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Observations of the Behavior of the Giant Prairie Robberfly, *Microstylum morosum* Loew (Diptera: Asilidae), at Terre Noire Natural Area, Clark County, Arkansas

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Running title: Behavior of *Microstylum morosum* at Terre Noire Natural Area

The blackland prairie region of southwestern Arkansas consists of calcareous clay soils that lie mostly in the West Gulf Coastal Plain (Foti 1974, Foti et al. 2003). The Arkansas Natural Heritage Commission (ANHC) and The Nature Conservancy (TNC) own remnant prairie patches in Clark County, known and managed as Terre Noire Natural Area (TNNA). The history of the area was summarized by Tumilson and Benjamin (2011). The TNNA is home to several species of plants and animals considered by ANHC to be species of special concern in Arkansas, including the giant prairie robber fly (*Microstylum morosum* Loew, 1872). Arkansas is on the eastern border of the range of this species, but management interests are inhibited by a lack of information concerning its basic ecology. First reported at TNNA by Warriner (2004), *Microstylum morosum* is the largest North American member of the Asilidae (Back 1909) reaching a length of 50 mm (Bromley 1934). Males are shiny black and have brown to black wings. Females are larger than males and can be dimorphic with legs and abdomen being either black or reddish (Bromley 1934). Both have distinctive emerald-green eyes.

Other than distribution, practically nothing is known about the biology of this robber fly except for a few comments on behavior of feeding (Bromley 1934). Herein we detail results of three years of observations of behavior and habitat use of *M. morosum* in the protected habitat at TNNA, and attempt to interpret these aspects of the biology of this ANHC-listed species of special concern.

Methods

We visited TNNA in search of *M. morosum* 12 times in 2010, 15 times in 2011, and 7 times in 2012. Initially, we selected prairie patches and conducted random walks to locate and document the presence of *M. morosum*. Based on all historic dates of observation and collection, it was clear that adults of the species do

not appear until summer. We began searches in May of each year while conducting research on other insects at TNNA, but we did not encounter any individuals earlier than 29 June 2010, about 3 weeks earlier than the initial discovery at TNNA on 19 July (Warriner 2004).

After determining the distribution of this insect on TNNA, we revisited sites to observe patterns of behavior. To avoid disturbing located individuals, we tried to maintain a distance of at least 5 m while observing behaviors. We recorded the kind of structure used as a perch and estimated perch elevation (to the nearest 0.3 m) to avoid disturbing the robber fly. Height at some perches was measured after observations were concluded to validate our estimates. We recorded time spent at each perch (rounded to the nearest min) and any related foraging or defensive behaviors.

Results and Discussion

Dates of observation

During 2010, 4 of our 5 observations of *M. morosum* occurred on the most restored prairie in the northernmost part of TNNA. On 29 June 2010, we located a male *M. morosum* at 1100 hr on the prairie side of an ecotone with the patchy forest. This turned out to be the only observation we made of a male during the study. Within a few min, a female joined the male, which had perched on woody vegetation. We found another female nearby in the prairie along forested ecotone, close to the location of Warriner's (2004) observation, at 1145 hr. A third female was located on 21 July 2010 at 1132 hr. On 28 July, at 1122 hr, a fourth female was found at the southern edge of the unit. On 30 July 2010 a female was observed at 1153 hr on the northern part of the second unit south (there are 4 units to TNNA).

During 2011, *M. morosum* was observed 7 times, 6 times on the North Unit and once on the northern part of the second unit south. General locations and habitats

were consistent between years, and all individuals were females and found along prairie-forest ecotone. On the North Unit, individuals were found at 1024 hr on 8 July 2011, at 1041 hr on 26 July 2011, and at 1052 hr on 16 August 2011. On 29 July 2011, Dr. Bill Baltosser (UALR) reported 3 observations of *M. morosum* on the North Unit, at 1245 hr, 1410 hr, and 1420 hr. Of particular interest, he noted observations on the wooded side of the ecotone whereas previous indications were that the robber fly spends its time on the prairie side, where most of our searches had been conducted. On the second unit south, 1 female *M. morosum* was located at 0942 hr on 15 July 2011.

Due to the observations of this robber fly within the woods, we altered our search strategy in 2012 to include searches on both sides of the ecotone. The first *M. morosum* of 2012 was found at 1159 hr on the northern end of the South Unit on 5 July, on prairie about 7 m from the treeline. On 17 July at 1136 hr, we observed another female in the North Unit, within a sparsely wooded area. On 24 July 2012 at 1138 hr and 1230 hr, we located two female *M. morosum* in the southern portion of the North Unit, also on the wooded side of ecotone.

On 24 August 2012 at 1142 hr, Dr. Baltosser observed a female *M. morosum* at a previously unsampled site on the North Unit. This site was an "inlet" of prairie conditions surrounded by forest, and further supported a developing notion that *M. morosum* at Terre Noire uses both sides of the ecotone between prairie and wooded conditions, rather than being an outright prairie species.

Activity period

Although we often began searches by 0900 hr, *M. morosum* was not encountered until later in the morning when temperatures had reached about 33 °C (90 °F). Earliest encounter was at 0942 hr on 15 July 2011, but most encounters were after 1030 hr. Length of activity period could not be estimated as the afternoon heat caused us to terminate field work, but the observations of the insect in the wooded areas after 1400 hr on 29 July 2011 may indicate that the robber fly escapes the afternoon heat by sheltering in the shady wooded side of ecotone. Although we extensively searched through open prairie, we found *M. morosum* only within a few meters of wooded ecotone. Similarly, Bromley (1934) found the species to be common in open woodlands in Texas. It appears that *M. morosum* is an ecotonal species at TNNA, where the best foraging habitat for grasshoppers is the grassy prairie, and the best escape and loafing cover is

the elevated vegetation of the treeline.

Perching behavior and activity patterns

When perching, *M. morosum* tends to hang with the abdomen pointing at a 45–90° angle toward the ground, even if the perch is oriented horizontally. Other robber flies we observed commonly positioned themselves with the abdomen oriented more horizontally.

During foraging periods, *M. morosum* most commonly perched on dead portions of woody stems including redbud (*Cercis canadensis*) and young sweetgum (*Liquidambar styraciflua*), leaves of compass plants (*Silphium laciniatum*), old flower heads of pale purple coneflower (*Echinacea pallida*), or other sites providing a vantage point just above the level of grasses at the site. The robber flies used several perch sites, remaining at any one location usually less than 10 min before switching to another site. Movement may have been a tactic to flush prey, or to try to search for prey from different vantage points.

On 8 July 2011, a female moved among perches 22 times during 112 min of observation. Perches averaged 0.5 m (range 0.3–1.0) in height and generally were about even with the top of the grasses. Compass plants grew to heights of 1–2 m, but the robber fly perched on them closer to the grasses, presumably minimizing distance from prey. During movement between perches, the robber fly often flew in a zigzag pattern just above the level of grasses. Distance between the perches averaged 4.5 m (range 0.3–20.0), and the average time spent on a perch was 4.9 min (range 1–17).

On 15 July 2011, a female moved among perches 19 times during 90 min of observation. Perches averaged 0.4 m (range 0.2–1.0) in height and were about even with the top of grasses. Distance between the perches averaged 5.3 m (range 1.0–10.0), and the average time spent on a perch was 4.7 min (range 1–14). At this site, we measured the distance between distant points in the area used and were able to estimate the area covered by movements at about 820 m².

On 26 July 2011, a female moved among perches 7 times during 24 min of observation. Perches averaged 1.0 m (range 0.3–1.2) in height. Distance between the perches averaged 2.8 m (range 0.3–7.0), and the average time spent on a perch was 3.7 min (range 1–8).

Agonistic interactions

Agonistic interactions were witnessed between *M. morosum* and another common robberfly (*Promachus*

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hinei Bromley 1931). *Promachus hinei* is not as large as *M. morosum*, but it is so aggressive that one perched near a hummingbird feeder repeatedly pursued approaching hummingbirds and returned to its perch (*pers. obs.*, 25 July 2011). It tends to take hymenopterans (including red wasps and bumblebees; *pers. obs.*) as prey. Thus, competition should not be for resources, but apparently occurs for foraging space. On 3 occasions when we saw both species in the same space, *P. hinei* was chasing away *M. morosum* and the *P. hinei* returned to the area of its original perch.

Passing hymenopterans were chased away by *M. morosum* if they flew near the perch, after which the robber fly returned to its perch. Grasshoppers, the primary prey, typically were pursued but dragonflies and butterflies were ignored. The head was turned with each passing organism other than these, including passes by small birds such as flycatchers.

Escape behavior

Microstylum morosum is a large species that seemed to be tolerant of approach. We walked up to individuals without them showing much alarm unless the disturbance was sudden or very close. Perched individuals were slowly approachable, and on several occasions we took images from only 0.5 m away. On a few occasions, an individual would see and “buzz” us, circling to evaluate our intentions then settling back on a typical perch. If disturbed to the point of flight, escape cover was found at higher elevations of trees in the ecotonal areas occupied.

On 26 July 2011, a single *M. morosum* was flushed from a perch about 0.6 m high and escaped to a bush along the wooded edge at an elevation of about 3 m. After about 1 min., it flew to greater security farther into the woods.

The same escape behavior was observed even when an individual was captured and released. On 24 August 2012, a female was captured in an insect net and photographed. When released, she flew to a perch in a nearby eastern red cedar (*Juniperus virginiana*) at an elevation of about 2.5 m.

On other occasions, we observed disturbed *M. morosum* selecting escape perches on rattan vine (*Berchemia scandens*) at 3.0 m, eastern red cedar at 3.1 m; green ash (*Fraxinus pennsylvanica*) at 3.2 and 4.6 m; and sweetgum at 1.5 and 3.7 m.

Foraging behavior

We consistently observed *M. morosum* to move in a zigzag pattern when repositioning to a new perch. Most of our locations of the insect occurred when other

insect activity was high, when temperature ranged from 30–35°C (85–95°F), but none was observed foraging at higher temperatures.

Grasshoppers and cicadas are the primary foods (Bromley 1934) but only a few observations of attempted predation were witnessed. In these cases the robber fly left its perch in pursuit of a passing grasshopper, then returned to a perch after the unsuccessful attempt. On 21 July 2010, we located a female *M. morosum* already feeding on a small grasshopper while perched on a stem about 0.6 m above the ground, and about 15 cm above the surrounding grass.

We witnessed successful predation on 24 July 2012 at 1140 hr. We first noticed a female perched about 0.75 m high and about 10 m inside a sunny patch of a sparsely wooded edge. She was oriented facing the prairie when she dropped to the ground and caught a grasshopper, then carried her prey to a shaded perch about 0.75 m high (above grasses). The robber fly pierced the prey through the ventral thorax and began feeding. After 29 min that perch became sunlit, and she moved to a shady dead twig 0.3 m high and below the level of grasses and continued to feed. After 17 min, this perch also became sunlit and the robber fly moved to another shaded dead twig about 0.25 m high. She continued to feed in the shade until we terminated our observations after 16 more min. While feeding, she hung by the front legs as described by Bromley (1934).

During observations of this robber fly, another female appeared at 1230 hr, entering from the prairie with her grasshopper prey. The prey was about the same size as the robber fly. She landed on a twig about 1 m high, and when we approached she flushed and moved to a perch elevation of 3 m, then quickly sought escape higher and away from the site.

Oviposition behavior

Oviposition was observed on 4 dates, in which the female flew to the ground in patches of woody vegetation, then inserted her abdomen into the ground to lay eggs (Figure 1).

On 30 July 2010, we followed a female as she changed perches. About noon she moved from a perch to a dead redbud stem in a clump of bushes in the prairie, then she dropped to the ground by a small persimmon tree (*Diospyros virginiana*) surrounded by smaller redbuds. We found her hidden in vegetation with her abdomen in the ground.

On 15 July 2011 we witnessed a female drop to the ground at 1031 hr, where she remained for 6 min.



Figure 1. Oviposition by a *Microstylum morosum* at Terre Noire Natural Area, 17 July 2012. Arrow indicates the abdomen in the ground.

When she emerged from the location and perched, her abdomen repeatedly pumped up and down, thought to represent residual activity from ovipositing. At 1038 hr she returned to the ground in a clump of plants and remained 4 min, then at 1056 hr returned to the ground for 4 more min. At 1103 hr she descended to the base of a dead stump (10 cm diameter) where we were able to locate and photograph her. Her abdomen was pressed about 1.5 cm into the soil and she probed the ground in this manner 9 times over a period of 9 min.

On 5 July 2012 we found a female at a likely oviposition site and were able to make detailed observations. She dropped to the ground below a small persimmon and walked about the ground, which was hard and dry. Apparently it was difficult to find a proper oviposition site. She spread her wings partly, located a bit of bare ground and tried to push her abdomen into the ground. As attempts failed, she repositioned and tried again. She repeated this 7 times before she gave up, crawled from the grassy cover, and flew away.

On 17 July 2012 we saw another female land and crawl into grasses and among the ground litter, where she searched for places to insert her abdomen. Hard ground made some attempts unsuccessful, but the effort was repeated 7 times before she crawled above the surface, flew about 2 meters to another site and repeated the behavior, then a third time about 1 m away. These possible oviposition sites were not under shrubs as they had been in earlier observations, but were in shady ecotonal areas.

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