THE BRODIE CLUB

Established 1921

Website: http://thebrodieclub.eeb.utoronto.ca

THE 1,119th MEETING OF THE BRODIE CLUB

The 1,119th meeting of the Brodie Club was held on Tuesday, 16 April, 2019 in Room 432 of the Ramsay Wright Laboratories of the University of Toronto.

Chair: Anne Bell
Secretary: Katie Thomas

The meeting was called to order at 7:30 pm and was attended by 43; 32 members and 11 guests.

Roll Call:

Present: E. Addison, R. Addison, Bacher, Beadle, Bell, Bertin, Bryant, Crins, Currie, Curry, DeMarco, Dengler, Dunlop, Dunn, Eadie, A. Falls, B. Falls, Hussell, Hutchinson, Iron, Johnson, Lindsay, Machin, McAndrews, Moldowan, Pittaway, Reading, Rising, Slessor, Stones, Thomas, Tomlinson.

Guests: James Baxter-Gilbert (guest of Lindsay), Bill Lamond (guest of club), Ross Harris and Dan Kozlovic (Rising), Dierdre Tomlinson (Tomlinson), Antonio Moura (Johnson), Jessica Liebesley (Moldowan), Ron Dengler and Jim Eckenwalder (Dengler), Sharon Hick (McAndrews), Ron Jenkins (Bertin).

Regrets: Abraham, Coady, King, Kortright, LaForest, Martyn, Obbard, Peter, Seymour, Sutherland.

Minutes:

Minutes of the March meeting were accepted (moved by Rising, second by Hussell; passed) – but please note the following addition, added to the official minutes after correspondence with John Riley. John had asked the March speaker about the past presence of cormorants in Great Lakes, noting that early bird surveys done by astute observers (Agassiz, Hynes, McCallum, McIlwraith) found no evidence of cormorants in Ontario. In addition, Savage's 'Faunal Osteoarchaeology' book contained no reports of cormorant remains in midden sites in Ontario. Subsequent to the Brodie meeting, however, Riley re-checked these sources and found that Savage's *Birds from the Ground* documented one (1) bone of Double-crested Cormorant, from the site of a year-round village of Late Woodland/Neutral age in the NE corner of Brant Township, Brant County.

Committee Reports:

Program: Next month's meeting (May 21) the speaker will be Chris Wilson of the MNR, on "Evolution and paleoecology of Lake Trout: from the Ice Age to the present."

Field Trip: Reminder that this year's field trip will be to Darlington Provincial Park. The park naturalist is being lined up to speak to and guide us. More details at the May meeting.

Announcements:

Curry reminded us of the Hamilton Naturalists' Club 100th Anniversary Dinner to be held on Saturday, November 2. Mike Runtz is the featured guest speaker. Cost is $75 per ticket, cheque or cash. Glenda and Bob had tickets at the meetings, or you can purchase online (https://www.eventbrite.ca/e/hamilton-naturalists-club-100th-anniversary-dinner-tickets-59473703448). Bob and Glenda also brought publications for purchase: *New Checklist to the Birds of Hamilton-Wentworth* ($2.) and *Date Guide to the Birds of Hamilton-Wentworth* ($5.).

Jean Iron noted that a paper written by Dunn was published the previous day in *The Auk*: "Dynamics and population consequences of irruption in the Red-breasted Nuthatch (*Sitta canadensis*)."

Patrick Moldowan had illustrated note cards for sale, in support of the Algonquin Wildlife Research Station (suggested donation: $25 per pack).

John Bacher reported that there is a public consultation on the proposed recovery strategy for the Red-Headed Woodpecker in Canada by Environment and Climate Change Canada. Consultation period is April 3, 2019 to June 2, 2019. More details at: https://wildlife-species.canada.ca/species-risk-registry/document/default_e.cfm?documentID=3514

SPEAKER:

Ed Addison introduced the speaker, Dr. Marc Johnson (Dept. Biology, UofT Mississauga), who as a club member should need little introduction -- but got a nice one nonetheless.

DOES URBANIZATION AFFECT EVOLUTION?

We are living in a fundamentally unique period of biological history, often referred to as the Anthropocene. Social scientists are calling it the "century of the city." In 2008 more than 50% of the world population was living in urban areas. This pattern is not specific to Canada. Three percent of land surface is covered in urban development and it is rapidly increasing.

Urbanization alters abiotic and biotic environments over time and space, and with these changes there is increase in pollution, temperature, and species' abundance (usually decrease). Some of the clearest changes to the physical environment caused by urbanization involve increase in impervious surface cover (such as buildings and roads); higher temperatures; and elevated air, noise, and light pollution. Changes to the biotic environment include increased habitat fragmentation, arrival of invasive species, lower diversity and abundance of some native species, and a loss of phylogenetic diversity within communities.

Cities create urban heat islands. City centres can be 20% warmer than rural areas, and this creates novel ecosystems through time. Although Toronto has pretty good tree cover (26%), it has less vegetative cover and higher temperatures than its rural neighbors. In addition, urban sprawl around Toronto has increased dramatically from 1984 to 2016, growing the size of urban core.

Abiotic changes caused by urbanization have long been recognized, but a bigger question that is only starting to be investigated is whether such changes also affect biological evolution.

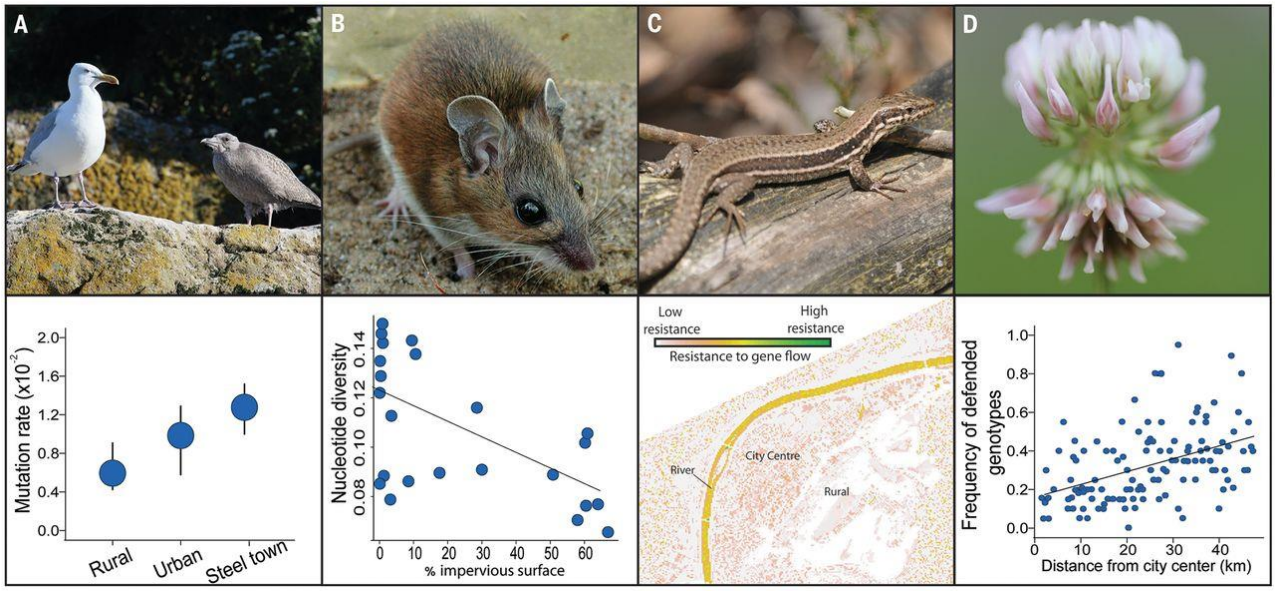
Populations can evolve very quickly to adjust to ecological changes – but have they done so in cities? Urbanization, and any evolutionary changes occurring as a result, could have important consequences for humans. Urbanization can be characterized as the best replicated and largest-scale natural experiment in evolutionary history, as it is happening all around the world in many different environments. A literature review found 192 studies of urbanization effects on 133 species – more than 50% published in the past five years. Johnson co-authored a 2017 paper in Science that gives an overview of what has been learned.

Urbanization affects evolution in four different ways:

1. Rates of mutation
2. Loss of genetic diversity
3. Increased genetic divergence between populations
4. Adaptation to urban environments

Mutation

A study of mutation rates in Herring Gull (*Larus argentatus*) found that gulls nesting near steel mills in Hamilton, Ontario had higher mutation rates than gulls in nonindustrial cities or rural areas (see panel A in figure). A follow-up laboratory study with House Mouse (*Mus musculus*) showed that under controlled conditions, polluted air alone cause mutation rates to double over the rate when clean air was provided. Surprisingly, effects of air pollution on human mutation rates have not been studied!



Reduction in genetic diversity

Urbanization causes habitat fragmentation, which can isolate populations (due to road building, urban barriers, buildings). This reduces gene exchange and loss of genetic diversity (e.g. panel B in figure), which in turn can lead to population decline and local extinction. Another example is from a study on Red-backed Salamanders (*Plethodon cinereus*) in a large urban park in Montréal (Mount Royal), which found less genetic diversity within the park than outside the city

Increase in genetic divergence

Decrease in dispersal can result in two populations diverging from each other. Urbanization can cause a decrease in the dispersal of organisms. For example, in the Red-backed Salamander study in Montréal it is likely that roads were a barrier to salamander dispersion, as genetic characteristics

divergence on either side (panel C in figure). Marc feels this is most likely to occur in less mobile organisms; but in Alaska, a fence built to prevent Moose from crossing the highway also resulted in divergence on either side.

Adaptation

A famous 1955 study by Kettlewell of a moth whose greyish colour matched tree trunks where it roosted was largely replaced with a melanistic form of the same species as urban pollution turned tree trunks dark with soot. Since then there have been numerous selection experiments with moths.

A study in New York found that the salamander *Plethodon leucopus* was using novel food resources in urban habitats and had adapted to those foods with metabolic changes.

Research was done on the urban evolution of White Clover (*Trifolium repens*), which has a cyanogenesis capability that protects them from herbivores, but which also reduces tolerance to cold temperatures. Because of the temperature cline between urban and rural areas there might be a cline in frequency of cyanogenic plants. Results of the study found that in 3 of 4 cities studied, the frequency of cyanogenic plants within populations decreased towards the urban core (panel D in figure).

Why is urban evolution important?

1. It is the best and largest scale experimental evolution study of all time!
2. Urban evolution has implications for humans. These include negative effects to conservation, whereby adaptations to the urban environment allow certain species to exist. An article in the New York Post (illustrated with the figure at right) noted that while some native species with important ecological functions adapt to urban environments, other organisms that adapt to our cities might increase disease transmission.

3. This makes an amazing subject for educating the public about evolution, conservation and environment.

Questions following the presentation:

Hussell: You expected White Clover to show more cyanogenesis in cities because they are warmer – but you found the opposite. Why?

A. Good catch. Although cities are hotter that rural areas in summer, winters are colder. Snow removal and salting removes the thermal blanket that snow cover provides, and cities have lower nighttime temperatures compared to rural areas. (We tested whether there were simply fewer herbivores in urban areas, providing a selective release, but damage from herbivory was similar in all areas.)

McAndrews: What is the effect of light pollution?

A. We don't really know. We do know that macro moths avoid lights in cities but not in rural areas, but micro moths do not appear to be affected in the same way. Birds are known not to sleep as well with light pollution, which disrupts their circadian rhythm, but whether there are evolutionary consequences is unknown.

Curry: There was a new species of Leopard Frog *Rana kauffeldi* discovered in New York City that in 2014 was found to be genetically distinct from all others. Has there been any research on this?

A. No one has done any extensive research on this new species.

Bertin: Noted that evolutionary consequences of urbanization for humans may be completely opposite to consequences for other species. Humans in isolated rural areas can be affected by fragmented habitat, barriers to gene flow etc., whereas urban populations are far more genetically mixed and physically mobile.

Dunn: Commented that we think of adaptation to urban environments as overwhelmingly negative (invasive and pest species), but should remember that native species may also adapt and thrive (e.g. songbirds that change singing characteristics to be heard above urban noise).

Eadie: Cheetahs in Africa that used to hunt in daylight are now hunting at night. Could that be due to increased tourism and more people around during the day?

A. Coyotes exhibit a similar behavior and hunt at night because of better opportunities and to avoid humans.

Baxter-Gilbert (guest): How do we make the jump to applied conservation? Should we apply evolutionary principles to urban conservation?

A. Yes. The Florida Panther is an example of how understanding of evolutionary processes can be applied to problems caused by urbanization. At one point these animals exhibited twisted tails, low sperm motility and cowlicks – as a result of being a fragmented, declining population with low gene flow and diversity. Twelve panthers were brought in from Texas and the population rebounded.

Bacher: Noted that habitats can be linked which reduces the barriers that roads cause. If the Florida Panther had fewer road barriers and more conduits it might not be so isolated. There is no silver bullet solution.

Hussell: Yes, adding genetic diversity from outside sources might not be needed if barriers can be reduced, such as the building of over- and under- passes for turtles at Long Point. If animals are brought in from elsewhere we should be taking seed sources from as many areas as possible, because single source populations may not be genetically diverse even when they are large.

Ed Addison thanked Marc for his talk.

OBSERVATIONS

Hussell: Observed Red Admirals and a few other butterfly species in Backus Woods on April 13th. Ontario Butterfly Atlas curators confirmed that these were the first observations in southern Ontario this spring, except for around Windsor, where they had arrived a couple of days earlier. First observations of Red Admirals were made by many others on the same day throughout southern Ontario as far north as Toronto.

The meeting was adjourned at 9:02 pm.