of nests, while UWE yielded best results for determining water velocity for posterior (0.02% and 0.54% respectively) section of nests. Compared to water current velocity calculated by ECA, UNE yielded best results for determining water current velocity through anterior (0.01% and 0.18% error, respectively) and middle (0.12% and 0.02% error, respectively) sections of nests, while UWE yielded best results for determining water velocity for posterior (0.04% and 0.02% respectively) sections of nests. UWE and UNE can be applied to nests of other species of *Nocomis* and those of *Semotilus* and *Exoglossum* after nest micro-water currents field evaluation.

ROBOTIC PLATFORM TO GUIDE AND ASSIST INFANTS, POSSESSING VISUAL IMPAIRMENTS, WITH CRAWLING AND EXPLORATION. Muhammed M. Naqvi, Sean W. Megahan, David S. Parker, Dr. Dianne T.V. Pawluk, Ross A. Petrella & Dr. Peter Pidcoe, Department of Biomedical Engineering, Virginia Commonwealth University, Richmond VA 23284-2006. Without visual stimulus, infants who are blind or visually impaired (BVI) lack an opportunity to develop their motor, cognitive, and social skills. To solve this problem a robotic platform was created teach and foster independent exploration in BVI infants using haptic feedback and variable motor assistance. The robot platform was controlled and tracked by a smart phone application. A microcontroller on the robot platform interpreted the application data and supplied the infant vibrotactile feedback which described the distance and orientation of the target. Training paradigms were created to teach the infant to use the vibrotactile feedback and then gradually transition the infant off motor assistance. Preliminary testing showed successful functionality of the initial prototype. The robot platform and Android application designed were capable of determining distance and orientation relative to one another as well as providing haptic feedback and motor assistance to the infant. With mild improvements to the chassis, user interface and motors, the prototype would be ready for clinical trials.

Botany

TREE SURVIVAL IN CREATED PIEDMONT WETLANDS AND THE EFFECT OF SOIL CONDITIONS. M. Seidel & R. B. Atkinson, Dept. of Organismal and Environmental Biol., Christopher Newport Univ., Newport News VA 23606. Forested wetlands are the most frequently lost wetland type in the Eastern United States, and tree establishment efforts in created wetlands may be inadequate where survival rates are low. The purpose of this study was to evaluate survival rates using environmental variables as predictors of survival for seven woody plant species and three stocktypes. Trees were planted in March of 2009 in three created wetlands in Loudoun County, VA and survival was assessed annually during early August from 2009 to 2013. Overall survival after five years was 44.4% and survival was lowest between the first and second growing seasons. Survival of *Quercus palustris* in 1-gallon pots stocktype was highest (76.3%) and *Q. phellos* in tubeling stocktype was numerically lowest overall (7.95%). Survival rate was negatively related to organic matter content in the soil; however, depth and/or duration of hydroperiod may have influenced organic matter content. Support from the Peterson Foundation is gratefully acknowledged.

LEWIS GINTER BOTANICAL GARDEN – OUR PASSION IS CONNECTING PLANTS AND PEOPLE. Shane W. Tippett, Lewis Ginter Botanical Garden, 1800 Lakeside Avenue, Richmond VA 23228. Botanical gardens as cultural institutions and community anchors have developed in multiple countries through hundreds of years for reasons as varied as the gardens themselves. Regardless of their founding principles, many botanical gardens are now good places for the discussion of challenges which might be addressed at least in part by plant-based solutions. What are challenges with plant-based solutions? Healthy air to breathe; sustainable, nutritious food to eat; limited water resources to steward; effects of climate change to mitigate; a changing world to understand and tend. Why a botanical garden, our garden? Lewis Ginter frequently is viewed as practical and educational on divisive issues, we draw a third of a million guests (students) annually, and the guest experience is engaging, interactive and memorable.

VEGETATION PATTERNS AND HYDROLOGIC REGIMES IN THE GREAT DISMAL SWAMP. Kristina M. Kowalski & Robert B. Atkinson, Dept. of Organismal and Environmental Biology, Christopher Newport Univ., Newport News VA 23606. Draining activities in the Great Dismal Swamp (GDS) began with small ditches in the colonial era, however during the industrial era the ditches were extensively deepened, which dramatically altered the hydrology of the swamp. Since 1974, the GDS National Wildlife Refuge has ceased ditching and began managing the swamp for restoration of hydrology and natural plant communities. In 2013, two new weirs were installed on the eastern side of the GDS, which influences the hydrology of the proximate management units. The purpose of this study was to [1] assess the vegetative communities within management blocks soon to be influenced by hydrologic restoration [2] compare water table depth to vegetative community structure. Eleven 10-m^2 plots were established adjacent to well locations. Tree, shrub, herb, and vine strata were surveyed individually using estimated percent aerial cover. Percent cover and wetland indicator score were used to calculate weighted averages. Mean depth to the water table (MDWT) was calculated for the period of June 6 to July 21, 2013. Grand mean weighted averages among strata and MDWT were positively related (R^2 = 0.34). Weighted averages among tree, shrub, herb and vine strata varied in relation to MDWT (R^2 = 0.45, 0.14, 0.10, and 0.27 respectively). These results suggest that water levels significantly influence the plant community; however the relationship is not consistent among strata and responses to increased water levels may vary.

FLORAL ANATOMY AND COROLLA NECTAR TUBES IN *PHYSALIS* (SOLANACEAE). Deanna Dong & W. John Hayden, Dept. of Biol., Univ. of Richmond, Richmond VA 23173. We report on floral anatomy of five *Physalis* species from eastern North America. Tissues were prepared for light and scanning electron microscopy using standard techniques. All species studied possess flowers with five fused sepals that become accrescent in fruit, five fused yellow petals often with dense pubescence within the throat and dark spots nearby, and five epipetalous stamens. Flowers have a ring-like nectary below a two- or three-carpellate superior ovary. Anthers include sterile placentoids and stomium cells bearing crystal sand. Axile placentas bear numerous unitegmic anatropous ovules. Floral organs initiate in acropetal order as separate elements before fusing (connation). Notably, petal to stamen

adnation initiates (before petal-petal connation) as contact below tips of stamen primordia and proceeds basipetally; separate stamen primordium tips elongate, forming anthers. Corollas of all species studied possess a feature previously not well documented, capillary nectar "tubes;" these are anatomical grooves adaxial to petal midveins that extend from petal bases (adjacent to the nectary) to points approximately midway on the corolla limb. Nectar tubes develop as gaps between laterally adjacent mesophyll cells that divide and thicken petal gases, comparable to adaxial meristems of leaf ontogeny. Nectar tubes end at dark spots on the corolla, inferred to serve as nectar guides for pollinators. *Capsicum* and *Jaltomata* are reported to have similar nectar tubes.

ANATOMY AND MORPHOLOGY OF THE SUBTERRANEAN CLEISTOGAMOUS FLOWERS OF *COMMELINA BENGHALENSIS* (COMMELINACEAE). Elizabeth C. Fagan & W. John Hayden, Dept. of Biol., Univ. of Richmond, Richmond, VA 23173. Anatomical studies of the federally listed noxious weed *Commelina benghalensis* were undertaken to document structural and developmental details of its subterranean cleistogamous flowers. Specimens were collected on the University of Richmond campus in October 2012 and prepared for study with light and scanning electron microscopy using standard techniques. Results confirm and extend earlier literature. Cleistogamous spathes are solitary, axillary, subtended by a leafy scale, and bear a single bisexual flower. Three sepals enclose other floral organs, including three petals, three posterior stamens that are non-functional staminodes, three anterior stamens that are functional, and a three-carpellate gynoecium. Functional stamens have a well-developed endothecium and pollen grains are enveloped in an amoeboid tapetum. Ovules are orthotropic, bitegmic, and crassinucellate. Details of pollination within these closed flowers remains obscure; an earlier report noted pollen grains germinating on stigmas, an observation we cannot confirm. In some flowers, anthers were found in direct contact with stigmas, suggesting the possibility that pollen could germinate while still inside the anthers of cleistogamous flowers. Cleistogamous flowers produce dimorphic seeds, one large seed in the posterior locule and two small seeds in the anterior locules.

ADDITION OF BRYOPHYTE RECORDS TO THE DIGITAL ATLAS OF THE VIRGINIA FLORA AND OTHER CRYPTOGAMIC CURATORIAL NEWS FROM THE UNIVERSITY OF RICHMOND HERBARIUM. Catherine Sinclair, Michelle Ferrell & W. John Hayden, Dept. of Biol., Univ. of Richmond, Richmond, VA 23173. David A. Breil of Longwood University had summarized his knowledge of Virginia bryophytes in the form of a hardcopy atlas that remained unpublished upon his death in 1997. Breil's Bryophytes of Virginia Atlas contained records of occurrence by county for 148 species of liverworts and hornworts classified in 36 families and 349 species of moss classified in 45 families. These records are now incorporated into the Digital Atlas of the Virginia Flora website maintained by the Virginia Botanical Associates. To the extent possible, we have endeavored to update Breil's data using currently accepted nomenclature and current concepts of family placement. Other curatorial activity involving cryptogamic collections at the University of Richmond Herbarium (URV) has focused on lichens, notably: 1) integration of previously separate collections made by E. S. Luttrell in the early 1940's, (1202 specimens), K. L. Poff in

the early 1960's (210 specimens) and W. J. Hayden in recent decades (140 specimens); 2) identification of numerous "indets;" 3) replacing aged packets; 4) addition of 257 specimens collected by M. Ferrell; and 5) application of bar codes to each specimen. URV bryophyte and lichen collections have been loaned to and returned from DUKE Univ. as part of an NSF-funded herbarium digital imaging effort.

THE FLORA OF VIRGINIA PROJECT: A 2013-2014 PROGRESS UPDATE. Marion B. Lobstein, Northern Virginia Community College. Virginia, for its landmass, has the most diversity of vascular plant species of any state in the United States. The Colony of Virginia had the first flora, *Flora Virginica,* of any of the colonies which was last updated in 1762. Since 1926 the Virginia Academy of Science has supported efforts to produce a modern *Flora of Virginia*. In 2001 the Foundation of the *Flora of Virginia*, Inc, was formed in 2001to realize this goal. The *Flora of Virginia* was published in December 2012. The second printing with corrections was published December 2013. The Foundation of the Flora of Virginia project will continue to function to accomplish future goal of the Project. One of those goals is to development of teaching and learning modules. Marion Lobstein shared details of her efforts to develop workshops and materials to facilitate the use of the new *Flora of Virginia* by interested adult groups.

THE RELATIONSHIP BETWEEN RIPARIAN ZONE WIDTH AND FLORISTIC QUALITY ALONG STREAMS IN SHENANDOAH COUNTY, VIRGINIA. Jamie D. Smith & Conley K. McMullen, Dept. of Biology, James Madison University, Harrisonburg VA 22807. Riparian zones harbor an above average plant biodiversity. This biodiversity is increasingly threatened by invasive species and human disturbance such as deforestation from agriculture and urban development. This study will determine the relationship between the size of the riparian zone and the floristic quality of its vegetation. A bioassessment tool, which utilizes plant community characteristics will be used to obtain an estimate of habitat quality. This estimate, in turn will determine whether larger riparian zones provide more protection from the impacts of disturbance and provide higher quality habitats for plants. Preliminary data from vegetation plots show that there is a trend towards higher floristic quality in larger riparian areas. However, the number of non-native species in a particular area appears to be unchanged as riparian zone size increases, indicating that although larger riparian areas do harbor more native and conservative species, they are not effective at limiting invasion by non-native species.

FLORISTIC SURVEY OF THE SMITH CREEK RESTORATION AREA, ROCKINGHAM COUNTY, VIRGINIA. Allison N. Welborn & Conley K. McMullen, Dept. of Biol., James Madison Univ., Harrisonburg, VA 22807. Smith Creek Restoration Area, in Rockingham County, VA, comprises a 1.5-mi section of creek and a 66-ft buffer zone along either side. Prior to the beginning of this study, for ca. 200 years, the property had been used for agriculture/pasture. As a result, the creek had become unsuitable as a habitat for native brook trout, and most of the native plants in the immediate area were lost. In 2006, the land bordering the creek was made available for a restoration project that planted thousands of trees in the hopes of eventually returning the area to its natural condition. The purpose of the research described here

is to catalog the native vascular plant species that occur in this area, thus providing baseline data for future studies that might occur as the landscape changes due to the tree plantings and the absence of agricultural and grazing pressures. The 254 species found in the area so far represent 158 genera and 52 families, with ca. 58% being native to Virginia and ca. 41% non-native.

FIRST REPORT OF *LEAVENWORTHIA* (BRASSICACEAE) IN VIRGINIA. Conley K. McMullen & Brinton E. Domangue, Dept. of Biology, James Madison University, Harrisonburg VA 22807. During a survey of the vascular flora of Shenandoah County, VA, a population of *Leavenworthia uniflora* (Michaux) Britton (Michaux' gladecress) was discovered on 22 March 2012. This collection represents the first report of *Leavenworthia* in Virginia. *Leavenworthia* comprises eight native species, primarily located in the southeastern United States. *Leavenworthia uniflora* has previously been reported from Alabama, Arkansas, Georgia, Indiana, Kentucky, Missouri, Ohio, and Tennessee. Consequently, the population reported here makes Virginia the easternmost state in which *Leavenworthia* is found. *Leavenworthia uniflora* typically inhabits rocky ledges, cedar glades, pastures, roadsides, old fields, thin soil on limestone beds, and seeps on limestone rubble. Fittingly, the described population is found adjacent to a limestone quarry. This population of perhaps 50 individuals will be monitored to determine its persistence and possible spread.

COMPARISON OF ANTIOXIDANTS FROM COMMERCIAL FRESH AND DRIED HERBS. Jessica C. Wagner, Michael H. Renfroe, Harley J. Burton & Michele L. Barber, Dept. of Biol., James Madison Univ., Harrisonburg VA 22807. Commercially purchased herbs and spices were analyzed for antioxidant content. Antioxidants are an important component of the human diet and previous research has demonstrated that antioxidants help reduce incidence of cancer, atherosclerosis, senility, and other diseases associated with aging. We analyzed hydrophilic antioxidant content in fresh tissues from cilantro, mint and parsley. We analyzed hydrophilic antioxidant content in dried tissues from basil, Mediterranean basil, parsley, cilantro, rosemary, gourmet rosemary, rubbed sage, oregano, chives, and thyme. Among fresh herbs, significant differences were found from plant to plant within species as well as between species. Of the observed herbs, mint had the greatest concentration of hydrophilic antioxidants. Among dried herbs and spices, rosemary contained the greatest concentration of hydrophilic antioxidant, followed by basil, thyme, gourmet rosemary, and sage. Mediterranean basil and oregano contained significantly less antioxidant concentration. Cilantro, parsley, and chives contained the least concentrations of hydrophilic antioxidants. Lipophilic antioxidant concentrations were not examined in this study. These results may prove useful to dieticians and the general public when choosing a diet rich in antioxidants.

AN UPDATED PHYLOGENY OF THE TRIBE CHIOCOCCEAE (RUBIACEAE)-NEW INSIGHTS INTO TAXONOMIC RELATIONSHIPS. S. K. Paudyal[1], P. G. Delprete[2] & T. J. Motley (posthumous)[1], [1]Old Dominion University, Norfolk, VA 23529 and [2]Herbier de Guyane, Cayenne Cedex, French Guiana, France. The Chiococceae is a monophyletic tribe in the subfamily Cinchonoideae (Rubiaceae) that includes 29 genera and over 200 species primarily distributed in the Neotropics but also

occurring in the islands of western Pacific Ocean with no members occurring on the expansive Pacific plate, thus exhibiting an intriguing biogeographic disjunction. Although monophyly of the tribe has been established by recent molecular phylogenies, many inter-generic and infra-generic relationships remain poorly resolved and therefore questions on the taxonomic affinities and evolutionary relationships within the group are yet to be fully understood. A number of larger genera have been shown to be para- or polyphyletic as currently treated. To resolve these taxonomic questions, we significantly expanded taxa sampling and used additional DNA sequence data. Based on the analyses of molecular sequence data of two nuclear (ETS, ITS) and two chloroplast (*petD*, *trnL-F*) loci obtained from 132 species representing 27 genera, here we present a comprehensive phylogeny of the tribe Chiococceae. Our results provide new insights into evolutionary relationships, thus suggesting need for a comprehensive revision of certain infra-generic classifications within Chiococceae.

Posters

WHITE CEDAR (*THUJA OCCIDENTALIS*) SAPLINGS IN THE NORTHERN SHENANDOAH VALLEY, VIRGINIA. Kirby Talbert & Joshua Kincaid, Environmental Studies Program, Shenandoah University, Winchester, VA 22601. White cedar (*Thuja occidentalis*) is a long-lived and shade tolerant coniferous tree species of eastern North America. The geographic range of white cedar extends from southeastern Canada to the New England and Great Lakes regions. Scattered, disjunct populations exist southward into North Carolina and Tennessee. While white cedar grows on a variety of organic and mineral soils, it tends to grow best on limestone-derived soils. In the Shenandoah Valley, white cedar forests are typically found on steep, north or west-facing slopes with underlying limestone or dolomite bedrock. According to the VA Department of Conservation and Recreation, white cedar populations are found in mixed forest stands, and are extremely rare in Virginia. Because white cedar forests are rare in the Shenandoah Valley region, more research is necessary to understand the composition, structure, and regeneration dynamics of these forests. A total of 10 white cedar saplings were destructively sampled to examine structural and growth characteristics. Preliminary results suggest that white cedar saplings growing in sunny conditions are larger and taller than those growing in the shade. A mean difference of 23 years is found between the 0 m and 1.4 m sampling heights. White cedar sapling growth is also correlated with current and previous year temperature and precipitation.

INDUCING GERMINATION/PROPAGATION IN MOUNTAIN LAUREL, *KALMIA LATIFOLIA*. L. J. Queitzsch & Stephen W. Fuller, Dept. of Biol., Univ. of Mary Washington, Fredericksburg, VA 22401. Mountain Laurel, *Kalmia latifolia*, is a flowering shrub native to the Eastern United States. It thrives in acidic soil and shade, although during germination and propagation *Kalmia latifolia* enjoys constant sunlight. Mountain laurel is a popular landscaping plant but is difficult to cultivate in greenhouse and laboratory environments. This experiment attempts to propagate seeds and induce rooting in cuttings of *Kalmia latifolia*. Seeds of *Kalmia latifolia* were successfully propagated in soil mixtures [1] containing 4 parts peat moss and 1 part perlite/ vermiculite, [2] containing 1 part potting soil, 1 part sand, 1 part peat moss, and 1 part

perlite/vermiculite, [3] containing 1 part potting soil and 1 part peat moss, and [4] containing 1 part sand and 1 part peat moss. Seeds seem to be most successful in soil [4]. Stem cuttings of Mountain Laurel plants failed to root and propagate in all soils except for soil [2] containing 1 part potting soil, 1 part sand, 1 part peat moss, and 1 part perlite/vermiculite. This would indicate that the best possible soil mixture for propagating *Kalmia latifolia* changes depending on whether the plant is being propagated from seeds or stem cuttings. Of the hundreds of seeds sown, only 94 achieved a size where they could be transplanted, and of those, 70 achieved a size of 3-4 cm. After a year of care in a greenhouse, only 15 have survived. Once more establishing the difficulty of propagating this popular horticultural plant.

DEVELOPING AND EVALUATING NOVEL NUCLEAR MARKERS FOR PHYLOGENETIC RECONSTRUCTION IN THE MYRRH GENUS, *COMMIPHORA* JACQ. (BURSERACEAE). Kiera A. Coy, Andrea Weeks & Morgan Gostel, Dept. of Environmental Science and Policy, George Mason Univ., Fairfax VA. 22030. To date, widely available nuclear genetic markers (e.g., ETS, ITS) have not provided sufficient variation to fully resolve the evolutionary relationships among the ca. 200 species of *Commiphora.* Here we use genomic resources to expand the range of genetic markers that can be used for comparative phylogenetic analyses. This poster describes the development and evaluation of these markers from a target pool of about 950 putative shared single-copy nuclear genes using Madagascan species of *Commiphora* to test them. Development of these markers followed a bioinformatics process that compares the transcriptome of *Bursera simaruba* against a pool of putative single-copy, orthologous nuclear genes shared across angiosperms. Our analysis identified a subset of approximately 240 genes that aligned to the *B. simaruba* and our target gene pool. We demonstrate the effectiveness of a subset of markers for comparative phylogenetic analyses and propose criteria for future research that will consist of primer optimization, size standardization of target products, and sequencing the targets using microfluidic PCR and multiplexed next-generation sequencing. These gene regions may be useful for phylogenetic analysis in allowing us to better understand the rapid diversification of *Commiphora* in Madagascar and resolving challenging species-level relationships in other angiosperm groups beyond *Commiphora* and Burseraceae. We will develop test these markers more broadly in other angiosperm lineages for comparative phylogenetics at broad and shallow-scales.

PROGRESS IN PHYLOGENETIC STUDY OF NORTH AMERICAN *MELAMPYRUM LINEARE* (OROBANCHACEAE). Karoline Oldham, School of Systems Biol., George Mason Univ., Fairfax, VA 22030 & Andrea Weeks, Environmental Science and Policy, George Mason Univ., Fairfax VA 22030. *Melampyrum lineare* (Orobanchaceae) is the sole North American species of its genus, which comprises another 34 species in Eurasia. Previous literature proposes two competing historical biogeographical hypotheses: 1) *M. lineare* shares its most recent common ancestor with a European species, *M. pratense*; 2) *M. lineare* shares its most recent common ancestor with the Asian species *M. arcuatum*, or *M. laxum* var. *arcuatum*. However, these hypotheses were based solely on morphological observations and do not consider DNA sequence data. Comparison of ITS sequences from *M. lineare* and other members of the Rhinantheae tribe suggests that *M. lineare*

is not sister to *M. pratense*. Rather, this analysis provides mixed support for the competing hypotheses of European versus Asian ancestry.

Chemistry

CHEMICAL PROBES FOR PROTEIN N-TERMINAL METHYLTRANSFERASE. Rong Huang, Gang Zhang, Yunfei Mao, & Stacie Lynn Richardson, Department of Medicinal Chemistry, Institute for Structural Biology and Drug Discovery, Virginia Commonwealth University, Richmond VA 23219. The objective of this study is to develop chemical probes for N-terminal RCC1 methyltransferase (NRMT1). NRMT transfers methyl groups from S-adenosyl methionine to the N-terminal alpha-amine of proteins. It plays an important role in regulating protein-DNA binding and protein-protein interactions. However, there is no chemical tool available to further characterize NRMT biological and pharmacological roles. We have characterized the kinetic mechanism of NRMT1 using recombinant NRMT1 via a MALDI-MS method. Our results indicated that NRMT1 catalysis underwent a formation a ternary complex. Based on this mechanism, we adopted a bisubstrate strategy to design NRMT inhibitors to covalently link an N-adenosyl methionine (NAM) to a peptide derived from N-terminal protein substrate. We have successfully synthesized a series of bisubstrate analogues and determined their inhibitory activities via a fluorescent competitive assay. Among them, SPKR-NAM exhibits a highest inhibitory activity with an IC_{50} of 13.4 uM. As negative controls, both NAM-triazole and triazole-peptide did not show any significant inhibition at 100 uM. In conclusion, our bisubstrate inhibitors showed more than 10-fold inhibitory activities and they can be used as chemical tools for future study of NRMT1.

THE BLACK POLYMORPH OF TTF-CA: TTF POLYMORPHISM AND SOLVENT EFFECTS IN MECHANOCHEMICAL AND VAPOR DIGESTION SYNTHESES, FT-IR, CRYSTAL PACKING AND ELECTRONIC STRUCTURE. Silvina Pagola[1], Saul H. Lapidus[2], & Amit Naik[3], [1]Department of Applied Science, College of William and Mary, Williamsburg, VA, 23187, [2]Dept. of Physics & Astronomy, Stony Brook University, Stony Brook, NY, 11794, & [3]Thomas Nelson Community College, Hampton, VA, 23666. Tetrathiafulvalene-chloranil (TTF-CA) was synthesized by liquid assisted grinding (LAG) and vapor digestion (VD), largely reducing the use of reaction solvents. The effects of the small quantities of LAG and VD solvents towards the formation of a particular TTF-CA polymorph were studied from the orange and brown tetrathiafulvalene (TTF) polymorphs as reactants. A high solvent polarity favors the formation of the ionic (black) TTF-CA *vs.* the quasi-neutral green form, whereas the crystal structure and crystal habit of the orange TTF also favors the formation of the black TTF-CA. The crystal structure of the black TTF-CA was determined from synchrotron X-ray powder diffraction and it consists of dimerized $TTF^{+\bullet}$ and $CA^{-\bullet}$ radical ions, in agreement with room temperature magnetic susceptibility measurements indicating the material is diamagnetic. The black TTF-CA does not undergo a phase transition in the range 298K-20K. FT-IR showed that the compound is a semiconductor with a band gap of ~0.198 eV and it remains ionic at low temperatures. Band structure calculations are in good agreement with the measured band gap.