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NOTE

Attraction of adult Silphidae and Staphylinidae (Coleoptera) to river otter latrines

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ABSTRACT

Some carrion-feeding insects exhibit more generalist feeding strategies. We report on observations of carrion insects attracted to aquatic subsidies produced by river otters (*Lontra canadensis* Schreber) through spraining (i.e., defecation). From 26 May to 27 July 2017, during a study on spraint (i.e., otter scat) degradation in latrines along the banks of 4 beaver (*Castor canadensis* Kuhl) ponds in Kouchibouguac National Park (New Brunswick, Canada), we documented 16 instances of insects on spraints, including 3 gold-and-brown rove beetles *Ontholestes cingulatus* Gravenhorst (Coleoptera: Staphylinidae), 6 American carrion beetles *Necrophila americana* Linnaeus (Coleoptera: Silphidae) and 1 *Dinothenarus capitatus* Bland (Coleoptera: Staphylinidae). Also, *N. americana* was observed breeding on a spraint on two occasions. More research is needed to determine if animal latrines represent suboptimal habitat or if these insects are able to thrive by exploiting this novel habitat as a food source or for reproductive purposes.

INTRODUCTION

Species that exploit ephemeral resources are viewed as highly specialised species in terms of their form and function in food web ecology. However, observations of animal behavior and focussed research often reveal more complex trophic relationships for such species. For example, larvae of several saproxylic beetle species previously thought to be obligate or facultative predators were found to be omnivorous by studies focussing on larval gut content (Přikryl et al. 2012, Horák 2011). Their diet included mostly plant and fungal material but varied according to body size, containing less fungal material and more plant and animal materials as a function of size (Přikryl et al. 2012). Some dung beetles (*Saphobius* spp.) were shown in feeding experiments to consume not only dung but also carrion of various origins such as chicken, beef, earthworm and squid (Stavert et al. 2014). Additionally, the necrophilous beetle *Necrophila brunnicollis* Kraatz used to be listed as a carrion specialist (e.g., Ikeda et al. 2008) but was found to be more generalist than previously thought when subjected to controlled feeding experiments involving pieces of chicken breast and the larvae of blue bottle fly *Calliphora vomitoria* Linnaeus (Jarubec et al. 2020). Field observations and controlled experiments both contribute to improve our understanding of the trophic relations of such species.

As species exploiting ephemeral resources, carrion insects deliver a crucial service by contributing to the decomposition of dead organisms, hence facilitating nutrient cycling in ecosystems. For example, Barton and Evans (2017) found that colonisation by insects doubled mass lost by carcasses during a 12-day controlled experiment. Because of the importance of their role as decomposers, it is important to gain more information on the ecology of carrion insects and the breadth of resources they can exploit in their environment. Here we report on observations of carrion insects found on the spraints (i.e. otter scats) of river otters (*Lontra canadensis* Schreber), a species that creates

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ephemeral resource subsidies of aquatic origin in terrestrial ecosystems through its sprainting (i.e. defecation) and scent marking behaviour (Ben-David et al. 2005).

MATERIALS AND METHODS

We made observations on the banks of beaver (*Castor canadensis* Kuhl) ponds between 26 May and 27 July 2017 in Kouchibouguac National Park (New Brunswick, Canada), during the course of research focussing on the decomposition of spraints. Located in the Atlantic Maritime ecozone, in New Brunswick's lowlands, the park is characterised by flat topography with numerous wetlands such as bogs and forested wetlands, as well as beaver ponds and meadows (Leblanc et al. 2007).

River otters are the top predators of freshwater ecosystems in Kouchibouguac National Park. Their main social unit in the park is the family, usually composed of an adult female and her young, while males are solitary (D. Gallant, personal observation). Their density in the park ranges from 7.5 to 10 family groups per 100 km of riparian habitat over the last five years (Parks Canada, unpublished data). Most of their diet consists of fish predated in rivers, streams, beaver ponds and nearby lagoons (D. Gallant, personal observation). Spraints, the fecal matter of river otters, are black and slimy with a distinct smell of decomposing fish and contain numerous indigestible fish parts such as scales, bones and otoliths (Rivera et al. 2019). Freshwater otter species frequently defecate on land, at the interface of aquatic and terrestrial ecosystems (LeBlanc et al. 2007, Giovacchini et al. 2018). Spraints are distributed non-randomly on the landscape and are typically grouped at latrine sites (De Luca et al. 2018). They are associated to particular habitat features, for example around beaver ponds, along steep riverbanks, on points of land and under vegetation cover (Jenkins and Burrows 1980, Swimley et al. 1998, LeBlanc et al. 2007). Otters spraint often. For example, Jenkins and Burrows (1980) reported for a similar freshwater otter species, the Eurasian otter *Lutra lutra* Linnaeus, that individuals in captivity produced up to 15 spraints per day. Intensity of sprainting activity fluctuates seasonally, with high levels observed in spring and fall (Jenkins and Burrows 1980, Serfass et al. 2019). Otters also urinate and release gelatinous secretions from their anal sac at latrines, both of which can be deposited next to or on top of scats. This scent-marking behaviour serves various social functions ranging from territorial defense to communicating social status (Rostain et al. 2004, Ben-David et al. 2005). Beaver ponds constitute an important habitat for otters in Kouchibouguac National Park, where they can hunt for food and access shelter such as lodges and bank burrows (Gallant et al. 2009). Consequently, beaver ponds within river otter home ranges can have multiple latrines.

We made weekly visits to 14 active latrines used by otters on the banks of 4 different beaver ponds (46°49′04″ N, 64°58′33″W; 46°44′57″N, 64°56′14″W; 46°45′29″N, 64°57′01″ W; 46°49′05″ N, 64°58′34″ W). We monitored 56 spraints in total. We documented these spraints as they appeared at monitored sites and thus we knew their age to within 7 days. We recorded observations of insects found on them.

RESULTS AND DISCUSSION

We observed 16 instances of insects on spraints (detailed in Table 1): 6 were of American carrion beetles *Necrophila americana* Linnaeus (Coleoptera: Silphidae) (Figure 1a), 3 were of gold-and-brown rove beetles *Ontholestes cingulatus* Gravenhorst (Coleoptera: Staphylinidae) (Figure 1b), 2 were of green bottle flies *Lucilia* spp. Linnaeus (Diptera: Calliphoridae), 3 were of unidentified flies, 1 was of an isopod-like unidentified insect, and 1 was of *Dinothenarus capitatus* Bland (Coleoptera: Staphylinidae). All observations occurred when spraints were 7 days old or less. The only exception was *D. capitatus*, which was observed on a spraint that was 15 to 17 days old. We observed *N. americana* breeding on a spraint on two occasions (Table 1, Figure 2). On one of those occasions (13 July), there was also a third individual on the same spraint (Table 1). All insects were detected while they were present on a scat (Figure 2) but it is unclear if some scats also had urine or anal sac secretions on them as well.

Our observations show unusual resource selection by carrion-eating insects but similar accounts have been reported. For example, both adults and larvae of *O. cingulatus* have been found on moose (*Alces alces* Linnaeus) feces while only adults have been found on cattle feces (Macqueen and Beirne 1974, Egan and Moon 2013). For *N. americana*, which is a common Silphid in our region and mostly found in marshy habitats (Anderson 1982, Majka 2011), they were reported to be sometimes found on dung but to seldom breed there (Majka 2011). That *N. americana* would use a habitat feature as small as a spraint (≤10cm^3) is unusual because this species is known to select carcasses that are medium (e.g., fox, racoon) to large (e.g., deer, bear) in size (Anderson 1982). Surprisingly, most of our observations of *N. americana* on spraints involved reproductive behaviour, which suggests that spraints are a beneficial habitat feature for this species.

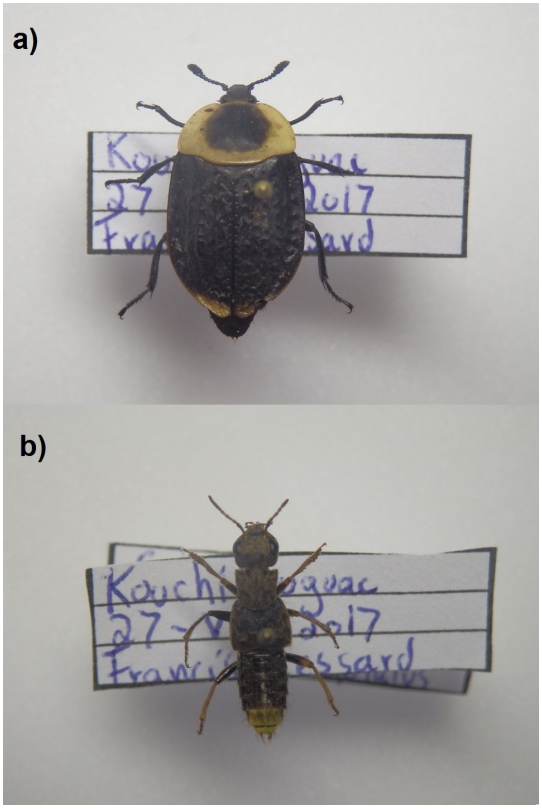
We were not able to collect the specimen of *D. capitatus*

Table 1. Dates and locations of insects detected on spraints at river otter latrine sites monitored from 26 May to 27 July 2017 in Kouchibouguac National Park of Canada.

Date	Species	Number	Easting*	Northing*	Comments
6 June	*Ontholestes cingulatus*	1	349249	5186830	
8 June	*Necrophila americana*	1	349295	5186861	
8 June	Unidentified Diptera	1	349295	5186861	
15 June	*Ontholestes cingulatus*	1	351071	5180122	
22 June	*Dinothenarus capitatus*	1	349295	5186861	
28 June	*Ontholestes cingulatus*	1	349297	5186863	
28 June	*Necrophila americana*	2	349297	5186859	breeding
28 June	Unidentified Diptera	1	349249	5186830	
13 July	*Necrophila americana*	3	349249	5186830	breeding
13 July	Unidentified Diptera	1	349249	5186830	
27 July	*Lucilia* spp.	1	352067	5179073	
27 July	*Lucilia* spp.	1	355207	5179128	
27 July	Unidentified isopod-like insect	1	352076	5179073	

*Coordinates are in UTM meters, zone 20.

Figure 1. Specimens of *Necrophila americana* (a) and *Ontholestes cingulatus* (b) collected on river otter spraints on 27 June 2017 in Kouchibouguac National Park, New Brunswick, Canada.



observed but identification was possible because of its distinct yellowish head (Brunke et al. 2011) and the fact that it is one of only two *Dinothenarus* present in New Brunswick (Webster 2016). That *D. capitatus* was only found on an older spraint suggests that it may have been

Figure 2. *Necrophila americana* mating on a river otter spraint on 13 July 2017 in Kouchibouguac National Park, New Brunswick, Canada. The male is seen on top of the female which stands on fecal matter and undigested fish parts (i.e., scales and bones).

predating on maggots, given the development duration of blow flies (Shiravi et al. 2011) and assuming that the latter's attraction to spraints led them to lay eggs. Given that the occurrence of carrion insects is useful to the applied field of forensic entomology (reviewed in Amendt et al. 2004), our field observations contribute to the important task of elucidating the feeding strategies of carrion insects and to determine their potential as forensic indicators, the most promising of them being those that are discovered to be obligatory necrophagous (Amendt et al. 2004).

The four beaver pond sites in this study were located in mixed forests where the canopy was opened and deciduous trees were locally depleted by the selective foraging of beavers, hence favoring the dominance of softwoods (i.e., conifers). Research over the last decades has established that coleopteran abundance and diversity is not only defined by different types of habitats, but also influenced by microhabitat features such as moisture, canopy structure, litter depth, dominant species in tree stands and age structure of the latter (e.g., Epstein and Kuhlman

1990, Michaels and McQuillan 1995, Werner and Raffa 2000). The importance of habitat type or microhabitats also concerns the Silphidae and the Staphylinidae (Werner and Raffa 2000). For example, Werner and Raffa (2000) found that *N. americana* was more abundant in stands dominated by northern hardwoods than in those dominated by eastern hemlock (*Tsuga canadensis* Carr (Pinaceae)), and were more abundant in even-aged forests than uneven-aged ones. While we did not study the effect of microhabitats, they likely influence the likelihood of encountering various carrion-eating insects on fecal matter.

Concentrations of fecal matter by otters in specific locations within their home range constitute both a perennial and an ephemeral habitat feature, as some latrines are frequently used for years while others are visited sparingly (D. Gallant, personal observation). There are eleven freshwater otter species around the globe (Cianfrani et al. 2018), and many other mammalian species create latrines, such as racoons (*Procyon lotor* Linnaeus) (Hirsch et al. 2014), lemurs (Primates: Lemuridae) (Irwin et al. 2004) and meekrats (*Suricata suricatta* Schreber) (Jordan 2005). Future studies are needed to determine if animal latrines represent suboptimal habitat for the Silphidae and the Staphylinidae, or if these insects are able to thrive by exploiting this novel habitat as a food source or for reproductive purposes.

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