Rochester Academy of Science

BULLETIN

"An organization of people in the Natural Sciences"

November 2021; Vol. 75, #8

President's Message

As you likely already know, the ***RAS 47th annual Scientific Paper Session*** is at Nazareth College on Saturday, November 6. Featured presenters will be area scientists, students, and RAS members, who will share their investigations and interests about scientific topics.

Are you interested in corals, coral reefs, or climate change and other environmental changes? Then join us for the Larry King Memorial Lecture given by SUNY Buffalo Professor of Environment and Sustainability Dr. Howard Lasker on that Saturday afternoon. He is an expert on coral reefs and has led numerous research trips to the Caribbean, investigating the impact of climate change on coral communities for many years now. His work in the Caribbean has included assessing damage and recovery of reefs after hurricanes. Dr. Lasker speaks frequently to the media and publicly about his research, as well as how climate change is affecting reefs and oceans around the world.

The lecture is free to the public. I hope you will come!

Save the Date!
Saturday, November 6, 2021
RAS Scientific Paper Session
Nazareth College

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I note here the passing of long-time member ***Samuel J. Ciurca, Jr.***, peacefully, on Saturday, October 2nd, 2021 at Rochester General Hospital. Sam was an ebullient and enthusiastic amateur scientist whose passion was fossil eurypterids.

Sam was presented with the prestigious Harrell L. Strimple Award in 2016 by the Paleontological Society. This award is given to one person each year for outstanding contributions to the field of paleontology by an amateur. He authored or co-authored scores of scientific papers and articles.

The November Fossil Section newsletter will be dedicated to Sam, and any RAS member not already on that mailing list may request a copy from me.

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Bill Hallahan has announced the ***2021-2022 Student Grants program*** run by the RAS to all the local area colleges. We have only enough funds for a few grants and I hope that you will make a small donation to increase this amount.

Did you enjoy the article in the October *RAS Bulletin* on the *Effects of artificial light at night on caterpillar predation and parasitism pressure*? This was John Deitsch's research at Cornell University. Last year we had enough endowment earnings to fund five grants. John's was the sixth one and was only possible because RAS members Judy Wadsworth and Mariana Rhoades joined me in donating enough to fund his research with an additional RAS student grant. These grants are important not only because they support research by developing young scientists, but also because they are given significant weight in qualifying these scholars for graduate schools and scholarships. A grant from the RAS is a prestigious award for them.

If you would like to help, please contact Dr. William Hallahan at whallah3@naz.edu to donate.

No part of our annual dues is used to make these awards. We can only make an additional award with the donations made by members by November 30. I invite you to join me in contributing, however small, to the Rochester Academy of Science Student Grants program.

Michael Grenier, President RAS

RAS Scientific Paper Session Schedule

Saturday November 6, Nazareth College

Register to attend, submit your abstract if presenting, order a lunch (optional), and get more information: **https://rochesteracademyofscience.godaddysites.com/paper-session**

Parking: Free. Park in lots G, P, and A.

8:30 a.m.: Presenters sign in. Refreshments for all attendees. Shults Center.

9:15 – 10:30 a.m. Oral Presentations Peckham Hall.

10:30 a.m. – 12:00 p.m.. Poster Session Peckham Hall hallways (floors 1-3).

12:00 p.m. – 1:00 p.m. Lunch – bring your own or prepaid ($16 per person).

1:00 p.m. Welcome and Larry King Memorial Lecture. Forum Room, Shults Center.

A campus map can be had at the paper session website above or at **www2.naz.edu/files/5214/4294/7624/ParkingMap.pdf**

Events for November 2021

For updates to events, check the Academy website http://www.rasny.org and section websites.

5 Fri: Astronomy Members Meeting

7:30 p.m. – 10:00 p.m. RIT Carlson Center for Imaging Science, CAR-1125. Parking Lot F. Meeting will be held in person at RIT as well as virtually via Zoom. Speaker: Segev BenZvi, Ph.D., Department of Physics and Astronomy, University of Rochester. Topic: How TeV gamma rays can be used as possible tracers of dark matter annihilation. Contact: Mark Minarich at mminaric@rochester.rr.com.

6 Saturday: RAS Scientific Paper Session and Larry King Memorial Lecture

9:15 a.m. — 10:30 a.m. Oral Presentations. 10:30 a.m. till noon, Poster session. 1:00 p.m. Keynote Larry King Memorial Speaker will be Howard Lasker, Ph.D., of the University at Buffalo, speaking on his research on the ecology of coral reef organisms. For more information see page 3 or contact Michael Grenier at paleo@frontier.com.

6 Sat: Astronomy Member Observing

Member Observing: Starting from dusk till last person leaves. Farash Center for Observational Astronomy, 8355 County Road 14 Ionia, NY 14475. For weather related cancellations or changes contact Mark Minarich at mminaric@rochester.rr.com.

7 Sun: Astronomy Open House

Open House: 12:00 p.m. - 3:00 p.m. Observatory tours and work parties. Indoors at normal capacity for those already vaccinated, otherwise masks and social distancing or outdoors only. Farash Center for Observational Astronomy, 8355 County Road 14 Ionia, NY 14475. For weather related cancellations or changes contact Mark Minarich at mminaric@rochester.rr.com.

9 Tue: Fossil Section Meeting

7:30 p.m. Meeting will be held remotely via ZOOM and is open to all RAS Members and guests. Speaker: Carl Fechko, past president of the North Coast Fossil Club in Cleveland, Ohio. Topic: The geology, history, and fossils of the Fossil Lake Sediments of the Green River Formation. For meeting details and login info Contact Michael Grenier at paleo@frontier.com.

10 Wed: Astronomy Board Meeting

7:00 p.m. UR Bausch & Lomb Hall, room 203, pending UR approval. Contact: Mark Minarich at mminaric@rochester.rr.com.

10 Wed: Herbarium Workshop

1 p.m. - 4 p.m. The Life Sciences section will hold a workshop at the RAS Herbarium, located in the basement of the Rochester Museum and Science Center (RMSC). At RMSC go to the front desk to meet other participants. You must be fully vaccinated, and masks are required for all visitors at RMSC. If you plan to attend, please send RSVP or any inquires to Elizabeth Pixley, herbarium curator, at eypixley@gmail.com, or call (585) 334-0977.

17 Wed: RAS Board Meeting

7:00 p.m. Virtual meeting using Zoom. For details, contact Michael Grenier at mgrenier@frontiernet.net.

23 Tue: Mineral Virtual Meeting

7:00 p.m. Zoom meeting. Meetings this academic year are being held on the 4th Tuesday of the month. Canadian David Joyce will speak about his adventures collecting Japan-law twinned quartz crystals at Foley Peak, in British Columbia over a 22-year period. See fantastic alpine scenery with changing ice fields and interesting minerals obtained with risky collecting techniques. Members will be emailed a link for the meeting. Guests welcome. Contact: J. Dudley at juttasd@aol.com.

Figure 1: Japan-law crystals grow together with axes oriented at an angle of 84° 33´. This type of twinning was named after the country where many were found. Specimen is from Naru Island, Japan. You can learn about this type of mineral twinning at the November 23 Mineral Section virtual meeting. *(Source: https://www.mindat.org/a/best_quartz_japan_law_twins)*

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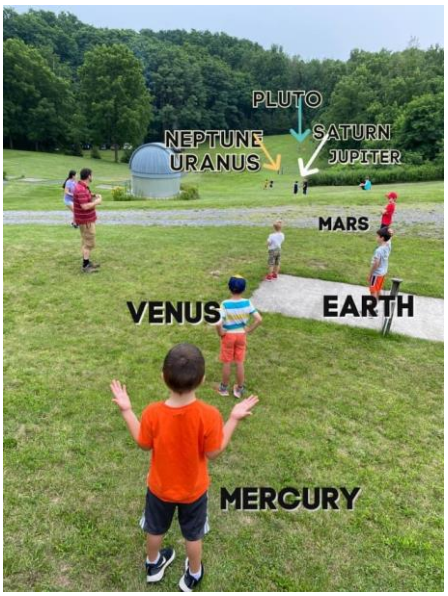

Figure 2: Fairport scout troop meeting at the Farash Center for Observational Astronomy in Ionia, NY on July 17, 2021. Joe Altieri doing a scale model of the solar system with the kids. *(Photo Credit: David Bishop)*

Daylight Saving Time ends 2:00 a.m. November 7, 2021 – Clocks "fall" back one hour.

47th Annual Fall Scientific Paper Session

The 47th Annual Fall Scientific Paper Session of the Rochester Academy of Science will be hosted by Nazareth College on Saturday, November 6, 2021 from 8:30 a.m. to 2:00 p.m. Presentations will be scheduled between 9:15 AM and noon. This session provides a forum for Academy members, the collegiate community, and others engaged in scientific research to present the results of their investigations in an atmosphere that promotes discussion and interaction.

The Academy covers the full scope of basic and applied sciences, including anthropology, botany, chemistry, computer science, ecology, environmental science, geography, geology, physics, physiology, science education, and zoology. Undergraduate students, graduate students, and faculty members are encouraged to attend and to present posters or oral reports. You do not have to be a member of the Rochester Academy of Science to participate.

Drinks and pastry will be available during on-site registration starting at 8:30 AM. A 1-page schedule and map will be handed out at registration. A luncheon follows the presentations and the Larry King Memorial Lecture is featured after lunch.

There is no charge to attend. For presenters, there is only one $10 fee per abstract submission, either individual or group. RAS members pay $5. All payments are donations to the RAS.

Presentations may be oral presentations or posters. Oral reports are limited to 15 minutes in length: Use 12 minutes for the presentation itself and allow 3 minutes for questions from the audience at the end of your presentation. Posters provide an excellent opportunity for author-audience interaction and students should consider this mode of presentation, particularly if this will be their first scientific meeting.

Dr. Lawrence J. King Memorial Lecture

We are pleased to announce that our Larry King Memorial Speaker this year will be Howard Lasker Ph.D., of the University at Buffalo, speaking on ***the ecology of coral reef organisms***.

Dr. Lasker studies coral reefs particularly the octocorals (soft corals and gorgonians). He and his students have conducted studies ranging from the feeding ecology of butterfly fish to the evolution and systematics of corals. Current research employs a combination of field experiments and molecular studies to examine the reproduction and recruitment of octocorals on Caribbean reefs. You will hear about SCUBA dive observations and lab work including DNA sequencing. Please join us for this interesting talk.

This talk is FREE, open to the public, and immediately follows lunch. For more information, you can visit the Buffalo Undersea Reef Research (BURR) at http://burr.bio.buffalo.edu/.

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Editor's Corner

RAS at the Golden Goose Awards

RAS longtime director and secretary, Helen Haller, Ph.D., is also our liaison to the American Association for the Advancement of Science. (AAAS). H. Haller attended the Tenth Annual Golden Goose Award Ceremony virtually on September 22, 2021. The award, sponsored and organized by AAAS, members of Congress, and other associations, is given to recognize federally funded research that may have seemed ridiculous or useless, that has turned out to be beneficial to society. The three projects were:

Making mRNA – The team spent decades doing research on mRNA that was initially not accepted by their colleagues and has turned out to be critically important to the production of two vaccines to protect against COVID-19.

The Fast and the Curious – A team of four graduate students hacked and studied all the computer-controlled systems in a car. Their research has dramatically improved the cybersecurity of all current cars, solving a problem that car manufacturers did not even know they had.

The Secret of SERMS – SERMS are Selective Estrogen Receptor Modulators. A single researcher (plus grad students and postdocs galore) has spent decades studying the effects of failed contraceptives on the body, expecting them to help

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Buffalo undersea coral research

Featured Article

Space Weather and Its Effects

By Donald Bridy, Ph.D., retired physicist, Syracuse, NY.

This article is partially a review of a presentation by Dr. Gemma Richardson, Geomagnetic hazard specialist, to an online meeting of the British Astronomical Association, Radio Astronomy Group (BAA RAG), Oct 1, 2021,entitled "The changing environmental conditions in near-Earth space", and partially based on an earlier 2016 presentation by the author [1].

Space weather refers to varying conditions in the near-Earth environment (slight paraphrase of Dr. Richardson's title). These include electromagnetic fields and charged particles. Solar events can cause a geomagnetic storm which can result in many negative effects including spurious signals in, disruption of, and damage to many systems. These include communications and navigation (both GPS and magnetic field based), satellites and spacecraft, semiconductor circuits including avionics and computers, power grids, and pipelines. In addition there can be increased radiation to astronauts and airline occupants. There are also a few positive effects including the viewing of auroral displays at more southerly latitudes and increased understanding of geomagnetic and ionospheric behavior under more extreme conditions. A number of these effects are illustrated below in Figure 1.

The most notable example of space weather effects is the Carrington Event of 1859. A Coronal Mass Ejection produced induced currents that shocked telegraph operators, set telegraph paper on fire, and in some cases destroyed telegraph apparatus which, with mid 1800's technology, was extremely robust compared to modern semiconductor electronics. When batteries were disconnected messages could still be sent using induced currents alone. Auroras could be seen in Cuba and Hawaii. It produced the largest geomagnetic storm on record. An instructive human-produced and more localized example for comparison is the Starfish Prime atmospheric nuclear test in the Pacific in 1962, where the Electromagnetic Pulse (EMP) crashed telephone service, disrupted the electric grid, burned out street lights, and set off burglar alarms in Hawaii almost 1000 miles away.

A second solar-induced example is the Quebec province-wide power blackout of 1989, caused by a Coronal Mass Ejection and sometimes referred to as the biggest geomagnetic storm of the space age. Auroral activity was visible as far south as Cuba and Florida. A third example that has been suggested to have been even bigger [2] than the Carrington event, although comparison is difficult, was the

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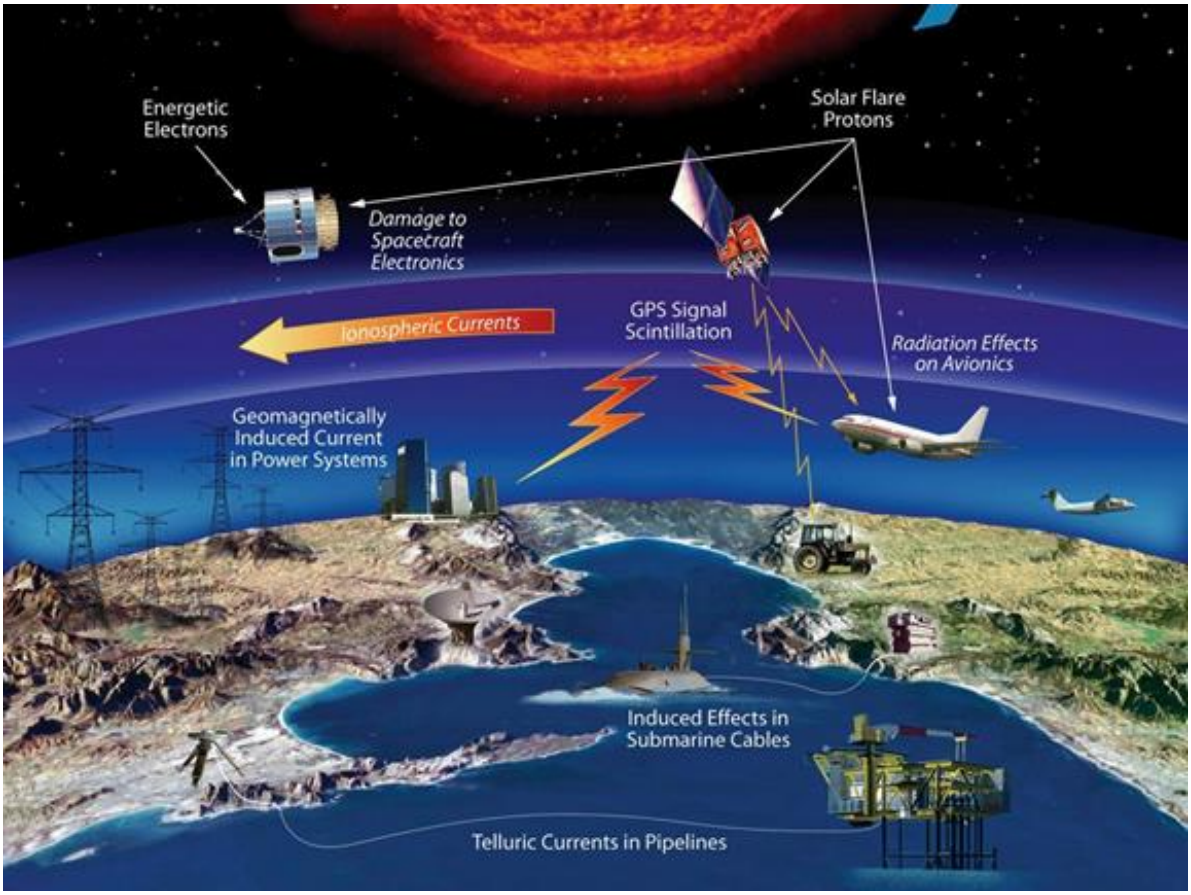

Figure 1 Effects of Space Weather [9]

New York Railway Storm in 1921, a worldwide event but named for the disruption of NYC trains. Trains were brought to a halt due to the fact that the signaling and switching systems below 125th street were rendered inoperable. It resulted in three major fires including one sparked by strong currents in telegraph lines which burned the Brewster, NY railroad station to the ground. A second fire destroyed a telephone exchange in Sweden. Telephone, telegraph and cable traffic were affected throughout most of Europe. Auroras were seen in Samoa.

Coronal Mass Ejections, Coronal Holes, and Solar Flares

The solar event with the greatest impact is a Coronal Mass Ejection (CME). This is a sudden and violent release of solar matter in the form of plasma (ionized gas) and associated entrained magnetic fields. A large CME can contain ~ a billion tons of matter travelling hundreds of kilometers per second. Two origins of CME's are associated with solar flares (see below) and associated with solar filament/prominence eruptions. A coronograph which blocks light from the sun's disk permits imaging of CME events. Examples are given in Figure 2.

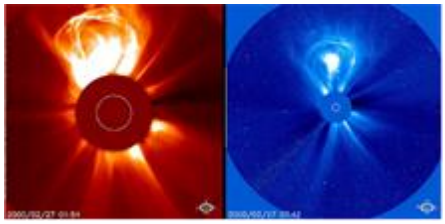

Figure 2: Coronal Mass Ejection Examples [10]

The solar wind is basically an outward extension of the sun's plasma (ionized gas), a stream of charged particles from the corona, together with an extension of the solar magnetic field. This extension of the sun's magnetic field throughout the solar system in known as the Interplanetary Magnetic Field. The earth's magnetosphere acts a shield, causing most of the energetic particles in the solar wind to be deflected and flow around and beyond the earth. Impact of a CME with earth's magnetosphere causes the magnetic field lines to be compressed on the front (day) side and stretched on the back (night) side even more severely than that caused by the continuing impact of the normal solar wind, transfers energy to the Earth's magnetosphere and results in a geomagnetic storm.

Figure 3 illustrates a CME on its way to Earth's magnetosphere. The blue lines represent magnetic field lines of Earth's magnetosphere.

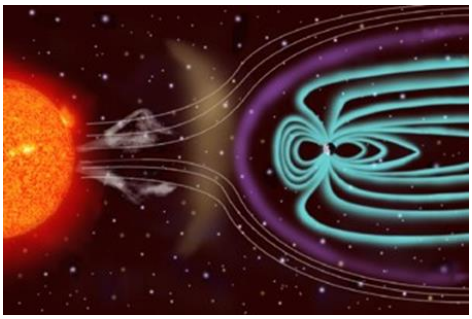

Figure 3: CME on its way to Earth's magnetosphere. [11]

A second type of solar event affecting space weather is a Coronal Hole, a cooler, denser region that appears dark in X-ray and extreme UV images. Ordinarily magnetic field lines are closed and reconnect with the sun's corona (upper atmosphere). Plasma flowing along these lines is generally contained and forms solar loops and prominences. Figure 4a illustrates closed field lines (region A) and open field Lines (region B). Above a coronal hole the magnetic field lines are open and do not reconnect with the corona.

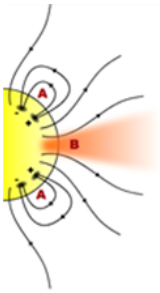

Figure 4a Closed and Open Field Lines [12]

Plasma can escape more readily resulting in a faster flowing solar wind, ~800 km/s as opposed to a normal speed of ~400 km/s. Interaction of the magnetosphere with high speed solar wind streams can produce geomagnetic storms, generally more moderate than those caused by CME's. Two Coronal Holes (dark areas) are shown in Figure 4b.

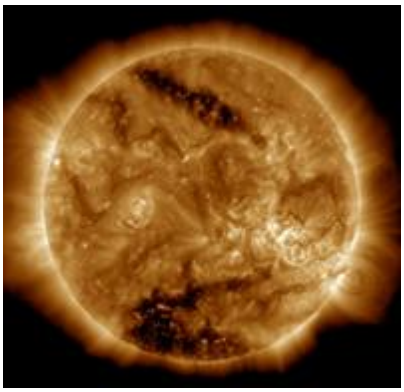

Figure 4b Two Coronal Holes [13]

A third type of solar event is a Solar Flare. Solar Flares occur when the energy in intense magnetic fields above active regions, usually sunspots, is suddenly released. This produces a very large eruption of electromagnetic energy encompassing a wide range of frequencies from gamma rays, X-rays, UV and visible light down to radio frequencies. Intense X-ray and Extreme Ultraviolet (EUV) radiation causes ionization in the denser D-layer of the ionosphere, degrading or absorbing high frequency (HF) radio waves and resulting in a radio blackout, primarily in the 3-30 MHz range. There can also be an associated CME.

Space Weather Forecasting

Space weather forecasting is much shorter term than our ordinary weather forecasting and a forecast is typically issued for 3 days. Several satellites, including DSCOVR, SOHO, SDO, and GOES, monitor the sun. As an example, imminent arrival of a CME can be detected by the Deep Space Climate Observatory (DSCOVR), a satellite located at the L1 orbital area. This can result in a 15-60 minute warning of imminent shockwave arrival at Earth.

Longer term forecasting relies on models. A CME can travel from <250 km/s to ~3000 km/s and arrive at Earth within several days for the slowest CME's to 15-18 hours for

(Continued on page 6)

the fastest CME's. It takes a few hours to download sufficient data from the satellites, and 6 hours to run the complex models resulting in a total of 8-10 hours to acquire data, model, and predict a likely outcome based on the modeling results [3]. This doesn't give much lead time for a warning of a faster CME. Unfortunately the most damaging CME's are typically the fastest CME's.

Critical Infrastructure Effects: Electrical Grids and Pipelines

Rapidly changing magnetic fields caused by the geomagnetic storm induce electric currents in conductors [4], called Geomagnetically Induced Current (GIC). In soil and water GIC is also referred to as telluric ("earth") current. In the case of the electric grid [5], the telluric currents seek the path of least electrical resistance and flow through grounded transformers which provide an entry point to powerlines. Two effects of GIC in powerlines are to saturate a transformer core which alters its functioning, causing wild current and voltage swings, which can result in damage and destruction of the transformer via heating and melting, and trip protective relays. These effects can lead to failure of the affected portions of the grid.

Telluric currents are affected by soil conductivity and underlying geology. As a first approximation, in soils with lower conductivity (higher resistivity), telluric currents are more likely to find their way into lower resistance powerlines. A more detailed analysis indicates that the most favorable situation for GIC to flow into powerlines is to have a region with low grounding resistivity (insuring a good ground connection) overlaying a high resistivity medium such as igneous rock [6], [7]. Note in relation to two events cited in the first section of this article, both Quebec and New York State sit on an expanse of Precambrian igneous rock.

A second negative effect to infrastructure is to counter galvanic protection in buried structures such as pipelines. A major approach to corrosion protection, Impressed Current Cathodic Protection, imposes a voltage difference between pipelines and anodes to inhibit corrosion. The current drives the electrochemical reaction in the right direction, such that the anodes are sacrificed (experience corrosion) while the cathode (pipeline) is protected. Figure 5 illustrates a section of pipeline with three anodes connected via a voltage source. GIC-induced voltage swings alter the Pipe-to-Soil Potential causing increased corrosion. A pipeline in New Zealand (Northland) may have failed due to enhanced corrosion from GIC.

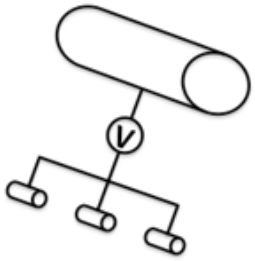

Figure 5. Cathodic Protection

Conclusion

Geomagnetic storms can cause a variety of hazards to humans, equipment and critical infrastructure. Improved space weather forecasting is critically important to anticipate and prepare for these events. In addition a variety of mitigation measures show promise [8]. In the case of the electric grid there are two major obstacles. 1) Many techniques which are available or in development have not yet reached the mature, proven stage. 2) Retrofitting the electric grid with these measures would be an extremely expensive undertaking.

References

[1] Dr. Gemma Richardson gave an interesting and informative summary of the current state of the field. It can be found at https://www.youtube.com/watch?v=a8GYBga1WNM .Also the BAA RAG hosts a stimulating series of radio-astronomy-related presentations. The author's presentation was given to a local scientific society in Syracuse in 2016. This article largely follows the order of Dr. Richardson's presentation. Due to the overlap of the two presentations and references/hyperlinks to NASA, ESA and similar sources, attribution to the two individual presentations was not given for the most part. Also additional material was included.

[2] This is discussed in Scientific American, "New Studies Warn of Cataclysmic Solar Superstorms" at https://www.scientificamerican.com/article/new-studies-warn-of-cataclysmic-solar-superstorms/

[3] Time estimates for data collection, modelling, and prediction are from Dr. Gemma Richardson's talk.

[4] The complete sequence is as follows. Varying ionospheric currents produce varying magnetic fields. These in turn cause varying electric fields (electromagnetic induction) producing electric currents in conductors.

[5] An overview of the Electric Power Grid and GIC can be found in Section 1 of the GAO report "Critical Infrastructure Protection, Protecting the Electric Grid from Geomagnetic Disturbances" at https://www.gao.gov/assets/files.gao.gov/assets/gao-19-98.pdf.

[6] A map of igneous rock areas in the US and Canada is included in the brief and highly readable summary of the Quebec blackout, "The Day the Sun Brought Darkness," at https://www.nasa.gov/topics/earth/features/sun_darkness.html.

[7] A more technical discussion can be found in Section 2 of "Modified GIC Estimation Using 3-D Earth Conductivity", in Space Weather, 10 June 2020 https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020SW002467.

[8] Section 3 of the GAO report in reference [5] has a summary of various mitigation techniques.

[9] Figure 1 Effects of Space Weather: NASA https://www.nasa.gov/mission_pages/sunearth/spaceweather/FAQ13.html

[10] Figure 2, CME Examples: SOHO, ESA and NASA https://www.nasa.gov/content/goddard/what-is-a-coronal-mass-ejection

[11] Figure 3: CME on its way to Earth's magnetosphere. SOHO (NASA/ESA) https://geomag.bgs.ac.uk/research/space_weather/sci_intro.html

[12] Figure 4a, Closed and Open Field Lines: Author: Sebman81 Creative Commons Attribution-Share Alike 3.0 Unported, 2.5 Generic, 2.0 Generic and 1.0 Generic license. https://commons.wikimedia.org/wiki/File:Coronal_Hole_Magnetic_Field_Lines.svg

[13] Figure 4b, Two Coronal Holes: NASA/Goddard/SDO Public Domain https://commons.wikimedia.org/wiki/File:Two_Coronal_Holes_on_the_Sun_Viewed_by_SDO_(16658479920).jpg

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Featured 2020-2021 Undergraduate Student Research Grant Award Winner

Lezhi Hao, Cornell University,
Female plumage traits as signals of mate quality, competitive ability, and stress resilience in the black-throated blue warbler.

Sponsor: Sara Kaiser, Ph.D., Research Ecologist; Director, Hubbard Brook Field Ornithology Program, Cornell Lab of Ornithology.

Abstract

Females of sexually dichromatic species are often similar in appearance to males but duller in color with smaller homologous traits. These conspicuous traits that males use in displays to females and in competitions with rival males may occur in females as non-functional byproducts of sexual selection in males. However, female plumage traits may function as signals of quality maintained by sexual selection and natural selection acting on both sexes. I propose to use experimental and correlative approaches to examine whether the size and coloration of female plumage traits in the Black-throated Blue Warbler (*Setophaga caerulescens*) function as signals of mate quality, competitive ability, and stress resilience.

This species is the most sexually dichromatic wood warbler in North America and has been the focus of a 40-year demographic study at the Hubbard Brook Experimental Forest (HBEF), NH where I will conduct this study during May-Aug, 2021-2022. Much of the work in this system has focused on explaining variation in male plumage traits that are thought to have evolved from sexual selection, yet variation in female plumage traits has been unexplored. My objectives are to (1) quantify variation in the size of wing patches and the coloration of breast feathers using field measurements, photos, and feather sampling, (2) associate wing patch size with reproductive performance (mate quality) and female aggression stimulated by simulated territorial intrusion experiments during territory establishment and nest building (competitive ability), and (3) associate the breast feather brightness with reproductive performance (mate quality) and oxidative status (stress resilience). Only by considering both sexes, will we be able to fully understand the function of plumage traits and the evolution of sexual dichromatism.

Background and Rationale for Hypotheses

Birds are remarkable for their extraordinary diversity in plumage coloration [1]. In sexually dichromatic species, females are often similar in appearance to males but duller in color with smaller homologous traits. A large body of research has explored how males use conspicuous plumage traits to increase access to mates by either improving their competitive ability against rivals or increasing their attractiveness to potential females [2]. These same traits may occur in females as non-functional byproducts of sexual selection in males [3]. Alternatively, female plumage traits may function as signals of quality maintained by sexual selection and natural selection acting on both sexes [4], [5]. However, the quantification of female plumage variation and examination of how selection shapes female plumage traits has received little attention despite the prevalence of sexual dichromatism in birds [6]. Only by considering both sexes, will we be able to fully understand the function of plumage traits and the evolution of sexual dichromatism.

Studies of the size and coloration of male plumage traits have found associations with measures of individual quality, such as social status, mate quality, and physiological condition. The size of male plumage traits often serve as age-dependent signals of social status and dominance that individuals display to each other in agonistic interactions to indicate competitive ability [7]. In species that exhibit less aggression, the size of male plumage traits can convey information on breeding experience and fitness [6]. Plumage coloration, such as carotenoid-based coloration, can be an honest signal of oxidative stress resilience, which is linked to higher fitness [8], [9]. Although fewer studies have examined these same associations in females, the size and coloration of female plumage traits are often positively associated with individual quality, suggesting a potential function of female plumage traits in sexual or social signaling [3], [10].

Objectives and Suitability of Study System

I propose to use experimental and correlative approaches to examine whether the size and coloration of female plumage traits in the Black-throated Blue Warbler (Setophaga caerulescens; hereafter BTBW) function as signals of mate quality, competitive ability, and stress resilience.

The BTBW is a sexually dichromatic songbird [11]. The species is named for the male's unmistakable appearance – they are blue above and white below, with a black throat and white wing patches. Females are distinct from males in their greenish-olive color above, whitish-yellow breast, with a narrow pale eyebrow and lower eye mark as in Figure 1.

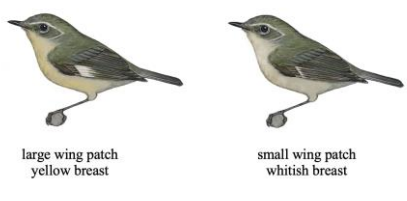

Figure 1

(Continued on page 8)

Lezhi Hao

(continued from page 7)

The only trait females share with the males is the distinctive white wing patch. The BTBW has been the focus of a long-term behavioral and demographic study at the Hubbard Brook Experimental Forest (HBEF), NH. Much of the work in this system has focused on explaining variation in male plumage traits that are thought to have evolved from sexual selection [12], [13]. For example, the size of male wing patches are highly variable and generally known to increase in size with age [14]. Males display their conspicuous white wing patches to females during courtship displays and also to rival males during territory establishment and while mate guarding [11]. Experimental manipulation of wing patch size in males indicated that this trait functions as an age-dependent signal of social status and competitive ability to conspecific males [14]. In contrast, variation in female plumage traits has been unexplored in this species.

Focusing on female plumage traits, my objectives are to (1) quantify variation in the size of wing patches and the coloration of breast feathers using field measurements, photos, and feather sampling, (2) associate wing patch size with reproductive performance (mate quality) and female aggression stimulated by simulated territorial intrusion experiments during territory establishment and nest building (competitive ability), and (3) associate the breast feather brightness with reproductive performance (mate quality) and oxidative status (stress resilience).

Research Procedure: Hypotheses, Predictions, and Tests

From May-Aug, in 2021 and 2022, as part of the long-term study on BTBW at the HBEF, all females will be captured at their nest in a 6 m mist net, color banded, aged, and measured, and all nesting attempts will be found and monitored to assess female reproductive performance within their social mates' territories, which will be mapped relative to a 50 x 50 m grid on the 290 ha study plot.

Hypothesis 1: ***The size of plumage traits signal mate quality*****.**

Prediction 1a: The size of the wing patch will be positively associated with reproductive performance.

Test 1a: I will measure wing patch size in the field and from spread wing photos using ImageJ. I will measure reproductive performance as the number of eggs laid, number of broods, and number of young fledged.

Prediction 1b: The size of the wing patch will be positively associated with annual apparent survival.

Test 1b: I will estimate annual apparent survival rates using capture–resight data [15].

Hypothesis 2: ***The size of plumage traits signal competitive ability and functions in female-female competition.***

Prediction 2a: The size of the wing patch will be positively associated with breeding territory quality.

Test 2a: I will assign an index of food availability for each territory as an indicator of breeding territory quality [16]. The index is a function of caterpillar biomass per leaf, territory size, and the estimated number of understory leaves per territory and estimated biweekly over the breeding season as part of the long-term study [16].

Prediction 2b: The size of the wing patch will be positively associated with female aggression.

Test 2b: I will perform simulated territorial intrusion (STI) experiments during territory establishment and nest building when females are observed engaging in aggressive interactions. I will create six unique 3D-printed decoys with an equal number of decoys with small or large wing patches and randomize across trials. Decoys will be placed near prospecting females (territory establishment) or nests (nest building) and paired with audio playback of aggressive conspecific calls for 5 min. After the bird first discovers the decoy, I will use a digital voice recorder to document behavior of the focal female. I will record the proportion of time spent within 1 m of the decoy and any aggressive behaviors, including contact with the decoy or swooping, and aggressive conspecific calling [17] and calculate an aggression score.

Hypothesis 3: ***Plumage coloration signals stress resilience.***

Prediction 3: Breast feather brightness will be negatively associated with oxidative status.

Test 3: I will take photos of the breast and belly to assess color [18] and collect 9 feathers from the center of the breast between the wrists, 3 from 3 separate locations (left, center, right) and measure brightness and carotenoid chroma in females, using a field spectrometer to measure reflectance in the ultraviolet (UV; 320– 400 nm) and visible (400–750 nm) spectra [6], [15]. To calculate oxidative status, I will measure both the pro-oxidant status using d-ROMs test and antioxidant status using OXY adsorbent tests of plasma samples (n = 40 samples per field season) [19], [20]. I will calculate oxidative status, which is the ratio of the two tests (ROMs:OXY) to indicate the balance of pro-oxidant and antioxidant substances [21].

Hypothesis 4: ***Plumage coloration signals mate quality.***

Prediction 4a: Breast feather brightness will be positively associated with reproductive performance.

Test 4a: Methods described above.

Prediction 4b: Breast feather brightness will be positively associated with annual apparent survival.

Test 4b: Methods described above.

Timetable and Expected Outcomes

I measured the size of female wing patches from photos previously collected from 2009-2013 with ImageJ for preliminary analysis from Aug–Dec 2020. I will conduct field experiments at the HBEF from

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May-Aug 2021 and 2022, measure wing patch size and feather coloration in fall 2021, receive training to conduct oxidative stress assays over the winter term, and conduct statistical analyses in spring 2022. I will begin preparation of two separate manuscripts in spring 2022 and spring 2023 and present at two scientific meetings in summer 2022 and 2023.

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Female foraging for termites at the John Heinz National Wildlife Refuge (wiki)

Editor's Corner

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with osteoporosis. Instead, he has uncovered the dramatic effect of Tamoxifen on some kinds of breast cancer.

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ASRAS at the Black Forest Star Party

Exceptionally dark skies are helpful for observing deep sky objects and nebulae. The nearest such place is the Black Forest Star Party, held this year from October 1-3 at Cherry Springs State Park, Potter County, Pennsylvania, USA.

RAS attendees this year were Hank Baronsky, Brett Carlson, David Terrazas, Mary Winzenburg, as well as their families.

Figure 1: David Terrazas doing extreme astronomy at the BFSP. *(Credit: David Terrazas)*

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