydropsychidae	Macronematinae	*Macrostemum*	*zebratum*	11.36	12.47	3.95	19.02	0.37	2.34	0.47	F	WI
		Macrostemum	*zebratum*	10.62	13.59	4.08	18.77	0.51	2.57	0.43	F	WI
		Macrostemum	*zebratum*	8.77	13.21	3.46	17.78	0.51	2.57	0.43	F	WI
		Macrostemum	*zebratum*	8.65	11.61	3.33	18.53	0.47	2.42	0.39	F	WI
		Macrostemum	*zebratum*	9.02	10.37	3.21	18.90	0.39	1.95	0.37	F	VA
		Macrostemum	*zebratum*	9.51	11.49	3.09	15.07	0.41	2.26	0.39	F	VA
		Macrostemum	*zebratum*	9.26	10.87	3.09	15.68	0.35	2.34	0.39	F	VA
		Macrostemum	*zebratum*	9.63	11.86	3.09	15.56	0.43	2.34	0.39	F	VA
		Macrostemum	*zebratum*	8.65	10.62	3.21	15.19	0.39	2.26	0.39	F	VA
		Macrostemum	*zebratum*	8.65	10.99	3.21	15.07	0.41	2.18	0.39	F	VA
		Macrostemum	*zebratum*	10.62	12.60	3.71	18.15	0.45	2.57	0.45	F	MD
		Macrostemum	*zebratum*	8.89	10.99	3.09	15.19	0.37	2.26	0.39	F	MD
		Macrostemum	*zebratum*	10.13	14.20	4.08	20.75	0.47	2.57	0.48	F	VA
		Macrostemum	*zebratum*	9.51	11.86	3.71	15.44	0.39	2.34	0.47	F	IL
		Macrostemum	*zebratum*	10.87	12.97	3.71	17.54	0.43	2.81	0.47	F	IL
		Macrostemum	*zebratum*	10.74	13.34	3.58	16.92	0.43	2.89	0.47	F	IL

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Macrostemum	*zebratum*	10.74	12.84	3.46	16.18	0.43	2.42	0.43	F	MD
		Macrostemum	*zebratum*	10.87	13.83	3.83	19.14	0.43	2.65	0.47	F	IL
		Macrostemum	*zebratum*	9.88	12.60	3.83	18.53	0.47	2.73	0.49	F	IL
		Macrostemum	*zebratum*	10.62	12.72	3.83	16.30	0.47	2.57	0.47	F	MD
		Macrostemum	*zebratum*	8.52	13.09	3.71	18.28	0.43	2.34	0.47	F	IL
		Macrostemum	*zebratum*	10.25	12.72	3.71	17.78	0.48	2.57	0.43	F	MD
		Macrostemum	*zebratum*	8.89	13.83	3.83	29.89	0.43	2.89	0.23	M	MN
		Macrostemum	*zebratum*	8.77	14.45	3.83	41.37	0.39	3.04	0.23	M	ON
		Macrostemum	*zebratum*	7.53	14.33	3.95	43.47	0.55	2.89	0.27	M	ON
		Macrostemum	*zebratum*	11.61	15.56	4.32	46.44	0.39	3.35	0.30	M	ON
		Macrostemum	*zebratum*	8.15	14.20	4.08	42.98	0.39	3.12	0.31	M	ON
		Macrostemum	*zebratum*	10.99	15.44	4.08	47.55	0.43	3.28	0.31	M	ON
		Macrostemum	*zebratum*	7.90	14.82	3.95	45.08	0.43	3.20	0.27	M	ON
		Macrostemum	*zebratum*	8.89	14.57	3.95	43.35	0.43	3.12	0.27	M	ON
		Macrostemum	*zebratum*	9.63	16.06	4.20	48.04	0.43	3.82	0.27	M	ON
		Macrostemum	*zebratum*	9.02	15.19	4.20	47.05	0.43	3.20	0.23	M	ON
		Macrostemum	*zebratum*	8.77	12.35	3.21	35.20	0.39	2.81	0.30	M	IL
		Macrostemum	*zebratum*	9.26	14.82	4.08	44.71	0.43	3.12	0.31	M	ON
		Macrostemum	*zebratum*	8.65	15.44	3.95	36.06	0.39	2.89	0.30	M	ON
		Macrostemum	*zebratum*	8.89	14.70	3.95	46.44	0.43	3.04	0.31	M	ON
		Macrostemum	*zebratum*	8.27	14.94	3.71	45.70	0.43	2.96	0.23	M	ON
		Macrostemum	*zebratum*	8.15	12.84	3.58	40.01	0.45	2.81	0.27	M	VA
Hydropsychidae	Macronematinae	*Macrostemum*	*zebratum*	7.90	12.35	3.46	35.44	0.37	2.96	0.31	M	IL
		Macrostemum	*zebratum*	9.63	13.34	3.71	41.00	0.39	3.04	0.30	M	IL
		Macrostemum	*zebratum*	8.77	13.09	3.83	38.90	0.39	3.04	0.27	M	IL
		Macrostemum	*zebratum*	8.40	13.21	3.71	40.76	0.39	3.04	0.27	M	IL
		Macrostemum	*zebratum*	9.26	13.83	3.83	37.30	0.43	3.04	0.31	M	IL
		Macrostemum	*zebratum*	9.02	13.83	3.83	43.23	0.39	2.96	0.31	M	WI
		Macrostemum	*zebratum*	8.65	12.35	3.33	36.43	0.35	2.96	0.31	M	IL
		Macrostemum	*zebratum*	8.40	13.34	3.83	39.52	0.43	2.65	0.23	M	VA
		Macrostemum	*zebratum*	9.20	13.88	3.59	41.03	0.43	3.12	0.23	M	IN
		Macrostemum	*zebratum*	10.74	14.20	3.71	44.83	0.39	3.12	0.31	M	VA
		Macrostemum	*zebratum*	9.39	14.82	4.20	46.93	0.43	3.28	0.31	M	VA
		Macrostemum	*zebratum*	9.26	14.94	3.83	46.93	0.39	2.96	0.31	M	VA
		Macrostemum	*zebratum*	9.14	13.96	3.95	43.23	0.41	3.12	0.31	M	VA
		Macrostemum	*zebratum*	9.39	14.57	3.95	42.98	0.43	3.04	0.31	M	WI
		Macrostemum	*zebratum*	7.90	12.47	3.33	35.94	0.37	2.81	0.27	M	IL
		Macrostemum	*zebratum*	10.25	13.96	3.71	43.10	0.43	3.04	0.31	M	WI
		Macrostemum	*zebratum*	9.63	14.20	3.83	42.73	0.35	3.04	0.31	M	IL
		Macrostemum	*zebratum*	9.39	13.59	3.58	41.13	0.39	2.50	0.23	M	WV
		Macrostemum	*zebratum*	7.41	13.09	3.71	40.88	0.35	2.50	0.20	M	WV
		Macrostemum	*zebratum*	8.27	13.46	3.71	43.47	0.47	2.73	0.23	M	WV

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Macrostemum	*zebratum*	8.40	13.59	3.71	41.13	0.41	2.73	0.23	M	WV
		Macrostemum	*zebratum*	9.02	13.34	3.33	38.90	0.39	2.73	0.27	M	WV
		Macrostemum	*zebratum*	8.77	13.59	4.08	45.02	0.43	2.89	0.31	M	WV
		Macrostemum	*zebratum*	8.27	14.45	3.95	44.58	0.43	2.89	0.23	M	WV
Hydropsychidae	Smicrideinae	*Smicridea*	*dispar*	3.95	5.80	1.73	4.69	0.23	1.33	0.16	F	CA
		Smicridea	*dispar*	4.57	6.55	1.85	5.19	0.27	1.33	0.17	F	CA
		Smicridea	*dispar*	3.83	5.68	1.85	4.32	0.31	1.17	0.16	F	CA
		Smicridea	*dispar*	4.08	6.42	1.61	4.57	0.31	1.17	0.16	F	CA
		Smicridea	*dispar*	4.82	6.67	2.10	5.43	0.23	1.25	0.16	F	CA
		Smicridea	*dispar*	4.57	6.42	2.10	4.94	0.31	1.40	0.16	F	CA
		Smicridea	*dispar*	3.58	6.05	2.10	4.57	0.31	1.25	0.12	F	CA
		Smicridea	*dispar*	4.94	6.55	2.10	5.06	0.31	1.33	0.16	F	CA
		Smicridea	*dispar*	4.69	6.42	1.98	4.94	0.26	1.25	0.16	F	CA
		Smicridea	*dispar*	4.08	6.18	1.85	4.69	0.31	1.33	0.16	F	CA
		Smicridea	*dispar*	4.20	6.30	1.98	5.06	0.31	1.25	0.18	F	CA
		Smicridea	*dispar*	4.45	6.18	1.85	4.82	0.31	1.25	0.18	F	CA
		Smicridea	*dispar*	3.83	5.19	1.85	5.06	0.31	1.25	0.10	M	CA
		Smicridea	*dispar*	3.71	5.68	1.73	5.31	0.31	1.33	0.08	M	CA
Hydropsychidae	Smicrideinae	*Smicridea*	*dispar*	3.83	5.68	1.98	5.80	0.31	1.40	0.12	M	CA
		Smicridea	*dispar*	3.95	5.80	1.85	5.56	0.27	1.40	0.12	M	CA
		Smicridea	*dispar*	3.83	6.05	1.85	5.31	0.31	1.25	0.16	M	CA
		Smicridea	*dispar*	3.83	5.43	1.85	5.06	0.31	1.17	0.12	M	CA
		Smicridea	*dispar*	4.08	5.80	1.85	5.43	0.31	1.33	0.12	M	CA
		Smicridea	*dispar*	4.08	5.80	2.22	5.06	0.31	1.33	0.12	M	CA
		Smicridea	*dispar*	3.83	5.93	1.98	5.68	0.31	1.40	0.12	M	CA
		Smicridea	*dispar*	3.71	5.80	1.48	5.31	0.39	1.33	0.08	M	CA
		Smicridea	*dispar*	3.83	5.56	2.10	5.06	0.31	1.33	0.12	M	CA
		Smicridea	*dispar*	3.95	5.80	1.73	5.68	0.31	1.25	0.08	M	CA
		Smicridea	*dispar*	3.33	4.94	1.61	4.57	0.23	1.33	0.16	M	CA
		Smicridea	*dispar*	3.33	5.56	1.85	4.69	0.23	1.33	0.16	M	CA
		Smicridea	*dispar*	3.83	5.56	1.85	5.06	0.31	1.33	0.09	M	CA
		Smicridea	*dispar*	4.20	6.05	2.10	5.68	0.27	1.33	0.12	M	CA
		Smicridea	*dispar*	3.83	5.80	1.85	5.56	0.31	1.17	0.12	M	CA
		Smicridea	*dispar*	3.83	6.05	1.85	5.68	0.31	1.25	0.08	M	CA
		Smicridea	*dispar*	3.71	5.68	1.85	5.19	0.31	1.33	0.08	M	CA
		Smicridea	*dispar*	3.83	5.93	1.85	5.68	0.23	1.33	0.08	M	CA
		Smicridea	*dithyra*	4.80	5.90	1.90	5.60	0.17	1.30	0.16	F	MX
		Smicridea	*dithyra*	4.60	5.50	1.70	5.40	0.21	1.30	0.16	F	MX
		Smicridea	*dithyra*	4.30	5.80	1.70	5.70	0.21	1.30	0.16	F	MX
		Smicridea	*dithyra*	4.30	5.70	1.80	5.50	0.17	1.30	0.16	F	MX
		Smicridea	*dithyra*	5.10	5.60	1.90	5.50	0.21	1.30	0.16	F	MX
		Smicridea	*dithyra*	5.00	5.80	1.80	5.50	0.21	1.30	0.16	F	MX

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
Hydropsychidae	Smicrideinae	*Smicridea*	*dithyra*	5.00	6.10	1.90	5.60	0.21	1.20	0.12	F	MX
		Smicridea	*dithyra*	4.40	5.70	2.00	6.10	0.21	1.20	0.16	F	MX
		Smicridea	*dithyra*	4.10	5.40	1.70	5.70	0.17	1.20	0.16	F	MX
		Smicridea	*dithyra*	4.40	5.70	1.80	5.70	0.24	1.20	0.16	F	MX
		Smicridea	*dithyra*	4.60	6.00	1.90	6.00	0.17	1.30	0.16	F	MX
		Smicridea	*dithyra*	5.00	6.00	1.90	6.20	0.21	1.30	0.20	F	MX
		Smicridea	*dithyra*	4.20	5.30	1.70	5.30	0.21	1.20	0.14	F	MX
		Smicridea	*dithyra*	4.20	6.00	1.90	6.10	0.21	1.30	0.17	F	MX
		Smicridea	*dithyra*	5.10	5.80	2.00	5.30	0.21	1.30	0.14	F	MX
		Smicridea	*dithyra*	4.30	5.70	1.90	5.30	0.21	1.20	0.16	F	MX
		Smicridea	*dithyra*	5.10	5.30	1.70	5.40	0.21	1.20	0.16	F	MX
		Smicridea	*dithyra*	4.80	5.70	1.70	5.20	0.21	1.20	0.13	F	MX
		Smicridea	*dithyra*	4.60	6.10	1.90	5.70	0.21	1.40	0.16	F	MX
		Smicridea	*dithyra*	5.00	6.10	1.90	6.00	0.17	1.30	0.14	F	MX
		Smicridea	*dithyra*	4.60	5.00	1.70	5.30	0.24	1.20	0.11	M	MX
		Smicridea	*dithyra*	4.30	5.50	1.70	5.60	0.17	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.60	5.00	1.90	6.20	0.17	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.60	5.50	1.80	5.80	0.21	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.30	5.20	1.80	5.80	0.19	1.40	0.11	M	MX
		Smicridea	*dithyra*	4.50	5.50	1.90	5.60	0.21	1.40	0.11	M	MX
		Smicridea	*dithyra*	4.70	5.20	1.80	5.50	0.21	1.20	0.11	M	MX
		Smicridea	*dithyra*	4.40	5.30	1.90	5.70	0.17	1.20	0.11	M	MX
		Smicridea	*dithyra*	4.60	5.30	1.80	5.80	0.24	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.50	5.00	1.90	6.00	0.21	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.10	5.20	1.60	5.60	0.21	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.20	5.20	1.60	5.60	0.24	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.40	5.50	1.80	5.00	0.24	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.50	5.40	1.80	5.40	0.24	1.30	0.12	M	MX
		Smicridea	*dithyra*	4.20	5.50	1.90	6.00	0.17	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.50	5.10	1.90	5.50	0.22	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.30	5.80	1.80	5.20	0.24	1.20	0.11	M	MX
		Smicridea	*dithyra*	4.10	5.50	1.80	5.60	0.24	1.30	0.12	M	MX
		Smicridea	*dithyra*	4.80	5.20	1.60	5.50	0.24	1.30	0.11	M	MX
		Smicridea	*dithyra*	4.80	5.30	1.80	6.00	0.21	1.30	0.11	M	MX
		Smicridea	*fasciatella*	5.06	6.79	2.22	6.05	0.25	1.33	0.16	F	TX
		Smicridea	*fasciatella*	5.19	6.42	1.85	5.31	0.27	1.40	0.16	F	TX
		Smicridea	*fasciatella*	5.06	6.55	2.10	5.68	0.27	1.40	0.16	F	TX
		Smicridea	*fasciatella*	4.94	6.30	1.98	5.19	0.23	1.40	0.16	F	TX
		Smicridea	*fasciatella*	5.80	6.67	2.22	5.56	0.23	1.48	0.20	F	CA
		Smicridea	*fasciatella*	5.31	6.42	2.10	5.31	0.23	1.40	0.16	F	TX
		Smicridea	*fasciatella*	5.06	6.18	1.85	5.31	0.23	1.48	0.14	F	TX
		Smicridea	*fasciatella*	6.18	6.67	2.10	5.80	0.25	1.33	0.17	F	CA

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibiai Width**	**Sex**	**State**
		Smicridea	*fasciatella*	6.42	6.79	2.10	5.19	0.25	1.48	0.16	F	CA
		Smicridea	*fasciatella*	5.31	6.55	2.10	5.56	0.23	1.48	0.16	F	CA
		Smicridea	*fasciatella*	5.80	6.55	2.10	5.56	0.27	1.33	0.16	F	TX
		Smicridea	*fasciatella*	4.57	6.79	2.22	5.68	0.23	1.33	0.14	F	TX
		Smicridea	*fasciatella*	6.55	6.42	2.10	6.05	0.27	1.48	0.20	F	CA
		Smicridea	*fasciatella*	4.82	6.42	2.10	5.31	0.25	1.17	0.22	F	CA
		Smicridea	*fasciatella*	4.82	6.18	2.10	5.06	0.25	1.56	0.14	F	TX
		Smicridea	*fasciatella*	5.19	6.55	2.10	5.68	0.31	1.56	0.16	F	TX
		Smicridea	*fasciatella*	5.56	6.79	2.10	5.80	0.25	1.56	0.16	F	CA
		Smicridea	*fasciatella*	6.18	6.18	1.98	5.93	0.25	1.48	0.16	F	CA
Hydropsychidae	Smicrideinae	*Smicridea*	*fasciatella*	4.94	6.67	1.98	5.43	0.23	1.40	0.17	F	CA
		Smicridea	*fasciatella*	5.43	6.30	1.98	5.43	0.27	1.40	0.20	F	CA
		Smicridea	*fasciatella*	4.94	6.42	2.10	6.55	0.31	1.56	0.14	M	TX
		Smicridea	*fasciatella*	4.94	7.04	2.10	6.18	0.23	1.48	0.16	M	TX
		Smicridea	*fasciatella*	4.32	6.30	2.10	5.68	0.22	1.33	0.12	M	CA
		Smicridea	*fasciatella*	4.45	6.42	1.85	6.18	0.27	1.40	0.12	M	CA
		Smicridea	*fasciatella*	4.45	5.68	1.85	5.43	0.27	1.40	0.16	M	TX
		Smicridea	*fasciatella*	4.69	6.55	2.10	6.30	0.23	1.48	0.16	M	TX
		Smicridea	*fasciatella*	5.68	6.67	1.85	5.80	0.25	1.56	0.12	M	CA
		Smicridea	*fasciatella*	4.82	6.30	1.98	6.30	0.23	1.56	0.16	M	TX
		Smicridea	*fasciatella*	4.69	6.55	2.10	6.30	0.27	1.48	0.14	M	TX
		Smicridea	*fasciatella*	4.82	6.30	2.10	6.30	0.27	1.48	0.14	M	TX
		Smicridea	*fasciatella*	4.69	5.80	1.98	5.56	0.25	1.17	0.14	M	TX
		Smicridea	*fasciatella*	4.57	6.30	1.73	5.93	0.23	1.48	0.09	M	CA
		Smicridea	*fasciatella*	5.06	6.42	1.98	6.42	0.27	1.33	0.14	M	CA
		Smicridea	*fasciatella*	5.93	5.56	1.85	5.80	0.23	1.40	0.14	M	CA
		Smicridea	*fasciatella*	4.57	5.80	1.85	5.93	0.27	1.40	0.14	M	TX
		Smicridea	*fasciatella*	4.57	5.93	1.85	5.56	0.23	1.48	0.14	M	CA
		Smicridea	*fasciatella*	4.57	6.30	1.73	6.18	0.23	1.48	0.14	M	TX
		Smicridea	*fasciatella*	5.43	6.55	2.22	6.42	0.27	1.33	0.12	M	CA
		Smicridea	*fasciatella*	5.68	6.55	1.98	6.30	0.25	1.48	0.14	M	CA
		Smicridea	*fasciatella*	4.57	6.30	1.85	5.93	0.25	1.17	0.12	M	CA
Philopotamidae	Chimarrinae	*Chimarra*	*aterrima*	5.68	8.15	2.22	6.30	0.23	1.40	0.16	F	VA
		Chimarra	*aterrima*	5.80	7.41	2.10	6.05	0.27	1.48	0.16	F	VA
		Chimarra	*aterrima*	5.43	7.78	1.73	5.93	0.27	1.48	0.16	F	VA
		Chimarra	*aterrima*	5.31	7.78	2.22	6.30	0.23	1.56	0.20	F	VA
		Chimarra	*aterrima*	5.43	7.66	2.10	5.80	0.27	1.25	0.16	F	VA
		Chimarra	*aterrima*	5.68	7.53	1.98	5.80	0.23	1.48	0.16	F	VA
		Chimarra	*aterrima*	5.43	6.79	2.22	6.05	0.23	1.48	0.16	F	VA
		Chimarra	*aterrima*	5.80	7.53	1.98	5.80	0.23	1.40	0.16	F	VA
		Chimarra	*aterrima*	6.18	7.53	1.98	6.30	0.23	1.48	0.20	F	VA
		Chimarra	*aterrima*	5.93	7.66	2.10	5.93	0.23	1.56	0.16	F	VA

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
Philopotamidae	Chimarrinae	*Chimarra*	*aterrima*	5.80	8.03	2.22	6.05	0.27	1.56	0.16	F	VA
		Chimarra	*aterrima*	6.18	8.03	2.10	6.30	0.27	1.48	0.16	F	VA
		Chimarra	*aterrima*	5.43	7.90	1.98	6.67	0.23	1.48	0.16	F	VA
		Chimarra	*aterrima*	5.43	7.53	2.10	6.30	0.23	1.40	0.16	F	VA
		Chimarra	*aterrima*	5.68	7.41	2.22	5.31	0.23	1.33	0.16	F	VA
		Chimarra	*aterrima*	6.55	8.03	2.10	6.30	0.27	1.40	0.16	F	VA
		Chimarra	*aterrima*	5.56	6.79	1.98	5.80	0.23	1.48	0.16	F	VA
		Chimarra	*aterrima*	5.43	7.53	1.98	5.68	0.27	1.56	0.16	F	VA
		Chimarra	*aterrima*	5.43	7.29	1.98	5.93	0.23	1.33	0.16	F	VA
		Chimarra	*aterrima*	5.68	7.29	1.98	5.93	0.23	1.40	0.16	F	VA
		Chimarra	*aterrima*	4.57	5.56	1.73	6.18	0.22	1.25	0.16	M	VA
		Chimarra	*aterrima*	4.82	6.18	1.73	5.68	0.20	1.25	0.16	M	VA
		Chimarra	*aterrima*	4.57	6.55	1.85	6.79	0.23	1.40	0.16	M	VA
		Chimarra	*aterrima*	4.45	5.56	1.48	5.31	0.20	1.25	0.12	M	VA
		Chimarra	*aterrima*	4.69	6.30	1.73	6.30	0.23	1.17	0.08	M	VA
		Chimarra	*aterrima*	4.82	6.42	1.73	5.93	0.23	1.33	0.16	M	VA
		Chimarra	*aterrima*	4.57	6.55	1.85	6.55	0.23	1.33	0.09	M	VA
		Chimarra	*aterrima*	5.19	6.67	1.85	6.05	0.23	1.25	0.12	M	VA
		Chimarra	*aterrima*	4.82	6.18	1.73	5.93	0.23	1.17	0.14	M	VA
		Chimarra	*aterrima*	5.06	6.67	1.85	6.30	0.23	1.33	0.16	M	VA
		Chimarra	*aterrima*	4.57	6.18	1.73	5.93	0.27	1.17	0.16	M	VA
		Chimarra	*aterrima*	4.69	6.30	1.73	6.30	0.23	1.33	0.16	M	VA
		Chimarra	*aterrima*	4.69	6.79	1.85	6.30	0.23	1.33	0.12	M	VA
		Chimarra	*aterrima*	5.06	6.55	1.85	6.05	0.23	1.33	0.16	M	VA
		Chimarra	*aterrima*	4.94	6.92	1.98	6.30	0.23	1.33	0.12	M	VA
		Chimarra	*aterrima*	4.45	6.67	1.73	6.42	0.25	1.33	0.16	M	VA
		Chimarra	*aterrima*	4.20	6.42	1.85	6.30	0.23	1.33	0.09	M	VA
		Chimarra	*aterrima*	5.43	5.43	1.73	5.93	0.23	1.40	0.09	M	VA
		Chimarra	*aterrima*	4.69	6.55	1.85	6.42	0.23	1.40	0.09	M	VA
		Chimarra	*aterrima*	4.45	6.18	1.73	6.30	0.23	1.33	0.16	M	VA
		Chimarra	*texana*	6.05	7.53	2.10	6.79	0.39	1.48	0.16	F	TX
		Chimarra	*texana*	5.80	7.78	2.10	6.42	0.35	1.56	0.20	F	TX
		Chimarra	*texana*	5.31	6.30	1.98	6.30	0.31	1.48	0.16	F	TX
		Chimarra	*texana*	6.05	7.53	2.10	6.42	0.39	1.48	0.16	F	TX
		Chimarra	*texana*	4.82	7.66	2.10	6.30	0.31	1.64	0.16	F	TX
		Chimarra	*texana*	5.43	7.78	2.10	6.42	0.39	1.64	0.16	F	TX
		Chimarra	*texana*	5.56	8.15	2.10	6.18	0.39	1.72	0.16	F	TX
		Chimarra	*texana*	5.19	6.79	1.85	5.68	0.31	1.48	0.16	F	TX
		Chimarra	*texana*	4.32	6.92	1.98	6.30	0.35	1.48	0.16	F	TX
		Chimarra	*texana*	4.94	7.41	2.10	6.18	0.31	1.48	0.16	F	TX
		Chimarra	*texana*	4.57	7.04	1.85	5.68	0.25	1.40	0.16	F	TX
		Chimarra	*texana*	4.94	7.53	1.98	5.68	0.31	1.48	0.16	F	TX

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Chimarra	*texana*	4.08	7.66	1.98	6.18	0.23	1.56	0.16	F	TX
		Chimarra	*texana*	4.94	7.04	1.98	5.56	0.27	1.40	0.16	F	TX
Philopotamidae	Chimarrinae	*Chimarra*	*texana*	4.57	6.79	1.98	5.56	0.23	1.40	0.16	F	TX
		Chimarra	*texana*	5.56	7.78	2.22	6.30	0.35	1.48	0.16	F	TX
		Chimarra	*texana*	4.57	6.55	1.85	6.42	0.31	1.56	0.16	M	TX
		Chimarra	*texana*	4.69	6.05	1.85	5.68	0.31	1.25	0.16	M	TX
		Chimarra	*texana*	5.06	6.67	1.85	6.30	0.39	1.48	0.16	M	TX
		Chimarra	*texana*	5.06	6.55	1.98	5.68	0.31	1.56	0.16	M	TX
		Chimarra	*texana*	4.57	6.30	1.85	5.80	0.33	1.33	0.16	M	TX
Philopotamidae	Philopotaminae	*Dolophilodes*	*aequalis*	7.16	9.76	2.72	7.53	0.27	1.95	0.14	F	MT
		Dolophilodes	*aequalis*	6.55	10.50	2.72	8.27	0.31	2.11	0.16	F	MT
		Dolophilodes	*aequalis*	7.78	11.36	3.09	8.15	0.31	2.34	0.16	F	MT
		Dolophilodes	*aequalis*	9.02	11.73	3.33	8.40	0.27	2.18	0.16	F	WY
		Dolophilodes	*aequalis*	8.03	10.25	2.84	7.90	0.31	2.26	0.14	F	WY
		Dolophilodes	*aequalis*	9.76	12.10	3.09	9.26	0.31	2.50	0.20	F	ID
		Dolophilodes	*aequalis*	8.65	12.10	3.21	9.26	0.34	2.57	0.20	F	ID
		Dolophilodes	*aequalis*	9.14	10.87	2.84	8.65	0.35	2.50	0.18	F	ID
		Dolophilodes	*aequalis*	10.00	12.47	3.09	10.00	0.39	2.57	0.16	F	UT
		Dolophilodes	*aequalis*	9.26	12.23	3.21	9.02	0.31	2.50	0.20	F	UT
		Dolophilodes	*aequalis*	7.41	11.12	2.84	8.03	0.31	2.18	0.14	F	UT
		Dolophilodes	*aequalis*	7.04	10.37	2.72	7.66	0.27	2.18	0.16	F	UT
		Dolophilodes	*aequalis*	7.66	11.12	3.09	7.78	0.31	2.18	0.16	F	UT
		Dolophilodes	*aequalis*	7.90	10.37	2.96	7.78	0.31	2.34	0.16	F	UT
		Dolophilodes	*aequalis*	7.29	10.37	3.09	7.78	0.27	2.18	0.16	F	UT
		Dolophilodes	*aequalis*	6.92	9.76	2.84	7.41	0.31	2.11	0.16	F	UT
		Dolophilodes	*aequalis*	8.03	10.50	2.84	9.14	0.27	2.18	0.14	M	WY
		Dolophilodes	*aequalis*	6.18	9.63	2.72	10.25	0.27	2.03	0.16	M	MT
		Dolophilodes	*aequalis*	6.55	10.62	2.96	9.88	0.27	2.11	0.16	M	MT
		Dolophilodes	*aequalis*	6.79	11.12	3.09	9.88	0.31	2.26	0.12	M	MT
		Dolophilodes	*aequalis*	7.04	11.73	3.21	10.25	0.39	2.34	0.16	M	MT
		Dolophilodes	*aequalis*	6.67	8.89	2.59	8.89	0.31	1.87	0.14	M	MT
		Dolophilodes	*aequalis*	6.42	9.26	2.72	9.02	0.27	1.95	0.16	M	WY
		Dolophilodes	*aequalis*	7.04	10.25	2.96	9.51	0.31	2.18	0.14	M	MT
		Dolophilodes	*aequalis*	8.65	11.36	3.09	10.50	0.35	2.34	0.16	M	ID
		Dolophilodes	*aequalis*	7.41	10.99	3.46	10.13	0.31	2.26	0.14	M	UT
		Dolophilodes	*aequalis*	6.67	10.99	3.09	10.25	0.31	2.34	0.12	M	UT
		Dolophilodes	*aequalis*	6.79	10.50	3.09	10.00	0.31	2.18	0.16	M	UT
		Dolophilodes	*distinctus*	7.04	5.31	1.85	5.68	0.25	1.56	0.09	F	NF
		Dolophilodes	*distinctus*	5.56	7.04	2.22	5.68	0.27	1.72	0.12	F	NF
		Dolophilodes	*distinctus*	5.80	7.16	2.10	5.68	0.27	1.64	0.12	F	NF
Philopotamidae	Philopotaminae	*Dolophilodes*	*distinctus*	5.56	7.29	2.10	5.68	0.27	1.48	0.09	F	NF
		Dolophilodes	*distinctus*	5.19	7.16	2.22	5.68	0.23	1.64	0.12	F	NF

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Dolophilodes	*distinctus*	5.19	6.67	2.22	5.31	0.27	1.56	0.12	F	NF
		Dolophilodes	*distinctus*	4.82	7.29	2.35	5.06	0.26	1.64	0.12	F	NF
		Dolophilodes	*distinctus*	4.69	6.55	2.10	4.69	0.23	1.56	0.12	F	NF
		Dolophilodes	*distinctus*	5.56	6.92	2.10	5.80	0.23	1.56	0.14	F	NF
		Dolophilodes	*distinctus*	4.82	6.67	1.98	6.05	0.31	1.48	0.12	M	NF
		Dolophilodes	*distinctus*	4.45	6.42	1.98	5.19	0.27	1.40	0.08	M	NF
		Dolophilodes	*distinctus*	4.08	6.18	2.10	5.68	0.27	1.56	0.11	M	NF
		Dolophilodes	*distinctus*	4.45	6.79	2.10	5.68	0.26	1.56	0.12	M	NF
		Dolophilodes	*distinctus*	4.32	6.55	1.98	6.05	0.27	1.56	0.12	M	NF
		Dolophilodes	*distinctus*	4.57	7.29	2.10	6.18	0.27	1.56	0.12	M	NF
		Dolophilodes	*distinctus*	4.82	6.30	2.10	6.30	0.31	1.48	0.08	M	NF
		Dolophilodes	*distinctus*	4.45	7.16	2.10	6.30	0.31	1.64	0.09	M	NF
		Dolophilodes	*distinctus*	4.32	6.55	2.10	5.93	0.25	1.56	0.12	M	NF
		Dolophilodes	*distinctus*	4.45	6.79	2.22	6.42	0.27	1.40	0.08	M	NF
		Dolophilodes	*distinctus*	5.06	6.79	2.10	6.42	0.30	1.56	0.08	M	NF
		Dolophilodes	*distinctus*	4.45	6.92	2.10	6.05	0.27	1.56	0.09	M	NF
		Dolophilodes	*distinctus*	4.82	7.04	2.22	6.18	0.27	1.56	0.12	M	NF
		Dolophilodes	*distinctus*	4.69	7.04	2.10	5.80	0.23	1.72	0.12	M	NF
		Dolophilodes	*distinctus*	4.20	7.04	2.35	6.30	0.27	1.56	0.09	M	NF
		Dolophilodes	*distinctus*	4.69	7.16	2.22	6.30	0.27	1.79	0.12	M	NF
		Dolophilodes	*distinctus*	4.45	6.42	2.10	5.80	0.31	1.56	0.09	M	NF
		Dolophilodes	*distinctus*	4.69	6.67	2.22	5.93	0.31	1.56	0.09	M	NF
		Dolophilodes	*distinctus*	3.95	6.18	2.10	5.43	0.23	1.48	0.09	M	NF
		Dolophilodes	*distinctus*	4.69	6.79	2.35	5.68	0.27	1.48	0.12	M	NF
		Dolophilodes	*distinctus*	4.45	7.04	2.22	5.80	0.31	1.40	0.09	M	NF
		Dolophilodes	*distinctus*	4.08	6.67	2.10	6.05	0.31	1.64	0.09	M	NF
		Dolophilodes	*distinctus*	4.69	6.42	1.98	5.56	0.27	1.40	0.09	M	NF
Polycentropodidae		*Neureclipsis*	*bimaculata*	6.42	7.66	2.22	5.31	0.31	1.79	0.22	F	AK
		Neureclipsis	*bimaculata*	6.92	8.89	2.35	6.05	0.23	1.95	0.31	F	NWT
		Neureclipsis	*bimaculata*	5.93	8.27	2.10	5.68	0.23	1.87	0.27	F	NWT
		Neureclipsis	*bimaculata*	5.56	8.52	2.22	5.68	0.23	1.95	0.25	F	NWT
		Neureclipsis	*bimaculata*	6.79	9.26	2.47	6.42	0.24	2.03	0.31	F	NWT
		Neureclipsis	*bimaculata*	6.05	8.52	2.35	5.31	0.23	1.95	0.27	F	NWT
		Neureclipsis	*bimaculata*	6.79	8.65	2.35	6.18	0.27	2.03	0.29	F	NWT
		Neureclipsis	*bimaculata*	5.43	8.03	2.10	5.19	0.25	1.95	0.22	F	NWT
		Neureclipsis	*bimaculata*	5.93	8.65	2.22	5.43	0.31	1.95	0.26	F	NWT
Polycentropodidae		*Neureclipsis*	*bimaculata*	5.93	8.40	2.22	5.43	0.27	1.95	0.31	F	NWT
		Neureclipsis	*bimaculata*	5.68	9.51	2.47	6.55	0.35	2.18	0.32	F	NWT
		Neureclipsis	*bimaculata*	7.04	9.14	2.59	6.30	0.31	2.11	0.31	F	NWT
		Neureclipsis	*bimaculata*	8.52	9.51	2.96	5.80	0.31	2.18	0.31	F	ON
		Neureclipsis	*bimaculata*	8.40	8.77	2.47	6.92	0.35	2.11	0.31	F	ON
		Neureclipsis	*bimaculata*	8.03	9.14	2.72	6.30	0.39	2.03	0.33	F	ON

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Neureclipsis	*bimaculata*	8.03	9.63	2.84	6.05	0.35	2.26	0.33	F	ON
		Neureclipsis	*bimaculata*	8.15	9.39	2.96	6.30	0.39	1.87	0.34	F	ON
		Neureclipsis	*bimaculata*	7.78	9.51	2.59	6.18	0.35	1.64	0.35	F	ON
		Neureclipsis	*bimaculata*	8.03	9.51	2.84	6.55	0.35	2.11	0.33	F	ON
		Neureclipsis	*bimaculata*	5.43	6.79	1.98	5.56	0.27	1.56	0.16	M	AK
		Neureclipsis	*bimaculata*	5.43	7.41	1.98	6.18	0.27	1.79	0.16	M	AK
		Neureclipsis	*bimaculata*	5.31	7.41	1.98	6.18	0.25	1.72	0.17	M	AK
		Neureclipsis	*bimaculata*	4.45	6.79	1.98	4.32	0.23	1.64	0.17	M	AK
		Neureclipsis	*bimaculata*	5.19	7.16	2.22	5.68	0.27	1.64	0.16	M	AK
		Neureclipsis	*bimaculata*	5.68	7.04	2.10	6.05	0.30	1.72	0.22	M	AK
		Neureclipsis	*bimaculata*	4.57	6.79	2.10	5.06	0.23	1.56	0.16	M	AK
		Neureclipsis	*bimaculata*	4.82	6.42	1.73	5.43	0.23	1.64	0.16	M	NWT
		Neureclipsis	*bimaculata*	4.57	6.18	1.98	6.05	0.20	1.64	0.16	M	NWT
		Neureclipsis	*bimaculata*	3.95	6.42	1.98	5.43	0.23	1.56	0.16	M	NWT
		Neureclipsis	*bimaculata*	4.32	6.67	1.85	5.43	0.23	1.56	0.14	M	NWT
		Neureclipsis	*bimaculata*	4.20	6.18	1.73	5.06	0.20	1.56	0.16	M	NWT
		Neureclipsis	*bimaculata*	4.20	7.04	1.73	6.92	0.23	1.56	0.20	M	NWT
		Neureclipsis	*bimaculata*	4.94	6.67	1.98	5.31	0.27	1.64	0.16	M	NWT
		Neureclipsis	*bimaculata*	3.83	5.93	1.61	5.06	0.20	1.56	0.16	M	NWT
		Neureclipsis	*bimaculata*	4.20	6.67	1.98	5.56	0.23	1.56	0.17	M	NWT
		Neureclipsis	*bimaculata*	4.45	6.42	1.61	5.19	0.23	1.56	0.16	M	NWT
		Neureclipsis	*bimaculata*	4.45	6.67	1.85	5.56	0.23	1.56	0.16	M	NWT
		Neureclipsis	*bimaculata*	4.69	6.79	1.85	5.43	0.23	1.64	0.16	M	NWT
		Neureclipsis	*bimaculata*	4.69	6.79	1.98	5.80	0.23	1.56	0.16	M	NWT
		Neureclipsis	*crepuscularis*	6.55	7.66	2.10	5.80	0.23	1.56	0.23	F	ON
		Neureclipsis	*crepuscularis*	6.30	7.16	2.10	5.68	0.23	1.72	0.23	F	ON
		Neureclipsis	*crepuscularis*	5.80	7.66	2.35	5.80	0.23	1.72	0.23	F	ON
		Neureclipsis	*crepuscularis*	4.82	6.67	1.85	5.31	0.23	1.56	0.23	F	ON
		Neureclipsis	*crepuscularis*	5.43	6.92	1.98	5.56	0.25	1.72	0.20	F	ON
		Neureclipsis	*crepuscularis*	5.56	7.53	2.10	5.56	0.27	1.79	0.27	F	ON
		Neureclipsis	*crepuscularis*	6.42	7.66	2.10	5.80	0.25	1.56	0.27	F	ON
		Neureclipsis	*crepuscularis*	5.19	6.92	1.73	5.31	0.22	1.56	0.23	F	ON
Polycentropodidae		*Neureclipsis*	*crepuscularis*	5.43	7.16	2.22	5.06	0.25	1.64	0.23	F	ON
		Neureclipsis	*crepuscularis*	5.19	7.29	2.10	5.56	0.20	1.56	0.22	F	ON
		Neureclipsis	*crepuscularis*	6.05	6.79	2.22	5.93	0.27	1.72	0.27	F	ON
		Neureclipsis	*crepuscularis*	5.43	7.04	2.10	5.43	0.23	1.72	0.20	F	ON
		Neureclipsis	*crepuscularis*	6.30	7.29	1.98	5.56	0.23	1.79	0.23	F	ON
		Neureclipsis	*crepuscularis*	5.68	7.41	2.10	5.68	0.23	1.64	0.23	F	ON
		Neureclipsis	*crepuscularis*	4.45	6.67	1.98	5.06	0.23	1.56	0.22	F	AB
		Neureclipsis	*crepuscularis*	5.19	7.53	2.47	6.18	0.23	1.72	0.20	F	AB
		Neureclipsis	*crepuscularis*	5.56	7.16	2.59	6.30	0.31	1.87	0.23	F	ON
		Neureclipsis	*crepuscularis*	6.42	8.15	2.47	6.18	0.30	1.79	0.24	F	ON

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Neureclipsis	*crepuscularis*	4.57	6.05	2.10	4.82	0.35	1.56	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.69	6.55	1.85	5.19	0.23	1.56	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.32	6.18	1.85	5.19	0.23	1.56	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.45	5.19	1.85	5.43	0.23	1.56	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.20	5.93	1.61	5.19	0.23	1.40	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.20	6.05	1.73	5.43	0.23	1.48	0.16	M	ON
		Neureclipsis	*crepuscularis*	5.68	6.67	1.98	5.68	0.31	1.72	0.23	M	ON
		Neureclipsis	*crepuscularis*	4.69	6.30	1.85	5.19	0.23	1.48	0.14	M	ON
		Neureclipsis	*crepuscularis*	4.08	5.43	1.85	5.31	0.23	1.48	0.12	M	ON
		Neureclipsis	*crepuscularis*	3.83	5.31	1.73	5.31	0.31	1.33	0.12	M	ON
		Neureclipsis	*crepuscularis*	4.20	6.05	1.85	4.82	0.23	1.40	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.20	6.55	1.98	5.43	0.23	1.56	0.16	M	O
		Neureclipsis	*crepuscularis*	4.69	6.05	1.98	5.06	0.23	1.33	0.12	M	ON
		Neureclipsis	*crepuscularis*	4.82	6.30	1.98	5.31	0.23	1.33	0.12	M	ON
		Neureclipsis	*crepuscularis*	3.95	6.30	2.10	5.68	0.23	1.56	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.08	6.55	1.85	5.56	0.31	1.56	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.20	6.05	2.10	5.06	0.31	1.48	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.20	6.18	1.98	4.94	0.27	1.56	0.12	M	ON
		Neureclipsis	*crepuscularis*	4.45	5.93	1.98	5.19	0.27	1.48	0.16	M	ON
		Neureclipsis	*crepuscularis*	4.32	5.80	1.85	5.06	0.23	1.40	0.16	M	ON
Polycentropodidae		*Polycentropus*	*cinereus*	6.18	7.66	2.47	6.42	0.31	1.79	0.23	F	ON
		Polycentropus	*cinereus*	6.18	8.03	2.47	6.42	0.23	1.87	0.26	F	ON
		Polycentropus	*cinereus*	5.80	7.78	2.47	6.42	0.23	1.79	0.23	F	ON
		Polycentropus	*cinereus*	6.05	8.03	2.35	6.42	0.23	1.95	0.23	F	ON
		Polycentropus	*cinereus*	6.18	8.40	2.47	6.55	0.27	1.79	0.23	F	ON
		Polycentropus	*cinereus*	5.43	7.78	2.47	6.30	0.27	1.87	0.23	F	ON
		Polycentropus	*cinereus*	5.43	7.53	2.22	6.05	0.27	1.79	0.23	F	ON
		Polycentropus	*cinereus*	6.79	8.03	2.47	6.30	0.27	1.95	0.23	F	ON
Polycentropodidae		*Polycentropus*	*cinereus*	5.80	7.78	2.35	6.42	0.23	1.72	0.22	F	ON
		Polycentropus	*cinereus*	6.30	8.65	2.59	6.42	0.23	2.03	0.23	F	ON
		Polycentropus	*cinereus*	5.93	7.29	2.35	6.05	0.23	1.79	0.23	F	ON
		Polycentropus	*cinereus*	6.05	8.40	2.47	6.30	0.23	1.72	0.22	F	ON
		Polycentropus	*cinereus*	5.93	7.29	2.22	6.05	0.27	1.56	0.18	F	ON
		Polycentropus	*cinereus*	5.56	6.42	2.22	5.56	0.27	1.56	0.17	F	ON
		Polycentropus	*cinereus*	5.80	7.78	2.35	5.56	0.31	1.72	0.17	F	ON
		Polycentropus	*cinereus*	6.30	7.53	2.59	6.18	0.30	1.95	0.23	F	ON
		Polycentropus	*cinereus*	5.56	7.16	2.22	5.80	0.31	1.64	0.23	F	ON
		Polycentropus	*cinereus*	5.68	7.16	2.22	5.80	0.23	1.87	0.22	F	ON
		Polycentropus	*cinereus*	5.68	7.29	2.47	6.18	0.31	1.79	0.23	F	ON
		Polycentropus	*cinereus*	6.18	7.90	2.47	5.56	0.27	1.87	0.23	F	ON
		Polycentropus	*cinereus*	5.19	7.29	2.59	6.92	0.31	1.79	0.16	M	ON
		Polycentropus	*cinereus*	5.43	7.04	2.35	6.55	0.31	1.72	0.16	M	ON

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Polycentropus	*cinereus*	5.06	7.41	2.47	6.92	0.27	1.79	0.23	M	ON
		Polycentropus	*cinereus*	5.06	7.16	2.22	6.55	0.31	1.79	0.16	M	ON
		Polycentropus	*cinereus*	5.43	7.29	2.47	5.93	0.31	1.79	0.16	M	ON
		Polycentropus	*cinereus*	5.31	7.16	2.22	6.30	0.31	1.79	0.16	M	ON
		Polycentropus	*cinereus*	6.42	7.53	2.59	6.92	0.27	1.87	0.16	M	MT
		Polycentropus	*cinereus*	5.43	6.79	2.10	6.67	0.31	1.79	0.16	M	MT
		Polycentropus	*cinereus*	6.05	6.92	2.22	6.30	0.31	1.72	0.16	M	MT
		Polycentropus	*cinereus*	5.19	6.79	2.22	6.55	0.27	1.56	0.16	M	MT
		Polycentropus	*cinereus*	5.56	7.41	2.22	6.55	0.29	1.79	0.16	M	MT
		Polycentropus	*cinereus*	5.93	7.90	2.35	7.04	0.27	1.87	0.16	M	MT
		Polycentropus	*cinereus*	4.69	6.55	2.10	6.30	0.27	1.64	0.14	M	MT
		Polycentropus	*cinereus*	5.56	6.79	2.22	6.30	0.31	1.64	0.16	M	MT
		Polycentropus	*cinereus*	5.56	6.55	2.10	6.42	0.31	1.64	0.16	M	MT
		Polycentropus	*cinereus*	5.43	7.16	2.22	6.79	0.27	1.72	0.16	M	MT
		Polycentropus	*cinereus*	5.19	6.92	2.10	6.42	0.31	1.64	0.16	M	MT
		Polycentropus	*cinereus*	5.56	6.92	2.22	6.42	0.27	1.64	0.16	M	MT
		Polycentropus	*cinereus*	5.56	6.92	2.10	6.92	0.27	1.64	0.16	M	MT
		Polycentropus	*cinereus*	5.43	7.16	2.22	6.92	0.23	1.79	0.16	M	MT
		Polycentropus	*crassicornis*	6.55	8.27	2.59	7.53	0.31	2.03	0.20	F	MD
		Polycentropus	*crassicornis*	6.05	7.90	2.35	6.42	0.24	1.79	0.16	F	MD
		Polycentropus	*crassicornis*	6.05	7.90	2.47	6.92	0.27	1.95	0.18	F	MD
		Polycentropus	*crassicornis*	5.68	7.53	2.22	6.18	0.27	1.72	0.16	F	MD
		Polycentropus	*crassicornis*	6.05	7.90	2.47	7.16	0.27	2.03	0.16	F	MD
		Polycentropus	*crassicornis*	6.30	8.03	2.35	6.30	0.27	2.03	0.16	F	MD
Polycentropodidae		*Polycentropus*	*crassicornis*	6.55	7.78	2.47	6.55	0.23	1.72	0.16	F	MD
		Polycentropus	*crassicornis*	6.30	7.66	2.35	6.30	0.23	1.87	0.17	F	MD
		Polycentropus	*crassicornis*	6.18	8.03	2.59	6.42	0.31	1.87	0.16	F	MD
		Polycentropus	*crassicornis*	6.05	7.41	2.47	5.68	0.27	1.87	0.16	F	MD
		Polycentropus	*crassicornis*	6.79	8.77	2.72	6.92	0.31	1.95	0.22	F	MD
		Polycentropus	*crassicornis*	5.56	7.78	2.47	6.42	0.23	1.87	0.19	F	MD
		Polycentropus	*crassicornis*	6.67	8.65	2.59	7.53	0.30	2.11	0.23	F	MD
		Polycentropus	*crassicornis*	5.56	7.04	2.22	6.30	0.23	1.56	0.16	F	MD
		Polycentropus	*crassicornis*	6.42	7.53	2.47	6.79	0.25	1.87	0.16	F	MD
		Polycentropus	*crassicornis*	5.93	7.90	2.47	6.18	0.23	1.79	0.16	F	MD
		Polycentropus	*crassicornis*	5.56	7.29	2.35	6.55	0.27	1.64	0.17	F	MD
		Polycentropus	*crassicornis*	6.67	7.90	2.47	6.30	0.23	1.87	0.16	F	MD
		Polycentropus	*crassicornis*	6.30	7.53	2.59	6.79	0.23	1.95	0.20	F	MD
		Polycentropus	*crassicornis*	5.06	7.29	2.22	5.56	0.23	1.72	0.16	F	MD
		Polycentropus	*crassicornis*	6.18	7.53	2.59	6.92	0.31	1.87	0.23	F	MD
		Polycentropus	*crassicornis*	6.18	8.27	2.72	8.89	0.35	2.18	0.23	M	MD
		Polycentropus	*crassicornis*	7.53	9.02	3.09	10.37	0.39	2.34	0.23	M	VA
		Polycentropus	*crassicornis*	6.92	9.88	3.21	10.00	0.41	2.50	0.23	M	VA

Appendix B. Raw data (continued).

Family	**Subfamily**	**Genus**	**Species**	**Body Length**	**Wing Length**	**Wing Width**	**Antenna Length**	**Eye Width**	**Mesotibial Length**	**Mesotibial Width**	**Sex**	**State**
		Polycentropus	*crassicornis*	7.53	10.25	3.33	11.12	0.43	2.57	0.23	M	VA
		Polycentropus	*crassicornis*	7.66	8.77	2.96	10.00	0.43	2.18	0.23	M	VA
		Polycentropus	*crassicornis*	7.53	10.00	3.21	11.12	0.43	2.34	0.23	M	VA
		Polycentropus	*crassicornis*	8.03	10.13	3.33	11.36	0.47	1.95	0.23	M	VA
		Polycentropus	*crassicornis*	6.30	9.88	3.33	9.76	0.39	2.34	0.22	M	VA
		Polycentropus	*crassicornis*	5.93	9.26	3.09	10.00	0.39	2.42	0.23	M	VA
		Polycentropus	*crassicornis*	6.79	9.26	2.96	9.14	0.39	2.18	0.23	M	VA
		Polycentropus	*crassicornis*	7.16	9.26	3.33	9.39	0.43	2.26	0.23	M	ON
		Polycentropus	*crassicornis*	6.55	8.65	2.84	8.77	0.39	2.26	0.20	M	ON
Psychomyiidae	Psychomyiinae	*Lype*	*diversa*	3.83	5.31	1.48	6.79	0.16	1.33	0.09	F	MO
		Lype	*diversa*	3.46	5.43	1.24	4.45	0.16	1.17	0.12	F	MO
		Lype	*diversa*	4.57	5.31	1.48	4.57	0.16	1.33	0.12	F	MO
		Lype	*diversa*	3.83	5.06	1.36	4.08	0.17	1.25	0.08	F	MO
		Lype	*diversa*	4.57	5.19	1.48	4.57	0.16	1.33	0.09	F	MO
		Lype	*diversa*	3.58	4.94	1.36	3.71	0.23	1.09	0.16	F	WV
		Lype	*diversa*	3.71	5.06	1.48	4.32	0.16	1.33	0.16	F	WV
		Lype	*diversa*	3.33	5.06	1.36	3.83	0.16	1.09	0.12	F	TN
		Lype	*diversa*	3.21	5.06	1.36	3.95	0.20	1.25	0.14	F	ON
		Lype	*diversa*	3.09	4.82	1.24	3.83	0.16	1.17	0.13	F	ON
		Lype	*diversa*	3.46	5.56	1.36	4.32	0.16	1.25	0.16	F	ON
Psychomyiidae	Psychomyiinae	*Lype*	*diversa*	3.09	5.19	1.36	4.32	0.16	1.17	0.16	F	ON
		Lype	*diversa*	3.21	5.43	1.36	4.08	0.17	1.25	0.16	F	ON
		Lype	*diversa*	3.46	5.19	1.36	4.20	0.16	1.25	0.16	F	ON
		Lype	*diversa*	3.21	4.45	1.24	3.71	0.20	1.09	0.16	F	ON
		Lype	*diversa*	3.46	5.31	1.36	4.20	0.20	1.25	0.14	F	ON
		Lype	*diversa*	4.20	5.19	1.24	4.08	0.20	1.17	0.12	F	ON
		Lype	*diversa*	4.45	5.43	1.48	4.45	0.16	1.33	0.12	F	ON
		Lype	*diversa*	3.33	4.94	1.36	3.95	0.16	1.17	0.09	F	GA
		Lype	*diversa*	4.32	4.82	1.24	3.71	0.16	0.94	0.09	F	GA
		Lype	*diversa*	2.96	4.32	1.24	4.45	0.16	1.17	0.08	M	MO
		Lype	*diversa*	4.45	4.69	1.36	5.06	0.16	1.17	0.08	M	MO
		Lype	*diversa*	2.96	4.32	1.24	4.57	0.16	1.09	0.08	M	MO
		Lype	*diversa*	3.09	3.83	1.11	4.32	0.16	1.09	0.08	M	MO
		Lype	*diversa*	2.96	4.57	1.24	4.57	0.20	1.17	0.09	M	MO
		Lype	*diversa*	2.96	4.32	1.24	4.08	0.16	1.09	0.08	M	ON
		Lype	*diversa*	3.09	4.20	1.24	4.94	0.16	1.09	0.08	M	ON
		Lype	*diversa*	2.47	3.95	1.11	4.08	0.16	1.01	0.08	M	ON
		Lype	*diversa*	4.08	3.71	1.11	4.20	0.16	1.01	0.09	M	ON
		Lype	*diversa*	2.96	4.32	1.24	4.94	0.16	1.01	0.08	M	ON
		Lype	*diversa*	2.72	3.95	1.24	4.20	0.16	1.09	0.08	M	ON
		Lype	*diversa*	2.47	4.20	1.11	4.32	0.16	1.01	0.08	M	NC
		Lype	*diversa*	2.59	3.46	1.11	3.83	0.16	0.94	0.08	M	GA

Appendix B. Raw data (continued).

Family	Subfamily	Genus	Species	Body Length	Wing Length	Wing Width	Antenna Length	Eye Width	Mesotibial Length	Mesotibial Width	Sex	State
		Lype	*diversa*	2.47	3.46	0.99	3.83	0.16	0.94	0.08	M	GA
		Lype	*diversa*	2.47	3.09	0.86	3.46	0.16	0.78	0.08	M	GA
		Lype	*diversa*	2.84	3.58	1.11	3.83	0.20	1.33	0.08	M	ON
		Lype	*diversa*	2.84	3.95	1.36	3.83	0.16	0.94	0.08	M	ON
		Lype	*diversa*	2.59	3.58	0.99	3.95	0.16	0.86	0.08	M	ON
		Lype	*diversa*	2.47	3.58	1.11	3.83	0.16	0.86	0.08	M	ON
		Lype	*diversa*	3.21	3.95	1.24	4.45	0.20	0.86	0.09	M	ON
Psychomyiidae	Psychomyiinae	*Psychomyia*	*flavida*	4.20	4.94	1.11	3.83	0.16	1.17	0.12	F	MT
		Psychomyia	*flavida*	4.45	5.43	1.36	4.08	0.23	1.17	0.14	F	MT
		Psychomyia	*flavida*	4.32	5.43	1.24	2.96	0.16	1.09	0.14	F	MT
		Psychomyia	*flavida*	4.69	5.43	1.36	4.08	0.18	1.17	0.14	F	MT
		Psychomyia	*flavida*	4.32	5.43	1.36	3.71	0.18	1.25	0.16	F	MT
		Psychomyia	*flavida*	4.82	5.56	1.24	4.32	0.16	1.17	0.14	F	MT
		Psychomyia	*flavida*	4.45	5.31	1.24	3.71	0.16	1.17	0.15	F	MT
		Psychomyia	*flavida*	4.57	5.56	1.24	3.95	0.16	1.17	0.14	F	MT
		Psychomyia	*flavida*	4.20	5.43	1.24	3.83	0.16	1.17	0.12	F	MT
Psychomyiidae	Psychomyiinae	*Psychomyia*	*flavida*	4.32	4.94	1.24	3.83	0.16	1.17	0.14	F	MT
		Psychomyia	*flavida*	2.59	5.19	1.36	4.82	0.16	1.25	0.12	M	MT
		Psychomyia	*flavida*	2.84	4.82	1.36	4.69	0.16	1.17	0.12	M	MT
		Psychomyia	*flavida*	2.72	4.57	1.36	4.32	0.16	1.09	0.12	M	MT
		Psychomyia	*flavida*	3.33	5.06	1.48	5.06	0.20	1.17	0.08	M	MT
		Psychomyia	*flavida*	3.58	5.80	1.36	5.68	0.16	1.17	0.08	M	MT
		Psychomyia	*flavida*	2.47	4.32	1.11	4.08	0.20	1.17	0.08	M	MT
		Psychomyia	*flavida*	2.59	4.57	1.24	4.20	0.16	1.17	0.08	M	MT
		Psychomyia	*flavida*	3.09	4.45	1.11	4.45	0.16	1.09	0.10	M	MT
		Psychomyia	*flavida*	2.84	4.82	1.24	4.45	0.16	1.01	0.08	M	MT
		Psychomyia	*flavida*	2.84	4.32	0.99	3.95	0.16	1.09	0.10	M	MT

Table A.1. Sample sizes, museum collections and state/province where specimens of Hydropsychidae caddisflies were collected.

Subfamily *Genus species*	Sample Size		Collection	State/Province where collected
	F	**M**		
Arctopsychinae				
Arctopsyche grandis	20	20	Montana State University Entomology Collection (MTEC)	MT
Arctopsyche irrorata	6	20	Clemson University Arthropod Collection (CUCC)	SC
Parapsyche elsis	15	20	National Museum of Natural History (NMNH)	OR, UT, WY
			MTEC	MT
Diplectroninae				
Diplectrona modesta	20	20	CUCC	SC
Hydropsychinae				
Cheumatopsyche aphanta	15	19	Colorado State University Entomology Collection (CSUC)	OH
			NMNH	AR
Cheumatopsyche gracilis	20	26	California Academy of Sciences Insect Collection (CASC)	AR, NY, WY
			Royal Ontario Museum (ROME)	AB, ON
			CSUC	CO
Cheumatopsyche harwoodi	12	14	CASC	TN
			CSUC	NC, VA, WV
			NMNH	VA
Cheumatopsyche minuscula	21	12	CASC, ROME	AR, ON

Table A.1. Continued.

Subfamily *Genus species*	Sample Size		Collection	State/Province where collected
	F	**M**		
Hydropsychinae				
Cheumatopsyche pettiti	21	20	CUCC	SC
Cheumatopsyche speciosa	4	9	CASC, CSUC	MD, CO
Ceratopsyche alternans	20	20	CASC ROME	MN, NY, VA AB, ON
Ceratopsyche cockerelli	15	20	CASC, MTEC	OR, ID, MT
Ceratopsyche morosa	20	20	CSUC ROME	CO, MN, OK OK, ON
Ceratopsyche oslari	20	17	CASC, NMNH	AZ, CO
Ceratopsyche slossonae	19	18	Dr. Billie Kerans Personal Collection CASC University of Minnesota (UMSP)	PA NC MN
Ceratopsyche sparna	20	20	CUCC	SC
Hydropsyche betteni	20	21	CUCC	GA, NC, SC
Hydropsyche confusa	20	20	MTEC	MT
Hydropsyche elissoma	20	20	CUCC	SC
Hydropsyche hageni	6	18	CASC, CSUC, NMNH	PA, KY, VA,WV

Table A.1. Continued.

Subfamily *Genus species*	Sample Size **F**	 **M**	Collection	State/Province where collected
Hydropsychinae				
Hydropsyche occidentalis	20	21	CASC, MTEC	CA, MT
Hydropsyche scalaris	5	20	CSUC NMNH	SC, TX, VA PA, WI
Potamyia flava	18	20	CASC, CSUC, ROME NMNH	FL, NB, TX MD, OK
Smicrideinae				
Smicridea dispar	12	20	CASC	CA
Smicrideinae *Smicridea dithyra*	20	20	CUCC	Mexico
Smicridea fasciatella	20	20	CSUC	CA, TX
Macronematinae				
Leptonema albovirens	14	10	CASC UMSP	Mexico, Costa Rica
Macrostemum carolina	20	20	CUCC	GA, SC
Macrostemum zebratum	31	40	CASC, ROME NMNH Illinois Natural History Survey (INHS)	IN, MN, ON MD, VA, WV IL, WI