

## **Distribution, Abundance, and Seasonality of Tiger Beetles (Cicindelidae) in the Indiana Dunes Region**

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### **Introduction**

The sandy areas around the southern end of Lake Michigan provide particularly favorable habitats for various species of tiger beetles. In the early 1900's, V. E. Shelford conducted studies of cicindelids in this area and contributed much to the knowledge of the ecology of this interesting group of insects. His studies are, in fact, among the few significant ecological studies of tiger beetles in the United States. He detailed in laboratory and field studies the varied life history patterns and larval characteristics of the 12 species he found in this area (4). In another "classic" work he showed how soil conditions were important in limiting the distribution and abundance of tiger beetle species and, in particular, how the adult female of a species selects oviposition sites and thus provides optimum conditions for survival and development of the larvae of that species (5). This paper included the formulation of his well known "law of toleration" which was based on studies of tiger beetles. Earlier he demonstrated the relationship between the distribution of various species and the successional stage of the habitat (3).

Shelford's work was done primarily in the southeastern part of Illinois where a somewhat different composition of species are present compared to what I found in northwestern Indiana. For example, 4 species he found commonly there were not found during my study and probably do not exist in the Indiana dunes region. Also, in the time since his work the natural environment of the area has changed radically, resulting in an apparent reduction in the distribution and abundance of most species. This study is part of a continuing project aimed at determining distribution, abundance, seasonality, and habitat ecology of tiger beetles in Indiana.

### **Methods**

I conducted the study with the assistance of several Franklin College students from May 1977 through October 1978. Observations were made on 23 different dates during this period. Much of northwestern Indiana was surveyed for tiger beetle habitats, but the most favorable, most accessible, and least disturbed sites were found in the Indiana Dunes State Park and National Lakeshore or in adjacent areas. Only these sites, located between Gary and Michigan City, are included as part of this study (Fig. 1). A variety of habitat and ecological community types were identified and many had at least 1 species of tiger beetle.

Since tiger beetles are very active, wary insects which fly off at the slightest movement they are difficult to sample. Abundance and density data were

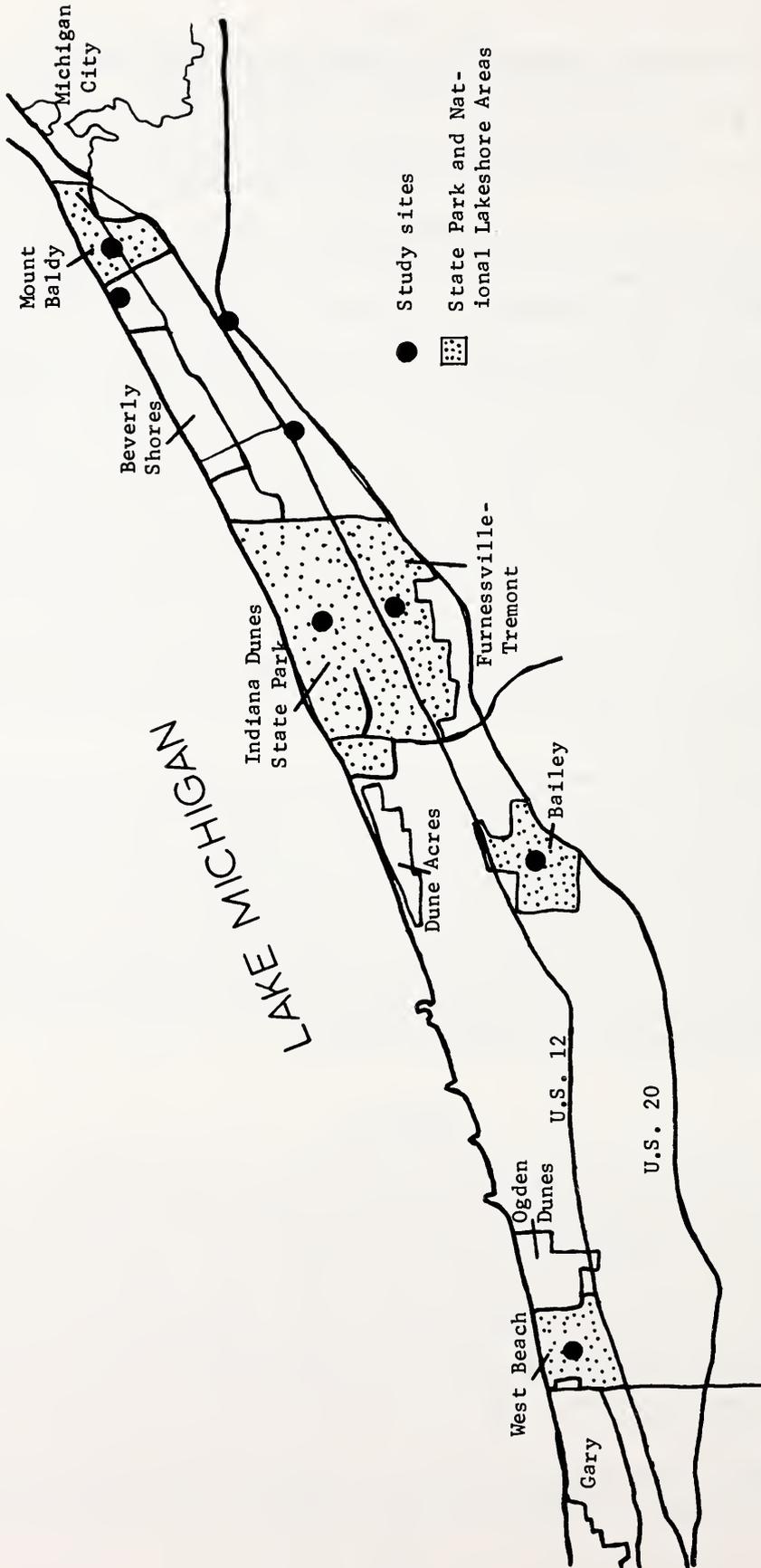


FIGURE 1. Map of the Indiana Lakeshore area showing primary study sites.

obtained using a direct count method (6). Two investigators would walk together slowly in a straight line and examine the ground 5-10 meters ahead. All beetles within about a 4 meter wide area were readily observed, then identified and recorded. The total area covered in each habitat or site was estimated so that densities could be determined. There was considerable variation in the total area examined in each site. Occasional specimens were collected to confirm identifications and for a reference collection. Additional observations provided information on cicindelid activity and behavior. Although this method of survey is rather simple, it was appropriate for giving comparative abundance and density for the different species.

### Results and Discussion

*Distribution and Habitats.* Eight species of tiger beetles and 12 types of habitats were found (Table I). *C. macra*, *C. repanda*, and *C. hirticollis* preferred fluvial habitats, specifically the edges of lakes, ponds, or streams. The open sandy flats, slopes and dune habitats were preferred by *C. lepida*, *C. formosa*, *C. scrutellaris*, and *C. punctulata*. *C. sexguttata* was found only in forest sites.

*Cicindela macra* Lec. was mostly restricted to the edge of Lake Michigan, where large numbers occurred on damp sand within 5 meters of the water edge. Occasionally individuals were on the middle beach and on the foredune faces. Small numbers were also seen at night resting on debris along the beach and on herbaceous vegetation at the base of the foredunes. Most other collection records for this species in Indiana are from the Lake Michigan beaches.

*Cicindela repanda* Dej. is an extremely common and widespread species in the United States. I have found it in all Indiana counties where I have sampled. Populations were found along the Lake edge and along several interdunal ponds in association with *C. hirticollis*. Small numbers were present in many of the other habitats, typifying this species wide distribution.

*Cicindela hirticollis* say prefers fluvial habitats where sandy beaches or flats are present near water. Several populations were found along the edges of several interdunal ponds and one blowout pond. Both ponds had permanent water available at or near the surface, even during late summer droughts. Occasional individuals were seen in several of the adjacent habitat types.

*Cicindela lepida* Dej. occurs over much of the United States, but is apparently restricted to areas with well developed sandy soils. Its distribution and abundance in the dunes and in other parts of its range seem to be decreasing in recent years. Preferred habitats in the dunes region were blowouts, the back beach, and foredune faces, but individuals were sometimes seen along the lake edge. Twice small numbers of adults were found in shallow burrows. Once was at mid-day when surface temperatures of the sand were very high and on another day during mid-morning after a cool rain shower. Adult cicindelids have been reported to dig such temporary burrows when conditions are unfavorable (7). This behavior would be especially important for a species like *C. lepida* which prefers the open sand flats where surface temperatures are frequently quite high.

*Cicindela formosa* say occurs over many of the sandy regions of Indiana, especially along the major rivers and in the northern part of the State. In this

TABLE I The numbers of sites in each habitat type where species occurred.

Species	Lake edge	Stream edge	Interdunal pond	Blow-out pond	Damp depression	Back beach	Fore dune face	Fore dune ridge	Blow-out	Dune flat, slope	Non-dune flat, slope	Woods trail
<i>C. macra</i> .....						4	3					
<i>C. repanda</i> .....		1	5*	4	2	4					2	
<i>C. hirticollis</i> .....			4*	1		3						
<i>C. lepida</i> .....						5*	4*		4*		1	
<i>C. formosa</i> .....			1			3	3*	8*	6*	5*	3	
<i>C. scutellaris</i> .....						1		3		5*	3	
<i>C. sexguttata</i> .....												3
<i>C. punctulata</i> .....						1		1	2	1	1	1

\*Habitats where species were most abundant

study it was found in more types of habitats (8) than any other species. It preferred foredune ridges, blowouts, and dune flats and slopes. Small numbers could also be found in most any dunes area that was open and sandy.

*Cicindela scutellaris say* is associated with *C. formosa* in sandy habitats over much of the United States. It was found in the above habitat types where *C. formosa* was abundant, except for blowouts. It was also more restricted in its habitat distribution though, apparently preferring more stabilized sandy areas where vegetation was not as sparse.

*Cicindela sexguttata Fab.* is the common six-spotted tiger beetle which is widely distributed along dirt paths, roads, and open areas in forests. Like *C. punctulata*, it was not common during this study and occurred in only 3 sites, all established park trails through fairly mature forests. Its limited occurrence is probably due to its preference for mesic woodlands rather than the xeric pine-oak forests in the dunes region.

*Cicindela punctulata Fab.* is an extremely common species in Indiana where it can be found in a great variety of sites with bare soil, such as paths, roads, eroded patches or field edges, agricultural areas and even pavements. This species was, however, not common in the dunes region. Only single individuals were seen but in a variety of habitats.

*Abundance and Density.* Maximum abundance and density were determined for each species and are given in (Fig. 2). These values are the highest

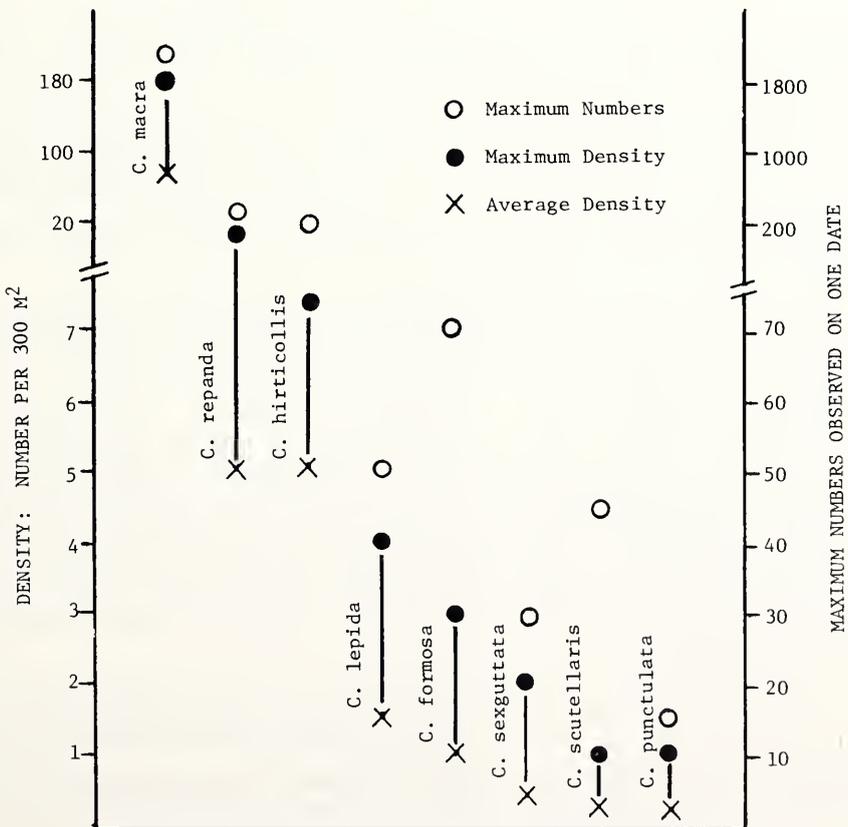


FIGURE 2. Densities and maximum numbers observed for each species. Maxima are for one site on one date.

recorded at all sites during the 2 years. Average densities are based on counts at all sites where a species occurred, but only on dates during the optimum season. In general, the species can be grouped into 3 levels of density and abundance. *C. macra* was very abundant and dense relative to the other species. On one date nearly 2000 were seen along several hundred meters of lake edge, and frequently hundreds were present in localized lengths of beach. Densities were also high and commonly 50-100 beetles were present in a 300 square meter area. They literally swarmed along the water edge and often over half were *in copula*.

A lower level of density and abundance was seen for *C. repanda* and *C. hirticollis*. On several dates 100-200 individuals of each species were seen with densities of 10-20. In addition to being less abundant and dense these species were more scattered within a habitat than was *C. macra*.

The other 5 species varied some in abundance but densities were always less than 5. *C. lepida*, *C. formosa*, and *C. sexguttata* were often present in small localized populations of 5-15 individuals, but *C. scutellaris* and *C. punctulata* were always scattered such that rarely were more than 2 or 3 collected in one area.

It is significant that the 3 most abundant species occurred in the fluvial habitats which are of rather limited occurrence in the dunes region. The other non-fluvial species occurred in habitats that were more extensive, but individuals were more sparse within those habitats.

*Seasonality.* Three seasonal patterns for tiger beetles have been recognized by Shelford (4). Species are designated as spring, spring-fall, or summer depending on the time of the year that the adults are active. All 3 patterns are represented by the dunes species and are given in (Fig. 3). The graphs for each species were constructed primarily from observations during this study, but in part from information I have obtained in other areas of Indiana. Times of adult emergence can be quite accurately determined, often to the day, because teneral have a characteristic soft, wet appearance.

*C. sexguttata* was the only spring species. Adults start emerging in mid-April and by early May the population peaks but declines in late June when adults begin to die off.

*C. macra*, *C. lepida*, and *C. punctulata* are typical summer species with similar patterns of adult activity. *C. lepida* emerges somewhat later than the others while some individuals of *C. macra* survive longer and can be found throughout September. *C. hirticollis* is unusual in that adults are active from May through October. Shelford (4) found this was because a second brood of adults emerges around mid-July before those individuals which emerged in spring have died off.

*C. repanda*, *C. formosa*, and *C. scutellaris* are spring-fall species and show similar seasonal patterns. Adults emerge from hibernation in April, reach peak numbers in several weeks when all have emerged, and then begin to die off by early July. Some individuals of all 3 species can be found throughout the summer, with *C. formosa* being most common. In late August a new brood of adults emerges from pupae that developed during late summer. These are active

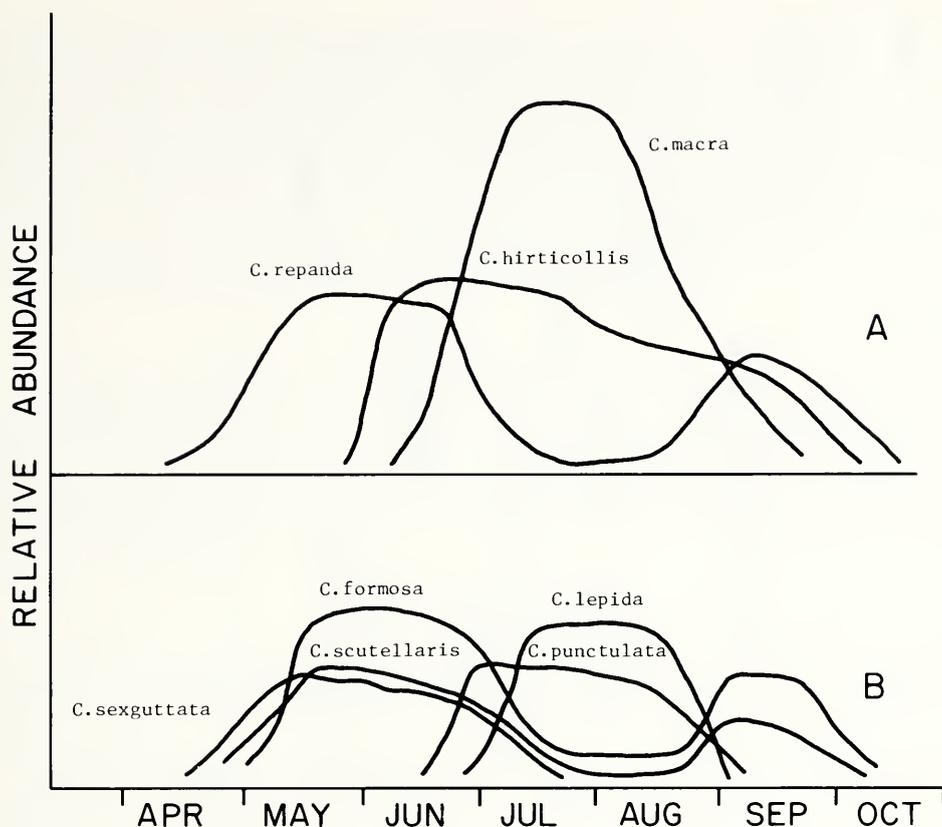


FIGURE 3. Relative abundance of fluvial (A) and nonfluvial (B) species throughout the year. Constructed from 1977 and 1978 data.

for much of September and October, yet are apparently sexually immature when they dig burrows for hibernation.

**Spatial and Temporal Segregation.** The 7 species inhabiting beaches and dunes of Lake Michigan show rather distinct spatial and temporal partitioning of these habitats. Most species were well segregated by their habitat preferences as can be seen in (Fig. 4). Both *C. macra* and *C. repanda* prefer the lake edge but are clearly segregated seasonally. *C. repanda* also is found along the interdunal pond edges with *C. hirticollis*, but the latter is most abundant during summer when *C. repanda* is scarce. *C. formosa* and *C. scutellaris* are both spring-fall species and both occur commonly on dune slopes and flats. However, *C. scutellaris* was found in sites that were more stabilized and with more vegetation cover. *C. lepida* is also in these same habitats but is a summer species and clearly segregated seasonally. *C. punctulata* was most often found on the dune flats and slopes farther from the water than the above species, but in the same types of habitats. Although the spatial and temporal segregation observed for adults is quite marked, Shelford (4, 5) has reported that larvae of some of these species are found in different microhabitats also.

**Other Dune Species.** A search of the literature and of museum records indicates that 5 other species have been collected from the dunes areas of Indiana and Illinois. Shelford (4) reported *C. tranquebarica*, *C. purpurea*, and *C. duodecimguttata* from the Illinois dunes area north of Chicago, and he worked

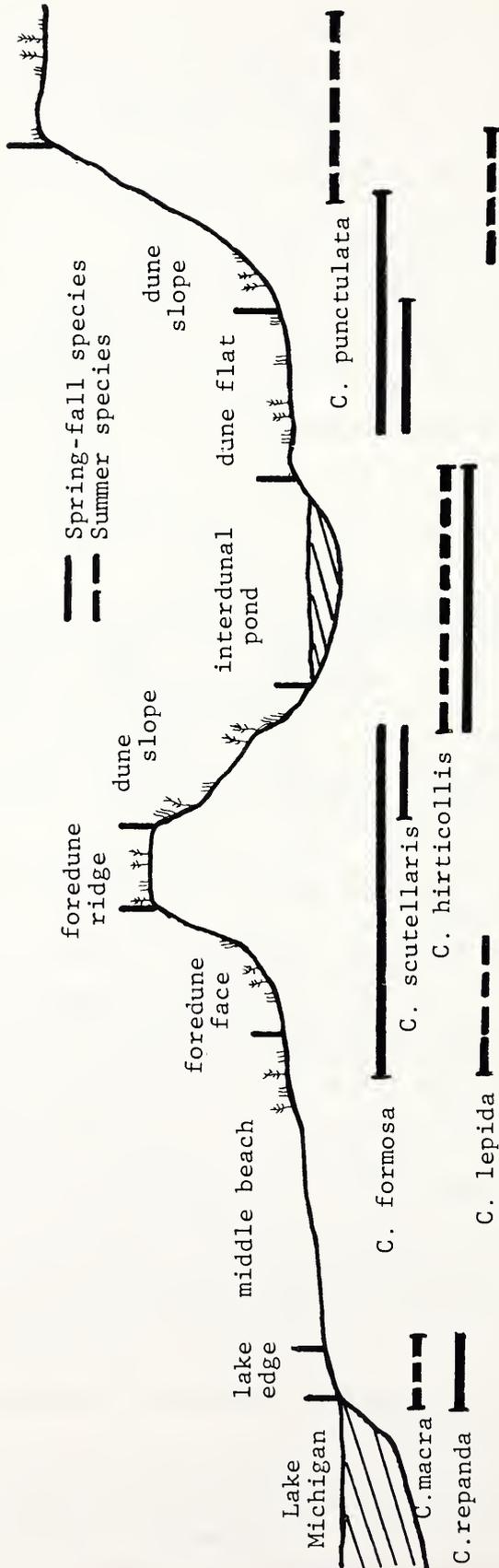


FIGURE 4. Profile of the Lake Michigan area showing habitat preferences and seasonal patterns of tiger beetle species.

out life histories for these species there. I have recently collected *C. duodecimguttata* from southwestern LaPorte County, but have not seen the other 2 species. *C. tranquebarica* has been reported from Lake county (2). *C. limbalis* was found commonly by Shelford but has not been reported from Indiana, probably because its preferred habitat (steep clay banks) is not common here. Another species, *C. patruela* has been reported from several locations in northern Indiana (1, 2). Museum records also indicate this species was collected in several localities in northwestern Indiana.

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