Influence of Physical Factors on Occurrence and Distribution of Tiger Beetles at Brookhaven National Laboratory

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Abstract

Tiger beetles (family Cicindelidae) are predatory insects with widespread geographic distribution that are considered to be important biodiversity indicators. Surficial geology, geography, and climate are important factors that influence the species diversity of tiger beetles in a region. Sandy substrates and the presence of open areas with sparse vegetation interspersed in undeveloped woodland areas make the property at Brookhaven National Laboratory (BNL) a favorable study area for several tiger beetle species that have historically been observed on Long Island, NY. This study, conducted in July 2007, was designed to identify and estimate populations of tiger beetles at BNL and to describe the physical factors of some of their preferred habitats on BNL property.

Introduction

Tiger beetles (Family Cicindelidae) are distinctive insects with recognizable physical characteristics and behaviors that make them relatively easy to identify in the field [1]. Cicindelids have widespread geographic distribution across a broad range of habitats with strong habitat preferences exhibited by individual species; therefore, tiger beetles are considered to be important indicators for biodiversity and conservation studies [2].

BNL is located in the western part of the Pine Barrens region of Suffolk County, Long Island, NY. BNL property lies between the Ronkonkoma moraine to the south and the Harbor Hill moraine to the north; the shallow subsurface is comprised of outwash -- sands and gravels deposited by glacial melt water as continental ice sheets receded at the end of the last stage of the Pleistocene glaciation [3]. Boring logs and down-hole geophysical logs from monitoring wells drilled throughout the site indicate that sand and gravel deposits ("upper Pleistocene deposits") are between 100 and 150 feet thick across BNL property [4]. Many tiger beetles species are known to inhabit a variety of sandy environments [1], a fact that makes BNL an excellent location to study tiger beetles.

Tiger beetles are ectothermic, relying on sunlight to maintain body temperatures needed for activity [5]. Furthermore, the tiger beetle life cycle is seasonally controlled – adults of some species are active in spring and fall, while others species are active in the summer [1]. Therefore, climate factors such as latitude, temperature, and precipitation patterns play an important role in determining the geographic ranges and specific habitats of different species. On a local scale, daily weather conditions such as wind, cloud cover and humidity influence the likelihood of tiger beetle encounters in the field.

Purpose

The primary purpose of this investigation was to identify tiger beetle species and estimate populations at BNL. A secondary objective was to characterize the physical factors of the study areas and assess the influence of substrate size and composition and weather conditions on tiger beetle occurrence and distribution.

Materials and Methods

Jonathan Mawdsley, an entomologist from the Heinz Center, visited BNL in May 2007. He conducted a preliminary survey of tiger beetle species and assessed potential tiger beetle habitats on site. Figure 1 shows the study areas of the investigation: pitfall traps were used at NF, NBA, NBB, TP and BB; insect nets were employed at NF, FB, FBB, and BL. Each site was visited several times a week during the period from 10 July through 31 July 2007. Time of day and general weather conditions were recorded for each site visit – when possible, sites were visited at approximately the same time each day. Beetles were identified and measured in the field, then marked with consecutive numbers and released near the area of first encounter. Subsequent sightings of marked beetles were recorded. Encounter histories for certain species at selected sites were summarized and entered into Program NOREMARK [6] to obtain population estimates.

Figure 1 Tiger Beetle Study Areas: North Firebreak (NF), New Burn (NBA and NBB), Firebreaks (FB and FBB), old burn area near Treatment Plant path (TP), Balloon Launch (BL), and Burying Beetle site (BB)

Substrate composition and texture were observed in the field. Shallow substrate samples were collected from four sites (NF, FB, FBB, and BL) and analyzed using standard grain size analysis techniques [7]. Preliminary weather data for July 2007 were obtained from the National Weather Service [8].

Figure 2 Tiger beetle capture locations, from left to right: NF, NB, FB, FBB, and BL (with close-up of substrate at BL)

Results

Table 1 summarizes the numbers and locations of tiger beetles encountered at BNL during July 2007. Five species, all from the genus *Cicindela*, were identified; Figure 3 shows photographs of four tiger beetles in the areas where they were captured and released. Tiger beetles were encountered at all sites surveyed except one (TP). *C. punctulata punctulata* was the most common tiger beetle found at BNL during this study. Individuals of the species were also observed in the developed areas of BNL on several occasions in addition to those encountered in the study areas.

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Table 1 Tiger Beetle Species and Numbers Found at BNL

Species Name	Site Name*							
	BB	BL	FB	FBB	NBA	NBB	NF	TP
C. formosa generosa	0	2	1	2	0	0	1	0
C. punctulata punctulata	0	14	14	18	0	0	0	0
C. scutellaris rugifrons	0	0	1	4	0	0	1	0
C. sexguttata	2	0	3	1	1	2	1	0
C. tranquebarica tranquebarica	0	3	1	0	0	0	6	0
Total	2	19	20	25	1	2	9	0

* BB = Burying Beetle BL = Balloon Launch FB = Fire Break FBB = Fire Break B NBA/B = New Burn A/B NF = North Fire TP = Treatment Plant

Figure 3 Tiger Beetles at BNL, clockwise from top left: *C. tranquebarica* at BL; *C. punctulata* at FB; *C. scutellaris* at FBB; *C. sexguttata* at FB

Figure 4 shows results of the grain size analysis of substrate samples. The surface sediment in the study area is predominantly medium and coarse sand. Results are nearly identical for three sites (FB, FBB, and NF), where medium sand comprises the greatest percent by weight of samples analyzed (43.70%, 41.91%, and 38.70%, respectively). The sand at BL is somewhat coarser, with 40.17% by weight in the coarse sand range. Visual observations of surface sediment at the sites indicate that the sand is composed primarily of the mineral quartz. Surface deposits at all sites also contained small, well rounded pebbles of quartz and other rock fragments; these were removed from samples prior to sieving. Overall, the number and sizes of pebbles were greatest at BL and in low washout areas along FBB.

Figure 5 summarizes temperature and precipitation data for the region for July 2007[8]. Daytime temperatures were typically in the middle to upper 80ºF range during most of the investigation; days with lower than average temperature coincided with higher precipitation, including two rainfall events that interrupted field work on 18 July and 23 July 2007.

Figure 4 Frequency Curves for Grain Size Distribution of Substrate at Four Tiger Beetle Study Areas

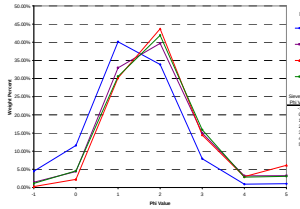
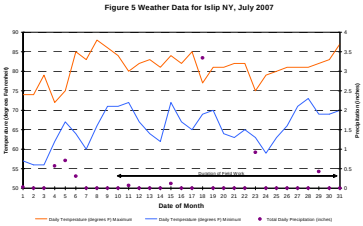


Figure 5 Weather Data for Islip NY, July 2007



Discussion

Tiger beetle findings at BNL were consistent with the life cycle and typical habitats of the species encountered [1, 9]. The assemblage of species at BNL is typical for the geology and climate of the site; the types of tiger beetles found in this study have often been observed together in similar settings [9].

C. punctulata punctulata is a summer species – adults emerge in early July and are active through the summer months. This species is found in a wide range of dry habitats, including rocky hillsides, dusty roads or trails, and sand pits, as well as sidewalks and parking lots[1]. The first noted observation of *C. punctulata* was on 13 July 2007 at site BL. All three study areas where *C. punctulata* were found are dry, sandy areas with little vegetation; other encounters at BNL occurred near buildings or paved roads. *C. punctulata* were most active in late morning and early afternoon, on warm, clear days with little or no wind.

The other species found at BNL are all spring/fall species [1]. Their small numbers are likely due to the fact that this study began near the end of the spring adult life cycle, so adults were sparsely distributed throughout the site. Each species was encountered in habitats where it would be expected – *C. tranquebarica* and *C. formosa* show a preference for open sandy areas like BL and NF; *C. scutellaris* occurs in open sandy areas with patchy vegetation that provides cover during escape flights, as at FB and FBB [1,9]. Exploration of these sites during the spring and fall will likely yield considerably higher counts of these species.

The small number of *C. sexguttata* and their locations are consistent with previous studies of the species – it is a woodland species with adults active primarily in spring; late in the season, adults tend to congregate in sunny patches in the forest in order to absorb solar radiation needed to maintain an acceptable body temperature [5]. When *C. sexguttata* was found in pitfall traps at NBA, NBA, and BB, it was always in traps located in sunny spots along the paths in wooded areas.

Conclusion

Brookhaven National Laboratory provides many favorable habitats for a variety of tiger beetle species common on Long Island. Large areas of the site are undeveloped and likely to remain that way. It is imperative to continue to provide and maintain tiger beetle habitats in suburban and urban areas [9, 10]. Habitat loss to human development is an often-cited cause of extirpation and possible extinction of certain tiger beetle species, and careful land management and conservation efforts are important for the preservation of these environmentally sensitive organisms [11,12]. Routine maintenance of firebreaks and dirt roads on the perimeter of BNL property ensures continued open habitat for species like *C. tranquebarica* and *C. formosa* and marginal species like *C. scutellaris*, while pine and oak woodlands provide habitat for *C. sexguttata*.

This investigation was not an exhaustive search of all potential tiger beetle habitats at BNL. Exploration of sites with similar surface geology and vegetation to BL, FB and FBB at seasonal intervals that coincide with emergence of adults of different species are encouraged to further delineate tiger beetle populations at BNL.

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