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ORIGINAL ARTICLE

Do habitat variables correlate anuran abundance in arid terrain of Rawalpindi–Islamabad Areas, Pakistan?

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Abstract The quantification of anuran abundance and habitat provides valuable baseline data for future monitoring in areas of planned or anticipated human activities. We carried out the present study to see if anuran abundance is associated with habitat variables (water quality, gravel size and vegetation) in Rawalpindi–Islamabad Area, Pakistan. We used area-constrained searches and quadrat method to gather data on anuran abundance and vegetation diversity, respectively, from September, 2012 to July, 2013. We recorded 28 ± 4.83 (mean number ± SE) individuals of six anuran species from the study area. We recorded *Euphlyctis cyanophlyctis* (10 ± 2.39) as the most abundant anuran species while *Microhyla ornata* (< 1 ± 0.09) as the least abundant species. The Kernel regression revealed strong and statistically significant association between habitat variables and abundance of *Hoplobatrachus tigerinus* (R^2 = 0.678) and *Bufo stomaticus* (R^2 = 0.624) but weak and statistically significant association between habitat variables and abundance of *E. cyanophlyctis* (R^2 = 0.482); *Duttaphrynus melanostictus* (R^2 = 0. 451); *M. ornata* (R^2 = 0.223) and *Limnonectes limnocharis* (R^2 = 0. 006). We concluded that the common frogs and toads in our area belong to families Dicroglossidae and Bufonidae while uncommon frogs are of family Microhylidae. We suggest inclusion of monitoring of water quality (dissolved oxygen and pH)

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and maintenance of native wild vegetation particularly herbs, shrubs and hydrophytes of the area in the on-going and proposed development schemes of Rawalpindi–Islamabad Areas.

1. Introduction

Anurans in Pakistan are represented by 25 species belonging to families Bufonidae, Microhylidae, Megophryidae and Dicroglossidae (Pratihar et al., 2014). Anurans are closely linked to wetlands (Brode and Burry, 1984). They are particularly sensitive because of their highly permeable skin which can rapidly absorb toxic substances (Blaustein and Wake, 1990). Distribution of anuran species in an area depends upon various factors such as the type of aquatic habitat for exclusively aquatic species, type of substrate, vegetation and the reliance on water of the mature individuals (Bousbouras and Ioannidis, 1997). Presence and abundance of anurans at breeding sites are likely to be influenced by a number of abiotic factors such as temperature (Pope et al., 2000), hydroperiod (Watson et al., 2003), water quality (Banks and Beebee, 1987) and biotic factors such as vegetation structure in and around the pond (Bosch and Solano, 2003).

The quantification of the distribution and abundance of anurans provides valuable baseline data for future monitoring particularly in areas of planned or anticipated human activities. Khan (2010) provided anuran species checklist and distribution in Pakistan while Yousaf et al. (2010) and Tabassum et al. (2011) reported anuran abundance in Gujranwala and Islamabad, respectively, but did not correlate it with habitat. We conducted the present study to see if anuran abundance is associated with habitat variables (water quality, gravel size and vegetation) in Rawalpindi–Islamabad Area, Pakistan.

2. Materials and methods

2.1. Study area

We conducted the present study in Rawalpindi and Islamabad areas (Fig. 1). The areas experience a humid subtropical climate with long and very hot summers, a short monsoon and mild wet winters. The area represents typical arid landscape with hard substrate and scrub vegetation. The wetlands of the area comprise of Rivers Korang and Soan with slow-flowing water during most part of the year; and water storage reservoirs such as Rawal Dam, Simly Dam and several other small dams with associated marshes (Chaudhry and Rasul, 2004; Ashraf et al., 2007).

2.2. Study design

We selected eighteen sampling sites (each having an area of 150 ha.) for data collection. These sites differed in land use, substrate and wetland type (Appendix 1). We from September, 2012 to July, 2013. We used standard area-constrained searches to gather data on anuran abundance during morning (8:00–10:00), after-noon (14:00–16:00) and evening (20:00–22:00). We systematically searched the area to record the presence/absence of species, number of individuals and area surveyed (Campbell and Christman, 1982; Corn and Bury, 1990; Heyer et al., 1994; Fellers and Freel, 1995; Sutherland, 1996). We followed Khan (2006) for anuran identification and Pyron and Wiens (2011) for taxonomy.

2.3. Habitat quantification

We laid out four quadrats ($4 \times 4\ m^2$) at each sampling site to record occurrence of plant species, and grouped the recorded plant species as herbs, shrubs, grasses and hydrophytes. We followed Daubenmire (1959) to estimate aerial percentage cover of each species, and calculated frequency of each plant species as number of quadrats in which a plant species occurs/total number of quadrats * 100. The circumference of the gravels was measured, and then converted in diameter by using the formula Diameter = circumference/Π. The air and water temperature were recorded using mercury thermometer. The water samples were collected from each sampling unit in sampling bottles. The basic water quality parameters-total dissolved salt (TDS) and electric conductivity (EC) were recorded using hand-held multi-meter (Omega, PHH-127). Dissolved oxygen (DO) was recorded with a multiprocessor dissolve oxygen meter (HANNA, HI-9146) and pH was tested with the help of water proof pH tester 1 (Oakton, 35624-02). Our data showed non-normal distribution, we therefore used non-parametric tests. We used Kernel regression in XLSTAT to see the relationship between anuran abundance and habitat variables. We performed Kruskal–Wallis test in SPSS 22.0 to see if number of individuals of anuran species recorded from different sampling sites differed significantly ($\alpha = 0.05$).

3. Results

3.1. Anuran species richness

We recorded six anuran species belonging to three families from Rawalpindi–Islamabad during present study (Table 1). The recorded species included: Family Bufonidae: Southeast Asian Toad (*Duttaphrynus melanostictus*), Indus Valley Toad (*Bufo stomaticus*); Family Microhylidae: Ant Frog (*Microhyla ornata*); Family Dicroglossidae: Skittering Frog (*Euphlyctis cyanophlyctis*), Bull Frog (*Hoplobatrachus tigerinus*) and Cricket Frog (*Limnonectes limnocharis*). We concluded that the anuran diversity of our study area was very low.

3.2. Anuran species abundance

We recorded 28 ± 4.83 (mean ± SE) individuals of six anuran species from the study area. Skittering Frog (10 ± 2.39) was recorded as the most abundant species followed by Indus Valley Toad (7 ± 1.15), Bull Frog (4 ± 1.25), Southeast Asian Toad (3 ± 0.69), Cricket Frog (3 ± 0.58) while Ant Frog (< 1 ± 0.09) was recorded as the least abundant species (Table 1). The Kruskal–Wallis test revealed that medians of