Faculty Research & Creative Activity   Biological Sciences

January 2013

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ABSTRACT

Odonata (dragonflies and damselflies) play an important role in habitat management and conservation, but our understanding of the causes of commonness versus rarity in this group is limited. In this study we examined the causes of rarity for the Odonata of Illinois. Using S-ratings for conservation status and published habitat classifications for Illinois odonates, we investigated whether habitat type (lotic versus lentic) or habitat specificity (whether they were limited to a specific type of aquatic habitat) was related to commonness. We found that lotic species and habitat specialists were more likely to be rare than lentic and generalist species. More information, however, is needed on the distributions and natural histories of Illinois odonates if we are to more fully understand the causes of rarity in this important group.

INTRODUCTION

Odonata are considered 'flagships' for the conservation of insects (Corbet, 1999). Of the 5,680 extant species of Odonata (Kalkman et al., 2007), the International Union for Conservation of Nature states that one in ten species are threatened, while 35% are defined as data deficient (Clausnitzer et al., 2009). The status of Odonata may be tightly linked to their habitats; because their larvae are aquatic, the degradation of many aquatic habitats can decrease the number of successful individuals (Olsvik and Dolmen, 1992; Bossart and Carlton, 2002; Korkeamaki and Suhonen, 2002; Clausnitzer et al., 2009). Consequently, odonate species may be good indicator species for the quality of aquatic habitats (e.g. Briers and Biggs 2003).

The purpose of this current study is to identify the habitat factors that may be correlated with species commonness for Odonata in the state of Illinois. As with studies on other taxa (Goerck, 1995; Bevill and Louda, 1997; Yu and Dobson, 2000; Manne and Pimm, 2001) or on Odonata in other regions or at other spatial scales (Korkeamaki and Suhonen, 2002; Kalkman et al., 2007; Clausnitzer et al., 2009), we address this goal by comparing the likelihood that rare and common species fall into different categories. Specifically, we compare the likelihood of Odonata in Illinois to be lentic versus lotic or generalists versus specialists.

MATERIALS AND METHODS

The list of Odonata for Illinois, as well as their state conservation status ("S-Ratings"), was obtained from the Illinois State Museum (www.museum.state.il.us). The taxonomy we used was the most current available according to the North American Odonata list maintained at the Pugent Sound Museum (www.pugetsound.edu). The state status ratings ranged from S1 to S5, with S1= critically imperiled with five or fewer occurrences, S2= imperiled in state with 6 to 20 occurrences, S3= rare or uncommon with 21 to 100 occurrences, S4= secure in state, and S5= demonstrably secure in state (www.natureserve.org). In order to obtain an adequate sample size for analyses, we created two categories, with S1, S2 and S3 representing the rare/uncommon species and S4 and S5 representing common species. For our analyses, we only wanted to include the species with breeding populations within the state. Accordingly, vagrant species, which are given an S-rating of SRF, SR, and SR/WL, were omitted from all analyses.

We classified habitat in two ways. First, the individuals were classified as lotic or lentic. Second, we classified them as specialist or generalist. We defined specialist as a species described as only in either the lotic or lentic habitat, or required certain vegetation (e.g. spatterdock for *Rhionaeshna mutata*). Generalist was defined as a species that could be found in both lentic and lotic with no specific vegetation requirements. Our classifications were determined using recent field guides for Odonata including Curry (2001), Lam (2004), Abbott (2005), Beaton (2007), and Paulson (2011). In the case of discrepancy among our sources (which occurred for only 3 species out of 136), we used Paulson (2011) or Lam (2004) because their field guides encompassed the majority of the Eastern United States.

The frequencies of uncommon/rare versus established species of Odonata were compared between suborders (Anisoptera – dragonflies and Zygoptera – damselflies), habitat specificity, and primary habitat using chi-square analyses. In order to take phylogeny into account, we conducted an additional set of analyses in which the average S-Ratings were compared between habitat type and specificity (using a Wilcoxon test) for those genera in which some members fell in both categories. For example, we would compare average S-ratings between *Aeshna* species which occupied lotic versus lentic habitats or were generalists versus specialists. All analyses were performed using StatView version 5.0, Abacus System. Nonparametric statistics took ties into account when appropriate.

RESULTS

We first compared the proportion of species in the uncommon/rare category to the proportion of common species between the suborders Anisoptera and Zygoptera (Table 1). Although a trend existed for Anisoptera to have a higher proportion of species in the uncommon/rare category than Zygoptera, the trend was not statistically significant (χ^2= 1.2, df=1, P= 0.26). However, because of this trend, in the remaining analyses we conduct analyses with suborders both combined and separate in order.

There were significantly more uncommon/rare odonate species that primarily inhabited lotic habitats than lentic habitats (χ^2= 7.8, df=1, P= 0.0053). Conducting the analyses within suborders, Anisoptera had a significantly higher proportion of uncommon/rare species that primarily inhabited lotic habits (χ^2= 11.0, df =1, P= 0.0009),

whereas Zygoptera did not (χ^2= 0.22, df = 1, P= 0.66).

For habitat specificity, we found no significant difference between the proportion of habitat generalists and specialists between uncommon/rare and common taxa for all Odonata (χ^2= 6.6, df=1, P= 0.10). However, when assessing suborders, specialist Anisoptera were significantly more likely to be uncommon/rare than generalist Anisoptera (χ^2= 8.0, df=1, P= 0.005). No significant pattern for habitat specificity was found for Zygoptera (χ^2= 0.22, df=1, P= 0.66).

Analyzing patterns within genera, we found a borderline-significant trend for generalist species to have a higher average S-Rating of Odonata than specialist species (8/12 genera had a higher average S-rating for generalists than specialists; specialist= 2.9 ± 1.05, generalist= 3.6 ± 1.36; Wilcoxon Z= -1.73, P= 0.08). No significant trend was found within genera relative to primary habitat, although the sample size of appropriate genera was small (4/5 genera had a higher average S-rating for lentic species than lotic; lotic= 2.5 ± 1.15, lentic= 1.4 ± 2.89; Wilcoxon Z= 0.94, P= 0.34).

DISCUSSION

We found that lotic odonates in Illinois were more likely to be uncommon/rare than lentic species, a result also found by Korkeamaki and Suhonen (2002) for odonates in Finland. This pattern may be because the survival of lotic populations is lower (Korkeamaki and Suhonen, 2002), perhaps due to degradation of some lotic habitats (Olsvik and Dolmen 1992). However, the type of habitat (i.e. lotic or lentic) was often shared by all the species within a genus. Thus, it is possible that the connection between habitat type and rarity is affected by a group's evolutionary history instead of, or in addition to, the habitat characteristics (Kunin and Gatson, 1993). Our within-genus analysis yielded a trend toward lotic species being more rare, but so few genera had species with both habitat types that statistical significance was unlikely to be achieved.

Our results also indicate a relationship between habitat specificity and rarity. In the case of habitat specificity, both the overall analyses and the within-genus analysis suggested that specialist species were more

Table 1. The number of rare/uncommon species over the total number of Illinois Odonata species in that habitat category (percentage given in parentheses). Numbers given for both the entire order and individually for each suborder.

	Generalist	Specialist	Lotic	Lentic
Odonata	23/52 (44%)	56/84 (67%)	38/52 (73%)	41/84 (49%)
Anisoptera	15/35 (43%)	42/58 (72%)	27/32 (84%)	30/61 (49%)
Zygoptera	8/17 (47%)	14/26 (54%)	11/20 (55%)	11/23 (48%)

likely to be rare than generalist species, a result that is again consistent with the results of Korkeamaki and Suhonen (2002). However, Anisoptera had a higher proportion of species falling into the specialist category than Zygoptera; therefore, the impact of evolutionary history cannot be ruled out.

In conclusion, we found that habitat type and specificity seem to be related to a species' commonness. Our analyses are necessarily dependent on current S-ratings for these species, and such ratings are at least partially dependent on documented occurrences for each species. Such information on Odonata is lacking in many parts of the world (Clausnitzer et al., 2009), and this is certainly true for some regions of Illinois. Clearly, better documentation for the species distributions within Illinois is necessary and this additional information may alter the patterns (or lack of pattern) found in our study. Because Odonata are useful in nature management and conservation (Olsvik and Dolmen, 1992; Corbet 1999; Kalman et al., 2007), it is imperative that biologists continue to investigate why certain odonate species are less common than others. Future studies should focus on gaining additional, detailed information on the natural history and distribution of Illinois' Odonata, so that more detailed analyses on factors influencing their commonness can be conducted. In addition, long term studies on the odonate communities of particular habitats, particularly those that are changing over time, would prove very useful.

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