ISOTOPICS

The Cleveland Section of the American Chemical Society

Volume 85 Issue 6 September 2009

On Deck:

Wednesday, October 21

Speaker: TBD

Venue: TBD

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September Meeting Notice

Wednesday, September 16, 2009
Dolan Science Center, John Carroll University

4:30 pm	Executive Committee Meeting
5:30 pm	Social Hour
6:30 pm	Dinner
7:30 pm	Presentation

Chemistry is for the Birds

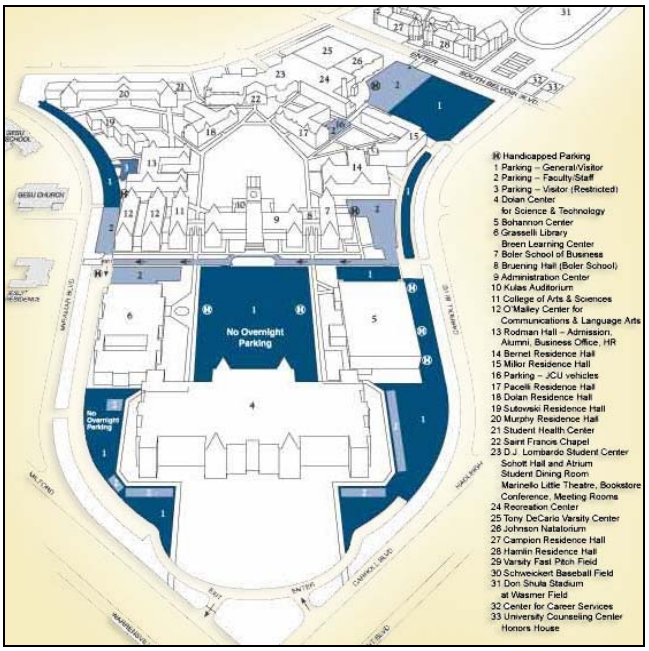
Dwight Chasar

Chemists like to think that chemistry is the central science. Recently, avian biologists and some chemists have examined more closely the chemistry associated with birds, using the tools we chemists have used for years to better understand facets of bird life and behavior. This presentation will discuss some recent as well as older research into this chemistry. The chemical pigments that give birds color, the chemicals that birds use for survival in the wild, chemicals that nearly extirpated raptors, and the use of stable isotopes to understand bird migration will be discussed. From the simplicity of bird poop to the complexity of bird DNA analysis, chemistry is playing a big role in understanding bird dynamics. Along the way bird photos should brighten up the chemistry discussions.

This PowerPoint presentation should cover enough chemistry to satisfy general interest chemists while being simple enough for non-chemists and students to understand and appreciate the beauty and complexity of chemistry and birds.

DINNER RESERVATIONS REQUIRED: Please RSVP by contacting David Ball, by phone at 216-687-2456 or by e-mail at d.ball@csuohio.edu by **5 pm** on **Friday, September 11.** (For phone reservations, please clearly spell your last name and leave a return phone number). Cost of the dinner is $20 for members & guests and $10 for students. Checks made out to “Cleveland ACS” are greatly appreciated.

Directions to John Carroll University



From I-271: Take I-271 to Exit 32 (Cedar/ Brainard Roads). Follow Cedar Road west for 2.5 miles to South Belvoir Blvd. Turn left onto South Belvoir and travel south 0.7 miles. The entrance to campus will be on your right after crossing Washington Blvd. The Dolan Science Center is highlighted on the map below.

For directions from other locations, please see: www.jcu.edu/map.htm. For the campus map, see: http://www.jcu.edu/pubaff/ABOUTJCU/campus_map.htm.

Speaker Bio

Dwight Chasar obtained his PhD in organic chemistry from Case Western Reserve University in 1968. After a post-doctoral stint and military service, he taught organic chemistry at the University of Pittsburgh at Johnstown for three years. Then he joined the BFGoodrich Co in 1974 as an R&D chemist, succeeding to the highest technical level of R&D Fellow. His research centered around polymer stabilization, nitrosamine formation in rubber, and vulcanization accelerators for rubber. He continued in this capacity through successive owners of the business, eventually retiring from Emerald Performance Materials in 2007. He holds 24 patents and presented and published a number of papers at technical meetings and in technical journals, respectively.

He became interested in bird watching about 25 years ago and has not looked back. He leads bird walks for a number of groups, including the Cuyahoga Valley National Park, and organizes or participates in a number of bird censuses and breeding bird studies. He has served on the Ohio Birds Record Committee for four years. He has published papers and given talks on his bird field work, historical aspects of birds, and travels to observe birds in other countries.

A member of the American Chemical Society since 1965, he has been active both locally in the Cleveland Section and nationally as a councilor from Cleveland.

Call for Nomination: The Morley Medal

By Kenneth Street

The Cleveland Section annually sponsors a regional award, which consists of the Morley Medal and an honorarium of $2,000. The next presentation of the Morley Medal will take place at the meeting of the Cleveland Section ACS in May 2010. The award is presented at a banquet, at which time the recipient will deliver the Edward W. Morley Lecture for that year. Travel expenses for the medalist and spouse will be provided.

The purpose of the award is to recognize significant contributions to chemistry through achievements in research, teaching, engineering, research administration and public service, outstanding service to humanity, or to industrial progress.

The area of eligibility includes those parts of the United States and Canada within about 250 miles of Cleveland. The contributions for which the award is given should have been made by the awardee when a resident of this area, or if a major contribution was made elsewhere, the nominee should have continued to make contributions while a resident of this area. Nominations may be made by any member of the American Chemical Society, The Chemical Society or the Chemical Institute of Canada.

Nominations for the Morley Medal should include a letter of nomination and curriculum vitae including the candidate's education, professional experience & activities, awards & honors, offices held and specifics on significant contributions. The letter of nomination should highlight these significant contributions. A representative list of references to the candidate's more important contributions, an evaluation of the significance of these achievements, and a listing of the nominee's most significant publications and patents are also appropriate. Strong seconding letters are suggested. The specific reference for every publication or patent is neither required nor encouraged. Electronic submissions are preferred.

Deadline for receipt of nominations is **December 4, 2009**. Send nomination and supporting material to:

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Chair, Cleveland Section Awards Committee
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Chemistry is for the birds - 6

By Dwight Chasar

All of us know that many of the elements consist of isotopes, e.g., the element isotopes have the same number of protons but a different number of neutrons in the nucleus. Some of the isotopes are radioactive and some are stable. So, for carbon-12, its two other isotopes are stable carbon-13 and radioactive carbon-14. The latter is used for carbon-14 dating of carbon-containing artifacts, the discovery of which won the Nobel Prize in chemistry for Willard Libby in 1960. Carbon-13 NMR makes use of the natural abundance of C-13 in organic compounds to help elucidate structures of the compounds. For my purposes here, however, I want to concentrate on the stable isotopes of hydrogen, i.e., deuterium or H-2, and oxygen, i.e., O-18, in particular but the discussion can apply to C-13, N-15, S-34 and others as well.

The natural abundance of the various stable isotopes that make up an element is fairly constant and any compound made up of elements that have stable isotopes will show that natural abundance or ratio. For hydrogen, the % ratio natural abundance is 99.985 H-1 and 0.015 H-2, while that for oxygen is 99.759 O-16, 0.037 O-17 and 0.204 O-18. So water, H_2O, will have some deuterium and some O-18 naturally occurring in it that reflect the natural abundances of hydrogen and oxygen stable isotopes.

There is a tiny glitch, however, in the last sentence that needs to be addressed. The various combinations of hydrogen and oxygen isotopes that form water create molecules of different molecular weights and each of these variations of the water molecule creates a version of water that may have different physical properties, albeit very minor. For example, H_2O is slightly lighter than HOD or H_2O-18 and therefore, the heavier version will vaporize ever so slightly more slowly than the lighter version. So, if one uses the Atlantic Ocean along the eastern US seaboard or the Pacific Ocean along the western as examples, it would be easier for the heavier version of water to evaporate in the southern climes than in the northern because of the higher average temperature of the water. This suggests that rain in the southern climes of the US will consist of a higher percentage of heavier water than the rain in the north. In other words, deuterium isotope ratios in precipitation show a strong latitudinal gradient in North America.

If you accept the premise in the previous sentence, then organisms (plants, insects, humans) that take up water and incorporate it will reflect that difference in the stable isotope abundance of hydrogen and oxygen in water from north to south. Through a large number of analyses of tap water north/south/east/west in the US, scientists have established crude contour intervals across the US that reflect these changes in isotope abundances in water. It has been shown that the isotope ratios of oxygen and hydrogen in human hair correlate with the isotope ratios of local tap

water and differ depending on where the individual lives (Proc. Nat. Acad. Sci. USA **2008**, *105*, 2788).

Thus, we finally get to the birds. Feathers are made essentially of the same keratin as in human hair. Keratinous tissues like hair and feathers are metabolically inert following synthesis. Birds that grow their feathers, either as a recently hatched bird, or from feather molt as an adult, will incorporate water either directly from the liquid or indirectly from plants and insects that they eat. Since those plants and insects would reflect a different isotope ratio depending on the water of incorporation, the bird feathers will differ in isotope ratios depending on where the bird foraged when its feathers developed. Avian biologists have well established where geographically and when feather development occurs in most species of birds. So let's use an example to show how this information is used. A bird develops its feathers somewhere in North America after birth and incorporates a specific isotope ratio of hydrogen. The bird migrates somewhere into Panama and is captured in a net, a standard technique for banding. A bit of feather is taken and the isotope ratio is determined. Based on the established contours for isotope distribution, an analysis indicates that the bird is from the New York area. Another bird of the same species is captured in Brazil and the isotope ratio reflects that the bird is from Nova Scotia. One can then begin to establish which geographic areas birds are born in and to where they migrate. Conversely, if a bird molts to breeding plumage on the wintering ground before migration and that bird is netted later at its breeding location that same year, then one has determined the bird's range as long as one has the isotope contours already established. This obviates the need for banding birds and then their subsequent recapture (a very low probability) to determine migration patterns, and breeding/wintering ranges. Chemistry comes to the rescue!

Avian biologists have also shown using stable isotope studies that certain species of birds wintering on excellent wintering grounds e.g., better food supply, migrate earlier in the season than the same species from a poorer wintering ground and in doing so, can claim the better breeding territories. Survival of the fittest?

In one more example, scientists analyzing hydrogen isotope ratios in Bicknell's Thrush in the Dominican Republic realized that these individuals must nest further north in NA beyond their known range and confirmed this through extensive searching in the appropriate isotope contour for nesting thrushes. Thus, all of these data can be put to use in conservation initiatives with birds.

For isotope analysis, an isotope ratio mass spectrometer operating in a continuous flow mode is used. The feather samples are pyrolyzed to form H2 and CO in a furnace. The gases are transported to a GC for separation and then to the mass spectrometer for determining the isotope ratio. A good all around review of how isotope analyses are being used in understanding animal migration is by Hobson (Oecologia, **1999**, *120*: 314-326).

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