CORRELATIONS BETWEEN INSECTS AND BIRDS IN TALLGRASS PRAIRIE RIPARIAN HABITATS

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Abstract. Previous observations in riparian habitats of Kings Creek, Konza Prairie Research Natural Area, Kansas indicated that emerging aquatic insects represent a concentrated source of food for insectivorous birds, particularly the flycatcher and gleaner guilds. This hypothesis was tested by concurrent measurements of net insect emergence (total emergence minus adults returning to the stream) and densities of birds at six sampling sites from June to August 1987 and May to June 1988. Significant positive correlations with emergence were found for flycatchers ($r = 0.93$) and gleaners ($r = 0.91$), the two insectivore guilds containing the majority of individuals along Kings Creek. Observations also showed that flycatcher and gleaner populations rapidly respond to temporal changes in insect emergence.

Key Words. fly catcher, gleaner, bird, aquatic insect, tallgrass prairie, stream, Kansas

INTRODUCTION

Streams in the prairie and desert regions of western North America support riparian ecosystems that are of critical importance as habitats for local and regional avifaunas (Knopf *et al.* 1988). In addition to providing cover and water, these habitats provide a concentrated source of insects as food for avian insectivores. Along desert streams, this insect food appears to consist mainly of emerging aquatic insects, such as midges and mayflies. Jackson and Fisher (1986), for example, found that the annual biomass of emerging aquatic insects from Sycamore Creek, Arizona, was over 23 g/m^2.

Emergence biomass from Kings Creek, a tallgrass prairie stream in the Konza Prairie Research Natural Area (KPRNA), averages 20.3 mg/m^2/day in the summer (Gray, unpublished). Field observations during previous summers had suggested that certain species, particularly flycatchers, were found in greater abundance along those stream reaches with the highest rates of emergence. Thus the objective of this study was to determine if riparian habitats of tallgrass prairie streams, like desert streams, serve as an important feeding area for insectivorous birds by testing the hypothesis that insectivore densities should be positively correlated with emergence biomass.

Previous studies of birds in the KPRNA primarily have dealt with typical grassland species (Zimmerman 1982, Finck 1984) rather than riparian species. Published information on riparian species is confined to a listing of seasonal occurrence and breeding status (Zimmerman 1985).

METHODS

The Kings Creek catchment (1,637 ha) lies entirely within the boundaries of KPRNA. The headwaters are typically ephemeral, except near springs and seeps, whereas intermittent and perennial reaches occur downstream. Riparian vegetation in the headwaters is composed of shrubs, small trees, grasses, and sedges. A relatively abrupt transition to a gallery forest of oak (*Quercus* L. spp.), hackberry (*Celtis* L. spp.), and elm (*Ulmus* L. spp.) occurs along lower stream reaches (Gurtz *et al.* 1982). In this study, three sampling sites were along third- and fourth-order channels in the prairie/shrub vegetation type, and three sites were located in fourth- and fifth-order channels bordered by gallery forest. Two of the prairie/shrub sites had flow during April and May but then dried completely by late June. The other four sites had flow until late June; discharge then declined until only isolated pools remained in July and August. No scouring floods occurred at any site. Discharge was measured by using a meter stick, stopwatch, and fluorescein dye.

Aquatic insect adults emerging from the stream were collected in traps constructed from inverted 15-liter plastic buckets similar in design to that used by Jackson and Fisher (1986). Each trap collected adults emerging from an area of 452 cm^2. Traps were emptied each 24-hour period using an aspirator. The number of traps placed at each site varied from 10 to 25, depending on flow conditions and habitat area. Adults were preserved in 80% ethanol, sorted by taxon, and dried at 80 C for 24 hours before weighing on an analytical balance.

Aquatic adults returning to the stream were collected by isolating a short section of channel with two drift nets (1.0 mm mesh) for a 24-hour period. Returning biomass was calculated by dividing the biomass collected in the downstream net by the channel area between nets. Net emergence equalled trap biomass minus returning biomass. Net emergence/m^2 was multiplied by the square meters of wetted area in 100 linear meters of channel to compensate for variations in total stream area.

Birds were censused by recording all sightings within an area of 0.2 ha for 15 minutes. For a given site and date, three replicate censuses were taken along a 250 m reach of stream channel. All censuses occurred within two hours after sunrise during fair weather. Census counts were not adjusted for undetectable (silent) birds (Emlen 1977). On the eight occasions when birds were counted at a site for a period of several hours, no birds were found in addition to those counted in the three, 15-minute censuses.

Insectivorous birds were placed into one of four feeding guilds based on the principal method of feeding as observed in the field. Gleaners actively search vegetation for stationary prey, whereas flycatchers wait for active prey (usually flying insects) to enter their field of view before moving from a perch. Sweepers feed on flying insects during flight, often ranging over a large area. Woodpeckers excavate deeply in wood and bark. Emphasis is placed here on the gleaners and flycatchers. The census method was not suitable for measuring the densities of sweepers, especially the common nighthawk (*Chordeiles minor*), the most abundant species. Woodpeckers were rare. Stream emergence and bird densities were determined for a total of 22 site-date combinations during June to August 1987 ($N = 10$) and late May to June 1988. Each study site was sampled at least once each year. Gallery forest sites were sampled a total of 12 times. For $N = 22$ (d.f. = 20), a correlation coefficient (r) > 0.42 is significant at $P = 0.05$; $r > 0.54$ insignificant at $P = 0.01$.

DISCUSSION

The emergence of aquatic insects from Kings Creek shows wide spatial and temporal variability (Gray, unpublished). For the sampling dates in this study, daily emergence varied from 0 to 21 g/100 m. Emergence is strongly dependent on stream flow. When stream channels dry to isolated pools, daily emergence biomass is 10 to 100 times less than that when stream flow is stable.

The most common insects emerging from Kings Creek were midges (Diptera: Chironomidae), mayflies (Ephemeroptera), and stoneflies (Plecoptera). These groups comprised 53%, 27%, and

10% of total emergence biomass, respectively. Midges and mayflies emerged throughout the spring and summer, whereas stoneflies primarily emerged in May.

Flycatchers included the eastern wood-pewee (*Contopus virens*), great crested flycatcher (*Myiarchus crinitus*), eastern phoebe (*Sayornis phoebe*), eastern kingbird (*Tyrannus tyrannus*), and western kingbird (*Tyrannus verticalis*). Eastern wood-pewees and great crested flycatchers were the most abundant species at the gallery forest sites, whereas kingbirds predominated at the prairie/shrub sites. Flycatcher densities were strongly correlated with net stream emergence (Figure 1). Among individual insect taxa, flycatchers were highly correlated with chironomid emergence (r = 0.85) and, to a lesser extent, stoneflies (r = 0.43). The correlation with mayflies (r = 0.40) was not significant.

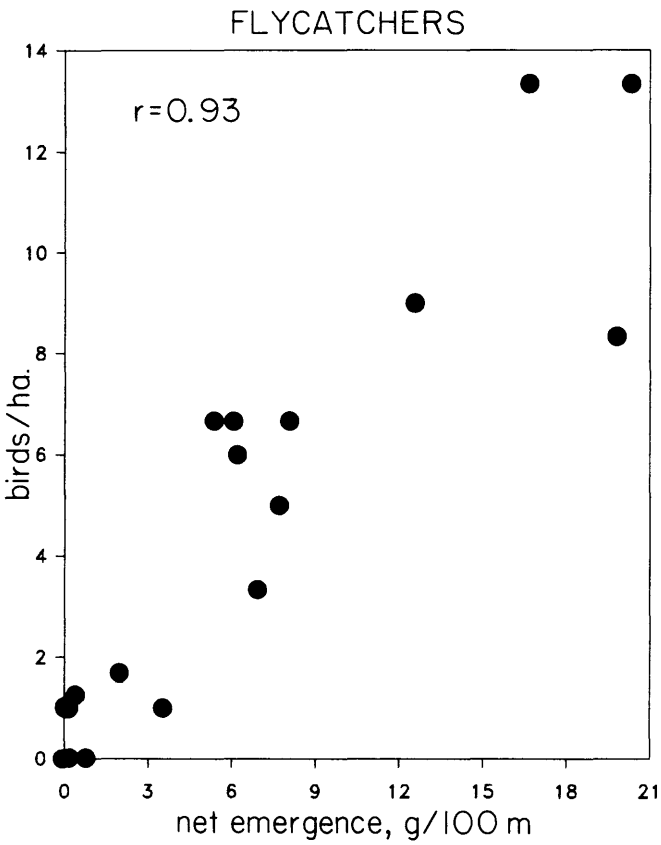

FIG. 1. Correlation between net emergence of aquatic insects from Kings Creek and the density of flycatchers. Net emergence equals total emergence biomass minus that returning to the stream and is given for a 100-m reach of channel to account for variations in wetted area at the various sites.

Common gleaners at gallery forest sites, in order of abundance, were the black-capped chickadee (*Parus atricapillus*), house wren (*Troglodytes aedon*), tufted titmouse (*Parus bicolor*), Louisiana waterthrush (*Seiurus motacilla*), and Bewick's wren (*Thryomanes bewickii*). The common yellowthroat (*Geothlypis trichas*) was the main gleaner at prairie/shrub sites. Total gleaner densities were strongly correlated with total stream emergence (Figure 2). The abundance of gleaners was highly correlated with stoneflies (r = 0.70), chironomids (r = 0.69), and mayflies (r = 0.49).

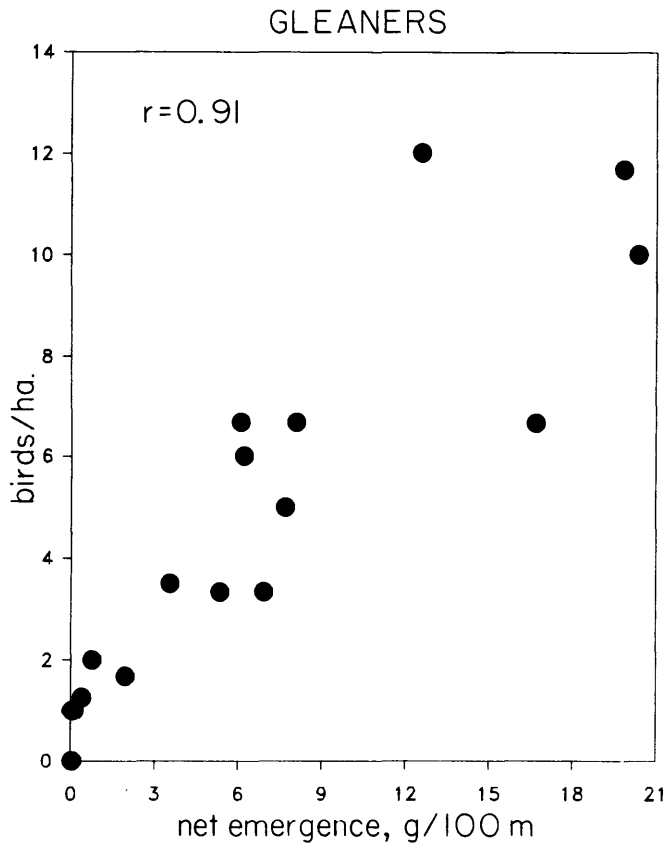

FIG. 2. Correlation between net emergence of aquatic insects from Kings Creek and the density of gleaners.

Correlations between specific insect taxa and the two insectivore guilds reflect the activity level of the insects and feeding behavior of the birds.In addition to resting on riparian vegetation, chironomids form mating swarms during the morning and late afternoon, and thus are exposed to predation by flycatchers. Eastern wood-pewees and eastern phoebes were observed feeding on chironomid swarms on several occasions. Mayflies and stoneflies spend most of the daylight hours resting on low vegetation near the stream channel. Most of the feeding activity of gleaners observed occurred in this habitat. The significant correlation between flycatchers and stoneflies may reflect some feeding on riparian vegetation by flycatchers. Stoneflies may be easier to detect than other insects against the background of vegetation because of their dark coloration and relatively large size (10-13 mm total body length).

A further indication of the importance of stream insects to flycatchers and gleaners is shown in Figure 3. At one of the gallery forest sites during 1987, discharge decreased from 100 l/sec in June to 20 l/sec in July. By August, only isolated pools remained. Total densities of flycatchers and gleaners declined in proportion to decreases in stream insect emergence. In August, nearly all of the birds had moved downstream to reaches that still had flow.

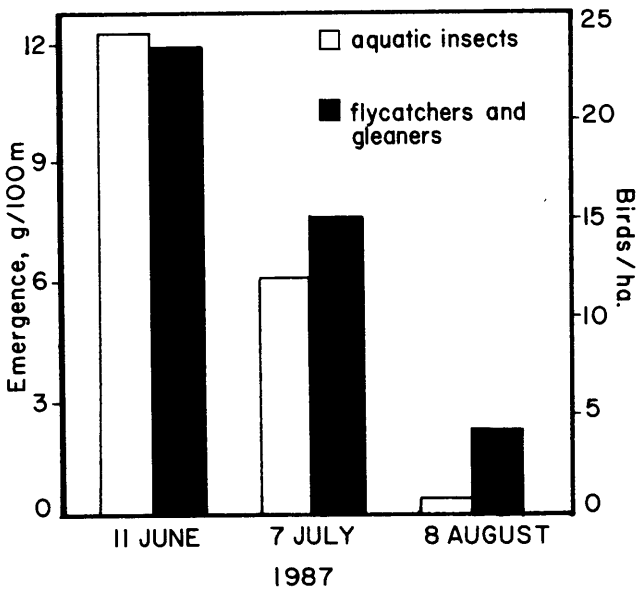

FIG. 3. Reduction in the combined densities of flycatchers and gleaners at a gallery forest site in response to decreases in aquatic insect emergence. Stream discharge declined from 100 l/sec on 11 June to 0 l/sec by 8 August.

Until the diets of insectivorous birds in riparian habitats of the Konza prairie can be analyzed in more detail, the contribution by stream insects is unknown. Although other factors are undoubtedly influencing the distribution of gleaners and flycatchers (e.g., competition, availability of nest sites, etc.), the strong correlations between bird densities and insect emergence, and field observations of feeding behavior, suggest that these birds are dependent to some extent on stream insects. Thus riparian habitats of tallgrass prairie streams, like that of desert streams, appear to be a concentrated source of insect food for riparian insectivores.

ACKNOWLEDGEMENTS

K. Johnson assisted with the field work, and E. Finck provided advice in the design of the bird census method. This research was supported by National Science Foundation Grant BSR-8704333 and the Division of Biology, Kansas State University, Manhattan.

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