Characterization of Tiger Beetle Habitats at Brookhaven National Laboratory and a Link to High School Earth Science

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Abstract

Tiger beetles (family Cicindelidae) are predatory insects with widespread geographic distribution and species-specific habitat preferences. Their distinctive appearance and quirky behavior make them a fascinating insect to study, historically popular among amateur observers. Researchers recognize their importance as biodiversity indicators on local and global scales. The tiger beetle's preference for specific environmental conditions makes it the focus of conservation efforts designed to restore and preserve habitats impacted or lost due to human activity. As such, tiger beetles can be used as a model to educate high school students about the connection between physical environment and biodiversity and the importance of open space conservation and protection. Sandy substrates with sparse vegetation make the undeveloped areas on the grounds of Brookhaven National Laboratory (BNL) favorable study areas for several tiger beetle species. This study, conducted in July 2008, was designed to characterize tiger beetle habitats at BNL and to develop a plan to incorporate such studies into a high school Earth Science class.

Introduction

Tiger beetles (Family Cicindelidae) are fascinating insects that are widespread geographically – they are found worldwide except in the Arctic and Antarctic, and some isolated locations like Hawaii and Tasmania. Their physical features and characteristic behaviors are easily recognized by even the untrained observer. Bright colors and interesting elytral markings, large eyes and long mandibles, and long spindly legs on which they run in short, rapid bursts make them popular among amateur entomologists and collectors.[1& 2] In fact, researchers credit amateurs for accumulating the extensive data base about tiger beetles.[2] Tiger beetle adults and larvae are predators. Adults dart around on the ground to capture prey; larvae hunt by sitting at the top of their burrows, anchored by specially adapted abdominal hooks on their abdomen.[2] Individual species exhibit strong preferences for specific habitats with distinct physical, chemical and climatic conditions.[1] These preferences make them important bio-indicators of potential habitat threats, and many researchers have recommended their use as an indicator taxon for biodiversity and conservation studies.[3]

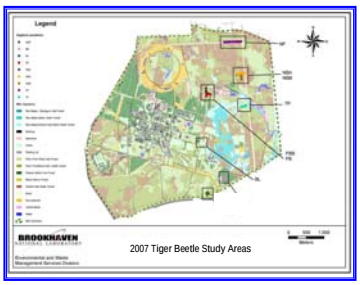
BNL is located in the western part of the Pine Barrens region of Suffolk County, Long Island, NY. Shallow substrates are predominantly sands and gravels deposited by glacial melt water at the end of the Pleistocene glaciation. Boring logs and geophysical logs from monitoring wells on site indicate that upper Pleistocene sand and gravel deposits are between 100 and 150 feet thick across BNL property.[4] Many tiger beetles species are known to inhabit sandy environments [1], a fact that makes BNL an excellent location to study tiger beetles. Large areas on BNL are wooded and undeveloped, with perimeter dirt roads and fire break trails in the woodlands that provide localized tiger beetle habitats.

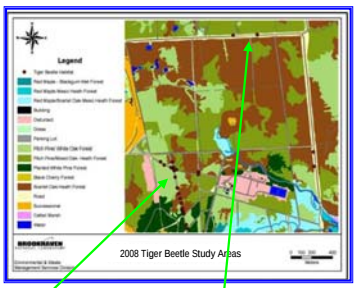
Purpose

The objectives of this investigation were to (a) use data from the 2007 tiger beetle survey to identify additional tiger beetle habitats at BNL, (b) observe tiger beetles in their habitats and attempt to locate larval burrows, and (c) explore the application of tiger beetle studies to the high school Earth Science curriculum.

Materials and Methods

Studies conducted in 2007 identified the tiger beetles species present on BNL property and their preferred habitats. We selected 2008 study locations based on previous surveys. We visited sites at different times of day during the weeks of 7 and 14 July 2008 to determine what species were present and when they were most active. The maps below show locations of the 2007 and 2008 study areas with photographs of typical tiger beetle habitats. This study focused on two areas – along fire breaks in the pine and oak woodlands west of the wastewater treatment plant (photo 1) and along the North and East fire break roads near the perimeter of the property (photo 2). All tiger beetle sightings were recorded, and areas were inspected for evidence of burrows. Habitat characteristics, including sediment composition, soil compaction, and the presence, abundance, and types of vegetation were described in the field. Substrate samples were collected from depths of 0 to 25 cm using a soil core sampler. Fourteen samples were collected and analyzed for moisture content and grain size employing standard sieve analysis techniques[5] Locations were marked using a Garmen eTrex H handheld GPS unit and plotted on a site map using GIS.



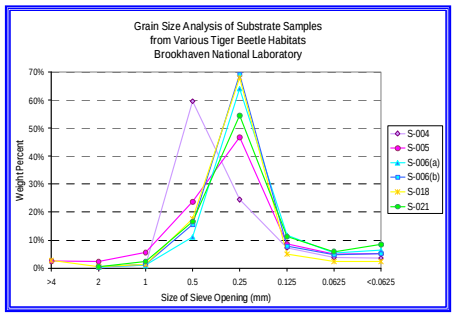


Results

The table below summarizes the species of the tiger beetle genus Cicindela found at BNL and their local habitats.

Tiger Beetle Species	BNL Habitat	Seasonality/Behavior[1]	Larval Biology[1]
C. punctulata punctulata Olivier	Wide range (most common species observed in July 2007 & 2008); dry, hard-packed sandy soil with sparse grass; sandy roads and trails, near sidewalks and parking lots	Summer (most July-August, found April-November); weak flier, short escape flights	Burrows in hard-packed soil with sparse grass
C. scutellaris rugifrons Dejean	Sandy trails in and adjacent to open pine and oak-pine forests	Spring (March-May) and Fall (August-October); use sparse vegetation or shallow holes for midday cooling	Burrows in open patches of deep, stable sand or in patches of sparse vegetation
C. sexguttata Fabricius	Sandy soil on hardwood forest floor (often found along trails)	Spring to early July, small number until September; solitary; warms in sunny spots on forest floor	Burrows along woodland trails or forest edges
C. tranquebarica tranquebarica Herbst	Open, dry sandy areas, including wider open trails and along roadsides of perimeter fire breaks	All months except December; most April-May and September-October; strong flier, wobbles before landing	Burrows in dry, bare clay areas
C. formosa generosa Dejean	Open, dry sandy areas, including wider open trails and along roadsides of perimeter fire breaks	April-July and August-October; warms slowly, active later in morning; population declines as vegetation increases	Burrows in open areas with well-drained soils; no/sparse vegetation

The graph below shows the results of grain size analysis of several substrate samples collected from locations where tiger beetles were frequently observed. Shallow substrate in the study area is predominantly medium sand. Samples S-004, S-005 and S-006 were collected along the trails near the wastewater treatment plant; samples S-018 and S-021 were collected along the North and East Fire Breaks, respectively. Moisture content was low, ranging from 5 to 7% in samples collected along the fire breaks in the woodlands west of the wastewater treatment plant and less than 3% in samples collected along the North and East Fire Breaks. Visual observations of surface sediment at indicate that the sand is composed primarily of the mineral quartz. Surface deposits at most sites also contained small, rounded quartz pebbles and other rock fragments. Soil compaction tests encountered a compacted layer at depths of 3 to 8 cm across most of the study areas. Loose sediment persisted to a depth of almost 14 cm in sandy wash areas where trails intersected at the base of slopes and along the North and East Fire Breaks. Vegetation was sparse to non-existent in most places where tiger beetles occurred, consisting mainly of sparse grasses and mosses and pine litter. Small pitch pine saplings and sweet fern shrubs were encroaching on some areas. Generally, as the vegetation became thicker, tiger beetle sightings decreased dramatically.



Grain Size (mm)	Grain Size Classification
>2.0	Gravel
1.0	Very coarse sand
0.5	Coarse sand
0.25	Medium sand
0.125	Fine sand
0.0625	Very fine sand
<0.0625	Silt and Clay

Typical substrate sample location along fire break trail

Discussion

The assemblage of tiger beetle species at BNL is typical for the geology and climate of the site. All species encountered are known to prefer relatively dry, sandy environments with sparse vegetation [1]. In places where larger shrubs, saplings, and taller grasses encroached on the roads and trails, tiger beetle encounters decreased almost immediately. Tiger beetles sometimes flew into the vegetated areas for cover when we walked through their habitat, but observation showed that they typically returned to the more open area when the perceived threat was gone, suggesting a preference for more open sites. The areas investigated at BNL represent only a small sampling of possible tiger beetle habitats on site; exploration of the many fire break trails throughout the northeastern and southern parts of the property would likely yield similar results. However, continued maintenance of the trails is necessary to continue to provide tiger beetle habitat. Studies show that where human activity has disturbed or eliminated tiger beetle habitats, species with historical occurrence in those locations have diminished or disappeared[6].

Tiger beetle studies provide the high school Earth Science teacher with a way to engage students in authentic research while learning and practicing important field and laboratory techniques. Students can easily learn to identify tiger beetles and will enjoy tracking these interesting bugs and observing their behavior. Substrate analyses like those performed in this study provide practice in scientific measurement, data recording, graphing and data analysis as well as use of GPS and mapping skills. Furthermore, students learn about the critical connections between living and nonliving environmental factors and the importance of environmental stewardship to preserve and protect natural habitats.

References Cited

[1] D. L. Pearson, C. B. Knisley and C. J. Kazilek. 2006. *A Field Guide to the Tiger Beetles of the United States and Canada: Identification, Natural History, and Distribution of the Cicindelidae*. New York: Oxford University Press.

[2] D. L. Pearson, and A. P. Vogler. 2001. *Tiger Beetles: The Evolution, Ecology, and Diversity of the Cicindelids*. New York: Cornell University Press.

[3] F. Cassola and D. L. Pearson, "Global patterns of tiger beetle species richness (Coleoptera: Cicindelidae): their use in conservation planning," *Biological Conservation*, vol. 95, pp. 197-208, Feb. 2000.

[4] M.P. Scorca, W. R. Dorsch, and D. E. Paquette. 1999. "Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, New York, 1994-97," U.S. Geological Survey Water-Resources Investigations Report 99-4086. Available: http://ny.water.usgs.gov/pubs/wri/wri994086/wrir99-4086.pdf.

[5] Walker, J.D. and H. A. Cohen, The Geoscience Handbook: AGI Data Sheets, 4th ed. Alexandria: American Geological Institute, 2006.

[6] J. R. Mawdsley, "The tiger beetle fauna of an anthropogenic sand barrens site in central Maryland, U.S.A. (Coleoptera: Cicindelidae)," *Cicindela*, vol. 38, pp. 47-58, 2006.

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