The Virginia Journal of Science

VOLUME I

Published by The Virginia Academy of Science
Monthly, except June, July, August and September
at
Lexington, Virginia.

CONTENTS

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Vol. 1 JANUARY, 1940 No. 1

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The Virginia Journal of Science

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VIRGINIA ACADEMY OF SCIENCE

ANNOUNCEMENT

With the first issue of the new VIRGINIA JOURNAL OF SCIENCE, *Claytonia* has ceased to exist. The last issue of Volume V appeared in April, 1939. It is now merged with the new JOURNAL.

At the annual meeting of The Virginia Academy of Science at Danville last May, chiefly due to the efforts of Lt.-Col. Robert P. Carroll of The Virginia Military Institute, the Academy voted to start an official periodical publication, leaving to the incoming President the appointing of a committee with power to act. This committee, under the chairmanship of Dean Ivey F. Lewis of The University of Virginia, has been at work for some weeks, and has authorized the publication of the first number. It also selected the name of the new journal, and has requested Lt.-Col. Carroll and the undersigned to serve as Managing Editor and Editor-in-Chief, respectively, pending complete organization of the new staff.

Claytonia was sponsored by the Committee on Virginia Flora of the Academy. Members of the Committee felt that, while its publication was continuing without a deficit, the purposes of the Committee in publishing *Claytonia* could be met as well in the VIRGINIA JOURNAL OF SCIENCE, and the new publication would in addition serve much broader needs. It seems certain that there will be just as many pages on Virginia flora in a volume of the new publication as in a volume of *Claytonia*.

The new journal will include papers from all sections of the Academy which wish to use it. An Editorial Board, including the Secretary of the Academy, Dr. E. C. L. Miller, and representatives of co-operating sections, will soon be formed.

Two issues will be devoted annually to the Program and the Proceedings of the annual meetings of the Academy.

The material in this issue is entirely botanical as it was necessary to use manuscripts on hand in order to start the Journal going promptly. Manuscripts are now urgently requested from workers in other scientific fields, as several sections have indicated they feel the need of such a publication as this, and should be represented in its pages.

It is especially important that subscriptions be forwarded as soon as possible to Lt.-Col. Carroll, Virginia Military Institute, Lexington, Va.

—RUSKIN S. FREER.

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Mixed Deciduous Forests of the Appalachians*

E. LUCY BRAUN

Mixed deciduous forests occur throughout the unglaciated Appalachian upland and to some extent beyond it. However, only in certain parts, especially the Cumberland Mountains and southern Allegheny Mountains, and adjacent Cumberland and Allegheny Plateaus, does the mixed deciduous forest which we know as mixed mesophytic forest prevail. A knowledge of the mixed deciduous forests of the unglaciated Appalachian upland is essential to an understanding of the deciduous forest formation as a whole. Here on the Appalachian upland is the key to the genetic development of our deciduous forests.

Among students of plant distribution the importance of the Appalachian upland as a haven for ancient species, and for relic occurrences of species which have migrated to younger land areas, is generally accepted. Yet students of plant communities have been slow to look for a parallel in the genesis of our forests. Most ecologists are accustomed to thinking of successional development, of the changes induced by vegetational reactions, by slow topographic changes, and by gradual climatic changes such as occurred during the Pleistocene. But succession alone cannot explain the complexities of the deciduous forest. In fact, on the ancient Appalachian upland, one finds little evidence in primary stands of any successional development still in progress. Through the ages since Angiospermous trees arose, forests have occupied this area. The mixed forest of the Appalachians is a remnant of the undifferentiated forest of the Tertiary.

The mixed mesophytic association, one of the four major associations of the deciduous forest, is best exemplified in this region, with its center or region of optimum development in the Cumberland and southern Allegheny Mountains and unglaciated Appalachian Plateaus.

Let us think of the deciduous forest as a whole as represented by the accompanying diagram which suggests position and genetic relations of the deciduous forest associations.

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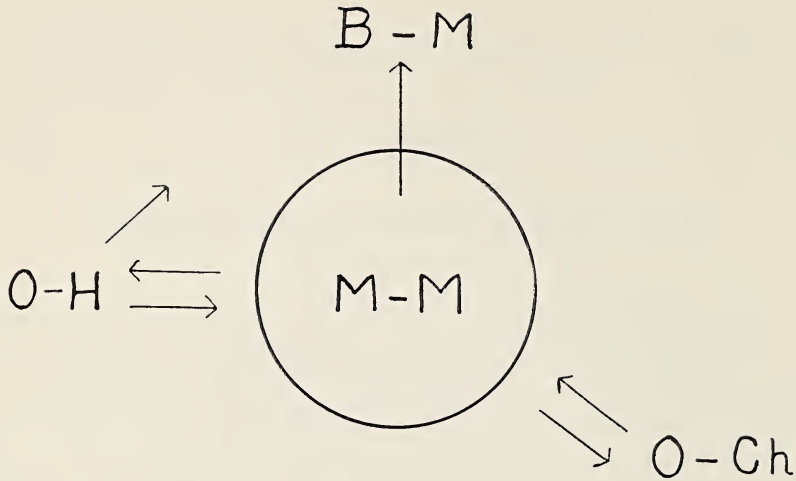
*Read before the Mountain Lake meeting of the Botanical Society of America, June 15, 1939.



The mixed mesophytic occupies a central position; oak-hickory forest lies principally to the west; oak-chestnut to the east and southeast; beech-maple to the north. Genetically, what does this represent? Because the undifferentiated mixed forest of the Tertiary once occupied a larger territory than is now occupied by its lineal descendant, the mixed mesophytic forest association, we cannot think only of migrations from this present center. Increasing aridity in the interior was unfavorable to certain species of the undifferentiated mixed forest, and their ranges were curtailed, involving then, a shrinkage in area or recessional migration of the western front of the mixed forest, leaving behind those species of lesser moisture requirements, and resulting in the formation of the oak-hickory association. In isolated spots in the Ozark region of Arkansas and Missouri, forest communities still exist which are closely similar to the mixed forests of the Appalachians, though the region as a whole is now oak-hickory forest. Glaciation curtailed the mixed forest on the north, and at its close, afforded a vast territory for invasion. Into this, trees moved from the south; the oak-hickory association came to occupy part of the western glaciated section, while some of the mesophytic species of the mixed forest moved northward from their Pleistocene haven. Thus arose the beech-maple forest so well represented in parts of Michigan, Indiana, Ohio, and western New York. The reasons for changes which appear to have taken place to the east and southeast of the present stronghold of the mixed mesophytic forest (i. e., the Cumberland Mountains and adjacent area) are less apparent. In the southern Blue Ridge province (including the Great Smoky Moun-

tains) the mixed mesophytic forest is in area subordinate to the oak-chestnut forest. Farther to the east and southeast, the importance of oaks in what some will prefer to call a mixed forest is apparent. To the northeast, the "mixed transition forest" of the foresters appears genetically to be a derivative of the mixed mesophytic forest.

Briefly, let us review a few of the outstanding features of the mixed mesophytic forest, the mixed forest of the Appalachians. Vegetationally, it is a mixed forest made up of about twenty or twenty-five species; a forest without definite dominants, or with several important species, rather than only one or two. The more important species in the area as a whole are beech, tulip, basswood, sugar maple, chestnut, buckeye, white oak and red oak. The limited time makes it impossible to give specific data on forest composition. Climatically, the mixed mesophytic forest occupies a region of abundant rainfall fairly well distributed throughout the year. Throughout its extent, and also wherever represented by isolated areas within other forest associations, it is marked by the mull type of humus layer and generally gray-brown soil. It occupies chiefly ancient land areas, but even within these appears to be more or less limited to the topographically mature areas.

The areal limits of the mixed mesophytic forest are indefinite, as is to be expected if we consider the long history of this association. Throughout the Cumberland Mountains and southern part of the Allegheny Mountains, the unglaciated Allegheny Plateau, and maturely dissected parts of the Cumberland Plateau, mixed mesophytic forest prevails. In these mountains, it is *not* confined to coves, as it is in the Southern Appalachians where the forester's term, "cove hardwoods," originated. Throughout this area it is remarkable in the complexity of its composition. Genetically, this is exceedingly important. Here was an undifferentiated forest. Through the ages, local and regional influences have been at work. No two species of the mixed forest are exactly equivalent, physiologically; each reacts in slightly different fashion to environmental stress. Thus there arise a multitude of variations in the mixed forest, communities which I have termed association-segregates, because they arise by segregation of groups of species of the association and are definite and recognizable communities of equivalent ecological status.

A great variety of association-segregates may be seen in the Cumberland Mountains, the optimum area of mixed mesophytic forest. Communities distinctly transitional to oak-chestnut forest, and communities in which chestnut oak and chestnut are the dominants are present, as well as the most mesophytic of forests, such as the sugar maple-basswood-buckeye type. The genetic relations of all, including these small areas of oak-chestnut, are

so apparent that it becomes evident, in the region of prevailing mixed mesophytic forest, that all are segregates of this forest, i. e., association-segregates.

The term, association-segregate, is not a synonym of lociation or of faciation, though it is true that some association-segregates might be termed lociations, that some have become faciations, and that some even have become associations. Here in an ancient forest area is a trying-out ground, so to speak, where local variations in environmental factors have resulted in a multiplicity of variations, of segregates, of the mixed forest. All, *genetically*, are equivalent, and to apply different terms to adjacent and ecologically equivalent communities, is to obscure the basic and fundamental principles in the origin of deciduous forest communities.

Going away from the center of the mixed mesophytic forest, the number of different association-segregates decreases. Finally, mixed mesophytic forest (in any form) becomes less prevalent. The great Appalachian Ridge and Valley province, with its wide expanses of uplifted peneplained valley flats, lies to the east of the Cumberland and southern Allegheny Mountains and Appalachian Plateaus where mixed mesophytic forest prevails. Here the greater importance of oaks, especially white oak, is apparent. In the Blue Ridge, too, mixed forests with the aspect of those of the Cumberlands, are limited in extent. Instead, oaks are more important. Even the Great Smoky Mountains, an important section of our Appalachian upland, support oak-chestnut forest on most of the slopes, while mixed mesophytic forest is limited to the coves, with hemlock generally very important in the mixed forest of deeper ravines.* East of the Blue Ridge, even to the Atlantic Coast, isolated areas of mixed mesophytic forest occur. To the northeast, in the mountains of Pennsylvania and in parts of New England, a mixed transition forest is seen. Westward on the Appalachian Plateaus, mixed mesophytic forest prevails except on undissected portions of the southern part of the Cumberland Plateau. Farther to the west, mixed mesophytic forest occupies less and less of the area and becomes confined to the most favorabe situations. Only to the north, along the boundary of the latest (or Wisconsin) glaciation, is the boundary of the mixed mesophytic forest rather well defined.

UNIVERSITY OF CINCINNATI.

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*At altitudes favorable for deciduous forest.

Bryophytic Succession on Boulders in the Mountain Lake Area, Giles County, Virginia*

PAUL M. PATTERSON

The purpose of this study is to analyze the early successions on boulders in the Mountain Lake area with particular reference to the bryophytes. The following types of rocks are excluded from this study: rocks in creeks submerged or emerged; stream beds periodically dry; cliffs, and their crevices; and boulders that, due to their fragmentation, relative positions, or overgrowth of roots mechanically collect humus of non-bryophytic origin.

The area investigated consists of approximately 15 square miles on Salt Pond, Big and Butt Mountains, together with the intervening valley. The tops of these ridges are capped by the resistant Clinch (Silurian) sandstone overlying the soft Martinsburg shale. The boulders studied are derived from the weathered strata at peak or ridge summits, or blocks of this sandstone lying at lower levels on Martinsburg shale. The altitude of the region studied lies between 2900 feet at the Cascades and 4363 feet at Bald Knob. The majority of the stations are above 3800 feet.

The sandstone, (in places a fine conglomerate), presents a rough surface to which bryophytic rhizoids may easily become attached. Probably on this account, no correlation was noticed between moderate slopes of the tops of the boulders and the types of bryophytes growing on them. Vertical or near vertical slopes bear as a rule only the early bryophytic invaders. As variation in slopes up to about 30 degrees, had no observable effect on the types of bryophytes growing on the boulders, and as the upper surfaces of practically all boulders falls within this variation, slopes of the rocks are disregarded. The boulders investigated range from about 2-20 feet in longest dimension.

The authorities for the plant names are omitted, the synonyms are those used by the following authors: lichens according to Fink (1935); hepatics, Evans and Nichols (1908); mosses, Grout (1928) in so far as that work has been issued, otherwise, Grout (1903); ferns, Small (1938); herbs and shrubs, Robinson and Fernald (1908); and trees, Coker and Totten (1934).

Eleven stations were selected which present the various habitat differentiations consistent with the presence of boulders. Five of these are on or below weathered cliffs at ridge or peak summits. Differences in microclimates result from different directions of exposure and different degrees of protection. These stations are as follows:

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*An abstract of this paper was published in the *American Journal of Botany* 25, pp. 3-4 of the supplement to No. 10, Dec., 1938. The work was done during the summer of 1938 at the Mountain Lake Biological Station of the University of Virginia.

GOLF COURSE, (#1). This station lies on an arm of Salt Pond Mountain in an oak-hickory forest, (chiefly *Quercus borealis maxima, Q. alba* and *Hicoria ovata*). The exposure is southern.

BUTT MOUNTAIN, (#2). Here a crumbling cliff at the west-by-southwestern end of the ridge has left a dense litter of relatively flat boulders in a hundred-yard belt where the slope is rather gentle. These boulders are shaded in part by *Sorbus americana* and *Betula lenta.* The boulders become scattered as the mountainside becomes abruptly steeper, and the *Betula* zone is succeeded by a *Quercus borealis maxima-Q. alba* forest.

BEAR CLIFF, (#3). This station is on the southeastern ridge of Salt Pond Mountain with a southeastern exposure. Massive strips of sandstone have slipped away from the body of the rock at the ridge summit forming roughly parallel fissures of varying width, depth and length, (mostly 10-30 feet wide and 10-40 feet deep). Loose boulders are scattered in these fissures and at the base of the cliff. Woody coverage over the cliffs and in the fissures consists chiefly of *Betula lenta* and *B. lutea,* and to a smaller extent *Quercus borealis maxima* and *Q. alba,* together with such shrubby plants as *Viburnum alnifolium, Rhododendron maximum,* and *Kalmia latifolia.*

BALD KNOB, (#7). This is a peak on the southwestern end of Salt Pond Mountain. On its northern side is a crumbling cliff that has left a litter of boulders on a gently sloping terrain. Below the cliff the rocks are shaded by a 20-30 yard belt of *Betula lenta* chiefly, followed, where the rocks are largely covered with humus, by the usual *Quercus* forest.

CASTLE ROCK, (#10). This station is on the northwestern ridge of Big Mountain near its juncture with Salt Pond Mountain. A crumbling portion of the cliff together with boulders at its base was selected for study. A *Quercus-Hicoria-Castanea* forest surrounds the station, while the chief coverage over the boulders selected is *Betula lenta, Sorbus americana, Quercus* spp. *Acer spicatum* and *Prunus pennsylvanica.*

ROAD TO LITTLE MEADOW, (#4). This station lies on the northwest side of the ridge on which station #1 is located. The coverage is a young secondary growth of *Quercus* spp., with a smaller mixture of *Hicoria* and partly dead *Castanea.*

MOUNTAIN LAKE, (#5). At the northwest tip of the lake on Salt Pond Mountain, the terrain bordering the water is relatively flat and strewn with a few immense and a number of smaller boulders. The forest cover at this spot is largely *Acer rubrum,*

Betula lutea, Tsuga canadensis, with smaller amounts of *Quercus borealis maxima, Fagus grandifolia* and*Castanea dentata.*

CASCADES AT LITTLE STONY CREEK, (#6). This station is an old rock slide on the southeast slope of a deep ravine formed by Little Stony Creek. The arborescent coverage at the base of the slide is *Tsuga canadensis* above which is a young forest of mixed hardwoods, (chiefly *Quercus coccinea, Q. montana, Tilia neglecta, Acer rubrum, A. spicatum, Betula lenta* and *Robinia Pseudoacacia*).

LAING ROAD, (#8). This station is along a private road on Salt Pond Mountain in a *Quercus-Castanea* wood. It includes a group of boulders at Hogskin branch that is more mesophytic. This latter area is shaded by *Betula lutea* and *Tsuga canadensis* chiefly. The terrain slopes gently with a northeastern exposure.

TWIN SPRINGS TRAIL, (#9). This station is on the gentle northern slope of Salt Pond Mountain, about a mile north of the Mountain Lake Biological Station in a second growth forest. The chief species in the forest cover are *Quercus borealis maxima, Q. montana, Robinia Pseudoacacia* and *Sassafras variifolium.*

HUNTER'S CREEK, (#11). This station is located on Salt Pond Mountain about a mile down the stream that drains Mountain Lake. It lies in a rich mesophytic forest consisting chiefly of *Fagus grandifolia, Acer rubrum and Betula lenta.*

A group of boulders was studied carefully at each station, making a total of 372. These were chosen in random groups or traverses to sample the most xeric as well as most mesic microhabitats of the localities consistent with the presence of bryophytes. The principal lichens, (excepting crustose forms), and all of the bryophytes and vascular plants occurring on these boulders were determined, and their relative order of abundance on each boulder was noted.

Since a number of bryophytes are separated specifically on microscopic characters, some of the larger and all of the smaller forms were brought to the laboratory for identification or confirmation of the identification made in the field. It is probable that some bryophytes were overlooked since a few were found as a minor constituent of a bryophytic mixture only after laboratory examination. A few occurrences of *Hypnum* were not positively identified because the plants were present in such small quantities or were so poorly developed.

The following list gives the presence data for the species, the number of boulders on which they occurred and the number of stations where they grew on the sample of 372 boulders. They are listed in the decreasing frequency of boulder occurrence.

Four common large lichens occurred on these boulders. No attempt was made to list the crustose forms or the less frequent foliose and fruticose species. Further, only those vascular plants are included that are well developed: herbs in flower or capable of fruiting, and shrubs and trees that have obviously lived longer than one year. Numerous recently germinated plants, chiefly *Betula,* were disregarded.

1. Lichens—	*Boulders*	*Stations*
Parmelia caperata	65	9
Cladonia rangiferina	41	8
Gyrophora Dillenii	37	9
Parmelia cetrata	21	7
2. Bryophytes—		
Thuidium delicatulum	187	10
Hedwigia albicans	164	10
Dicranum fulvum	151	11
Ulota americana	151	10
Dicranum scoparium	147	11
Hylocomium brevirostre	75	7
Frullania Asagrayana	44	7
Hypnum imponens	38	7
Polytrichum ohioense	22	6
Sematophyllum carolinianum	19	6
Hylocomium proliferum	17	7
Plagiothecium denticulatum	17	5
Scapania nemorosa	14	6
Climacium americanum	11	4
Hypnum Crista-castrensis	11	5
Leucobryum glaucum	11	5
Bazzania trilobata	10	5
Rhytidium rugosum	10	4
Hypnum spp.	7	4
Jamesoniella autumnalis	7	4
Brachythecium salebrosum	5	3
Mnium affine ciliare	5	5
Hypnum reptile	4	3
Brachythecium spp.	3	3
Entodon cladorrhizans	3	2
Eurhynchium serrulatum	3	2
Grimmia pennsylvanica	3	1
Rhodobryum roseum	3	2
Brachythecium plumosum	2	2
Brotherella delicatula	2	2
Brotherella tenuirostris	2	2
Cephalozia curvifolia	2	1
Cephalozia lunulaefolia	2	2
Hypnum fertile	2	2
Leucolejeunea clypeata	2	1
Lophocolea heterophylla	2	1
Lophozia barbata	2	2
Andreaea Rothii	1	1
Blepharostoma trichophyllum	1	1
Brachythecium oxycladon	1	1
Calliergonella Schreberi	1	1
Campylium chrysophyllum	1	1

Dicranum flagellare	1	1
Entodon brevisetus	1	1
Entodon seductrix	1	1
Mnium rostratum	1	1
Plagiothecium striatellum	1	1
Plagiothecium sp.	1	1
Ptilidium pulcherrimum	1	1
Radula complanata	1	1
Rhytidiadelphus triquetrus	1	1

3. Vascular plants—

Polypodium virginianum	67	9
Aster acuminatus	16	5
Oxalis Acetosella	12	1
Viola blanda	11	3
Dryopteris spinulosa	10	4
Heuchera villosa	10	4
Betula spp.	9	4
Menziesia pilosa	7	2
Ribes rotundifolium	7	5
Unifolium canadense	7	3
Dryopteris marginalis	6	2
Carex canescens	5	3
Psedera quinquefolia	4	1
Arisaema triphyllum	3	2
Rubus alleghaniensis	3	2
Saxifraga leucanthemifolia	3	2
Sorbus americana	3	1
Tsuga canadensis	3	1
Carex communis	2	2
Rhododendron maximum	2	2
Scutellaria pilosa	2	1
Viburnum alnifolium	2	1
Aster sp.	1	1
Carex aestivalis	1	1
Carex sp.	1	1
Clintonia umbellata	1	1
Deschampsia flexuosa	1	1
Dicentra eximia	1	1
Hieracium sp.	1	1
Impatiens biflora	1	1
Oakesia puberula	1	1
Pinus Strobus	1	1
Solidago odora	1	1
Solidago sp.	1	1
Vaccinium sp.	1	1

Many opportunities were present to observe the relation between exposure of the boulders and the principal kinds of plants occupying them. This observation was made on a much larger number of boulders than those included in the sample. On the most exposed or xeric boulders in the region, crustose lichens were most abundant. As one passed in the same or different stations to more protected or mesic zones, characteristic species were found to dominate each one. The vascular plants are exceptional in that they are more dependent upon the accumulation

of soil by the bryophytes than upon small variations in microclimate.

The characteristic boulder species of each zone, listed in order from extremely xeric to mesic environments, based on field observations are ideally as follows:

I. Lichen stages
  a. Crustose forms
  b. Foliose forms
    Umbilicaria pustulata
    Gyrophora Dillenii
    Parmelia caperata

II. Moss stages
  a. Xeric
    Ulota americana
    Hedwigia albicans and/or *Dicranum fulvum*
  b. Intermediate
    Dicranum scoparium
  c. Mesic
    Thuidium delicatulum and/or *Hylocomium brevirostre*

III. Vascular plants
  a. Early invaders
    Polypodium virginianum

The intermediate zone may be omitted at specific microhabitats, or telescoped into the mesic or xeric zones.

It is important to see how a study of the boulder sample bears upon the above observations.

In the first place, it is desirable to list all of the plants that are dominant on the boulders of the sample and note their relative boulder frequencies. Examination of the table below reveals that the dominant species are the same as those listed above by observation:

Dominant Plants	*Number of boulders*
I. Foliose lichens	
Umbilicaria pustulata, Gyrophora Dillenii and *Parmelia caperata,* singly, and in combination	44
II. Moss stage	
a. *Ulota americana, Hedwigia albicans* and *Dicranum fulvum, singly,* and in combination	72
Frullania Asagrayana	6
Sematophyllum carolinianum	1
b. *Dicranum scoparium*	46
Polytrichum ohioense	3
D. scoparium and *P. ohioense*	2
c. *Thuidium delicatulum*	86
Hylocomium brevirostre	33
T. delicatulum and *H. brevirostre*	10
Hylocomium proliferum	7
Climacium americanum	5

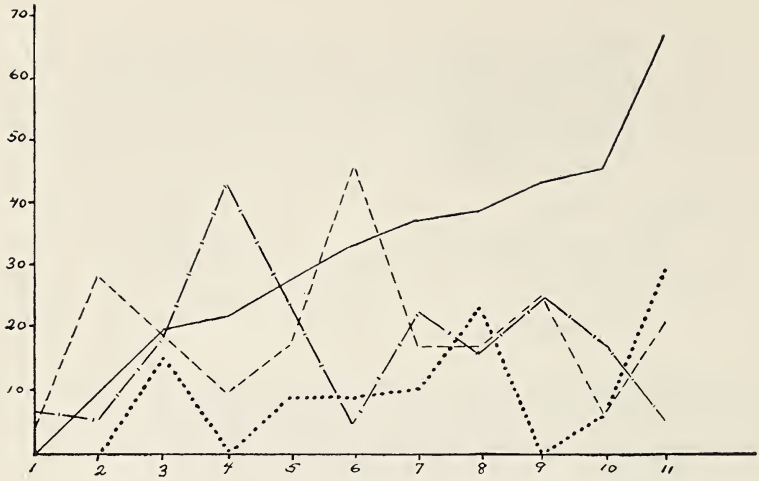
*No mention is made of the other plants occurring with the dominant species on their respective boulders unless present in equal amounts in regard to area covered.

Hypnum imponens	5
Thuidium delicatulum and *Dicranum scoparium*	3
Hypnum Crista-castrensis	3
Rhytidium rugosum	2
Bazzania trilobata	2
Hypnum reptile	1
III. Vascular plants	
Polypodium virginianum	19
Oxalis Acetosella	2
No dominance	20
Total boulders	372

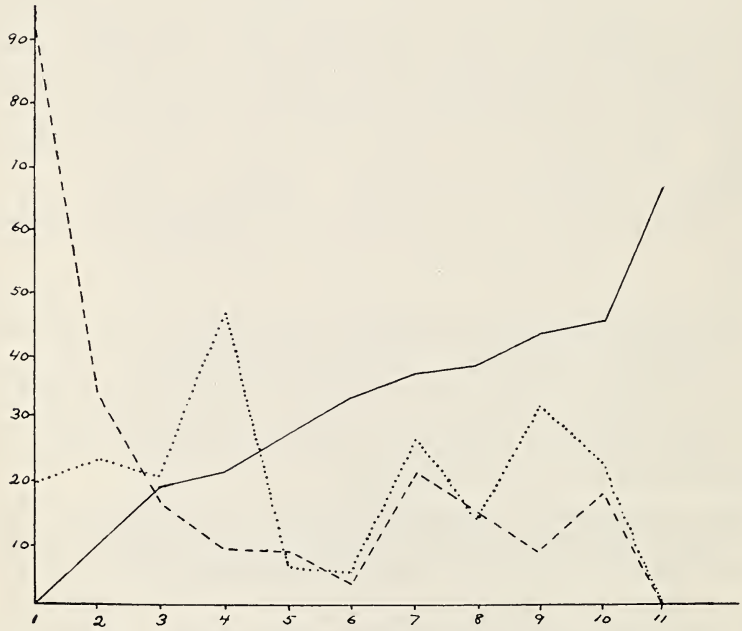
In the second place, it is pertinent to ascertain whether the zonation order of bryophytes according to ascending degrees of mesic environments established by observation, may be, to a degree, confirmed. Since the order of abundance of each species on each boulder was secured, mutually comparable figures for the relative order of abundance may be obtained for the principal mosses dominant on the boulders. This was computed for the principal mosses in each zonal group, (a total of six, as indicated above). The computation was made by dividing the average order of abundance of each of the principal mosses of the succession, in relation to all of the bryophytes occurring on their respective boulders at each station, into the percentages of boulders at the respective stations on which they did occur. *Thuidium delicatulum,* which by observation, does not occur in xeric situations, but attains its best development under mesic ones, was used as the plant indicator for the degree of mesophytism of the station sampled. The stations are arranged in the ascending order of abundance of *Thuidium delicatulum,* stations numbers 1 to 11, and it is presumed that the average mesic habitat of the boulders chosen at each station are in a similar ascending order of mesophytism.

If the relative orders of abundance of the other five mosses are plotted against that of *Thuidium delicatulum,* it is seen that *Ulota americana* dominates the most xeric stations; *Dicranum fulvum* and *Hedwigia albicans,* situations less extreme; *Dicranum scoparium* attains its maximum coverage at an intermediate station; while *Thuidium delicatulum* has the greatest amount of coverage at the more mesic stations.

This is graphically represented below. It is separated into two graphs with the *Thuidium* line repeated in each to prevent confusion resulting from a number of intercrossing lines.



Thuidium delicatulum
Dicranum scoparium
Dicranum fulvum
Hylocomium brevirostre



Thuidium delicatulum
Hedwigia albicans
Ulota Americana

Conversely, if *Ulota* is used to indicate the degree of xeric environment of the stations instead of *Thuidium,* and the other species are plotted to it as a base line, the picture is changed considerably in detail, but the same order of zonation is illustrated. Confirmatory again, is the series of foliose lichens which conform in general to the *Thuidium* line in that they are most abundant at the xeric stations and decrease fairly regularly to zero at the mesic stations except for a peak at station #4.

Thus the observation of the principal species dominant in the several zones, and their order of dependence upon different mesic degrees is confirmed by an analysis of the boulder sample.

The final moss stage in the Mountain Lake area on boulders, (*Thuidium delicatulum* and *Hylocomium brevirostre*), corresponds more or less closely to the final moss stage on boulders in the climax forest of Isle Royale [*Calliergon Schreberi, Hylocomium proliferum* and *Hypnum Crista-castrensis,* Cooper (1912)]; in a ravine in Illinois, [*Thuidium delicatulum,* Taylor (1920)]; and in the Great Smoky Mountains [*Thuidium delicatulum* and *Hylocomium brevirostre,* Cain and Sharp (1938)]. In each case the above mosses represent common local mesic pleurocarps. Braun's *Mnium cuspidatum,* (1917), the moss dominant in moist spots on limestone conglomerate near Cincinnati, is the only mesic acrocarpous form reported as the final moss stage on rock in this country.

Corresponding with the mosses of the intermediate stage in the Mountain Lake area, (*Dicranum scoparium* and, to an unimportant extent, *Polytrichum ohioense*), are the dominants of the final moss series on rocks near Bloomington, Indiana, [*Polytrichum commune* and *Dicranum scoparium,* Glenn and Welch (1931)].

Interesting sequences have been reported for xeric situations. The early rock shore succession on Isle Royale consists of a lichen sequence with mosses playing a secondary role, (Cooper 1912). The pioneer moss stage on a barefaced cliff in western North Carolina is succeeded later by lichen stages (Oosting and Anderson 1937).

In the Mountain Lake area, foliose and fruticose lichens, particularly *Cladonia rangiferina,* occasionally form small colonies on the bryophytes, especially *Dicranum scoparium. C. rangiferina* and related species were represented on 41 boulders sampled, but no indication was seen of a later lichen stage in zones dominated by bryophytes.

In the same area, a number of vascular plants invaded mature moss mats. Rarely appearing on the early moss stage, and more frequently on the intermediate, (especially at station #6), the vascular plants invade mosses of the final stage typically. Below are given the types of bryophytes dominating boulders of the

station samples that are invaded by vascular plants along with the frequency of their invasion:

BRYOPHYTES—	*Frequency of vascular invasion (Number of boulders)*
Xeric zone	
Hedwigia albicans	2
Hedwigia albicans and *Dicranum fulvum*	1
Intermediate zone	
Dicranum scoparium	21
Polytrichum ohioense	1
Mesic zone	
Thuidium delicatulum	28
Hylocomium brevirostre	13
T. delicatulum and *H. brevirostre*	2
Climacium americanum	4
Hylocomium proliferum	3
Hypnum Crista-castrensis	2
Thuidium delicatulum and *Dicranum scoparium*	2
Hypnum imponens	1
Thuidium delicatulum and *Bazzania trilobata*	1
Three or more mixed bryophytes	2
Total number of boulders	83

In the case of the more mesic bryophytes, the ratio of the frequency of invasion of moss mats by vascular plants corresponds roughly to the frequency of the occurrence of these mosses on the boulders. *Polypodium virginianum* is the characteristic early vascular invader.

The question arises whether the types of bryophytes characteristic of the successive zones are entirely static, or whether there is evidence of active succession.

Oosting and Anderson (1937) describe active moss and lichen successions in the formation of mats on a barefaced cliff in North Carolina.

Richards (1938), in the Derrycunihy Wood, Kerry Co., Ireland, lists the bryophytes characteristic of the "Open Boulder Associule" and the "Closed Boulder Associule". The former is the pioneer stage, and the latter, the associule climax. The succession is interpreted as an active one, the larger climax bryophytes on relatively flat surfaces overgrow and shade out smaller pioneer competitors.

Cooper (1928) has shown to what a small extent change takes place on xeric exposed rock: there being little or no change in numbers and sizes of lichen and moss colonies during a period of seventeen years on the early rock shore succession at Isle Royale.

At Mountain Lake, it seems that given a relatively constant

degree of exposure, there is little if any active successional change. For example, exposed rock outcrops are dominated by lichens, while boulders in dry *Quercus-Hicoria* forests on southern mountainsides progress little farther than the lichen and early bryophytic stages. In selected microhabitats where changes in degree of xerophytism are relatively rapid, as in the development of young trees and shrubs over exposed boulders, or the increase in shade due to the secondary development of a forest after logging or fire, conditions characteristic of most of the stations selected, bryophytes are often found overgrowing neighboring colonies. Such cases vary from one form overrunning another without any apparent immediate injury to cases where a more compact mat has killed the forms it has overgrown. Such cases are looked upon as stages in active succession. Below is given a list of such cases observed in the area. Some of them were seen many times.*

Species overgrowing	Species being overgrown
I. Early invaders—	
Dicranum fulvum	*Sematophyllum carolinianum*
Frullania Asagrayana	*Ulota americana*
**Hedwigia albicans*	*Ulota americana*
**Hedwigia albicans*	*Dicranum fulvum*
II. Final invaders—	
**Thuidium delicatulum*	*Hedwigia albicans*
**Thuidium delicatulum*	*Dicranum fulvum*
**Thuidium delicatulum*	*Dicranum scoparium*
Thuidium delicatulum	*Polytrichum ohioense*
**Hylocomium brevirostre*	*Dicranum fulvum*
**Hylocomium brevirostre*	*Hedwigia albicans*
Hylocomium proliferum	*Dicranum fulvum*
Hylocomium proliferum	*Hedwigia albicans*
Climacium americanum	*Dicranum scoparium*
Hypnum imponens	*Dicranum scoparium*
Hypnum Crista-castrensis	*Dicranum fulvum*
Hypnum Crista-castrensis	*Polytrichum ohioense*
Bazzania trilobata	*Dicranum scoparium*
Rhytidium rugosum	*Dicranum scoparium*

No effective competition could be seen between bryophytes of similar sizes, growth forms and growth rates.

Dicranum scoparium was not observed actively overrunning other bryophytes. This is probably accounted for by its growth form. By observation, however, all degrees of mat formation by *D. scoparium* have been observed from small separate colonies to larger, anastomosing ones, to completed, homogeneous mats. From the above table, it would seem, for some microhabitats, that succession is in progress and that success is dependent upon rate and habit of growth. It is to be noted that the direction of the succession corresponds to the successive bryophytic zones; that is, the mesic species succeed the more xeric ones. When the habi-

tat is stable, there seems to be little evidence of succession, but when the microhabitat is in flux, opportunities are presented for observing successional potentialities.

My hearty thanks are extended to Drs. Margaret Fulford and A. J. Grout for identifying several of my hepatic and moss specimens respectively; to Dr. John N. Wolfe for confirming the identification of several lichens; to Drs. John M. Fogg, Jr. and Ivey F. Lewis for the identification or confirmation of a number of the seed plants herein listed; and to Drs. A. J. Sharp and Stanley A. Cain for reading the manuscript and making helpful criticisms.

Summary

A total of 372 boulders of Clinch sandstone were studied in their entirety in random groups at eleven stations above 3000 feet elevation for the occurrence and relative abundance of bryophytes. General observations were made upon a much larger number. Cliffs, fissured rocks and boulders mechanically collecting humus were excluded. Although more than 50 bryophytes were found on this restricted substratum, only 6 mosses characterize the various zones between xeric and mesic habitats. The zones and characteristic plants on boulders are as follows: 1. Lichens; a. crustose forms; b. foliose forms, *Umbilicaria pustulata, Gyrophora Dillenii* and *Parmelia caperata;* 2. Moss stages; a. xeric; *Ulota americana, Hedwigia albicans* and *Dicranum fulvum;* b. intermediate; *Dicranum scoparium;* c. mesic; *Thuidium delicatulum* and *Hylocomium brevirostre;* 3. Vascular plants, *Polypodium virginianum.* Some evidence for active bryophytic succession is presented.

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"Iceland Moss", Cetraria islandica, in Virginia

H. A. Allard

I. Introduction

On July 19, 1937, while exploring the little travelled sections of the west side of Elliott Knob, in Augusta County, Va., for unusual plants, the writer found an interesting lichen on the upper slope of the ridges, which was identified by William W. Diehl of the Division of Mycology and Disease Survey, U. S. Department of Agriculture, as "Iceland Moss" *Cetraria islandica* (L.) Ach.

The writer has also found this lichen in considerable abundance at two points in the Massanutten range, in Shenandoah County, Va. On August 15, 1937, a large and flourishing colony was found at the south end of Short Mountain just east of Mt. Jackson, and on September 18, 1938 small patches were found on the shales of the west slope of Three Top Mountain about 3 miles north of Woodstock Gap.

The largest colony by far which has been found up to the present is that on Short Mountain, which by actual mapping by Mr. Diehl and the writer has been found to comprise about 2½ acres.

As there seems to be no previously published record of the occurrence of this lichen in Virginia, the present paper has been prepared.

II. Ecology

The ecology of this lichen as found in Virginia, in some respects, seems so strikingly unlike that of those regions of the arctic and alpine tundra, its more natural home, that some attention was given to its habitat relations here.

From the fact that this lichen is of widespread occurrence upon a great variety of terrains and geological formations in

both high mountain alpine and arctic regions, it is not probable that any particular rock formation as such in Virginia has much to do with its actual occurrence.

However these specific rock formations by their association with others have produced a particular terrain in Virginia due to differential weathering. This is true especially for the Martinsburg shales of Short Mountain which are capped by the resistant Clinton series of the Silurian Period. Here the resistant quartzites lying above the softer Martinsburg shales have served to protect the latter and these have formed ridges with very steep slopes. It is the dry and barren nature of these steep slopes, it would appear, which has affected directly the character of the vegetation cover, favoring indirectly the occurrence of *Cetraria islandica* here over a rather extensive area.

(a) Edaphic factors

The wide range of ecological conditions under which this interesting lichen can thrive is rather remarkable, for there seems to be little in common between the environment of the arctic tundra, or the high, cold, mist-saturated fell fields of Mt. Katahdin, and the hot, dry, sun-scorched shale barrens of Virginia. For the reason that this lichen has a rather restricted distribution on the shales and sandstones wherever found in Virginia, a rather careful survey was made of these conditions which appear to favor it here.

On Elliott Knob in Augusta County, and on South Mountain and Three Top Mountain in Shenandoah County where this lichen occurs, conditions are strikingly similar. In these three localities, the lichen colonies grow upon shale barrens characterized by a thin open woodland in which pine trees are more or less abundant, including individuals of *Pinus rigida, P. virginiana* and *P. pungens*.

On Elliott Knob the colonies appear to grow upon the red shales and sandstones of the Catskill formation of the Devonian Period at an elevation near 3500 feet. On Short Mountain and Three Top Mountain in the Massanutten, they are associated with the steep, barren Martinsburg shales of the Ordovician Period, near the 1500-1700 foot contours.

Wherever this lichen has occurred in the three Virginia localities mentioned, the terrain has been characterized by steep, more or less denuded slopes having a southern or western exposure. There are areas of great extent, on the shale barrens of the Massanutten ridges, however, which do not show a trace of *Cetraria,* but this will be explained later.

A study of its habitat preferences reveals one important fact; the lichen never occurs in heavy deciduous woods, and on the shales is sharply excluded from those areas having beds of duff

derived from deciduous trees, which may have drifted into holes or become built up around logs and other obstacles.

In places on the upper portion of the steeper shale ridges where the contours have become rounded giving greater stability to the soil particles and a consequent deepening of the soil here, the woodland cover becomes well developed and forms a closed canopy.

Due to the accumulation of soil and comminuted rock debris which has been carried downward from above by gravitational movements aided by rain, ice and snow, deep soils of the nature of talus material have also developed at the foot of these ridges, and here too, a heavy closed forest canopy has developed.

Between these two forest zones, where the shale rocks are mostly exposed or covered only with thin layers of the coarser shale debris, the trees do not form a closed canopy. There is little humus here, and conditions on the whole are very unfavorable to plant growth. Those trying cnditions have favored a very specialized shale barren flora on those steep, dry slopes, and it is here that *Trifolium virginicum* thrives, a characteristic endemic of this particular habitat.

Where the steepest shale slopes are found the *Cetraria* colonies are located invariably in the upper forested zone near the contact of this with th steeply pitching barren shale slopes, since here, the woodland cover becomes more open and a dense deciduous duff does not lie upon the ground.

These lichens have never been found in the forest zone below, since the forest cover tends to be very dense here, and the accumulation of duff excessive. Other conditions of an unfavorable nature may obtain here also, to prevent its successful permanent colonization, since higher air humidities and temperatures, and heavier shade are encountered in this lower and better developed forest.

On the gentler outlying slopes of Short Mountain where *Cetraria islandica* occurs in abundance, the dominant trees are pines, intermingled with thinly scattered deciduous trees, chiefly the Red Oak, the Chestnut Oak, Shad Bush (*Amelanchier*), and a few depauperate Cedars. The overhead canopy of foliage is noticeably thin or broken with open spaces, quite unlike the heavy closed canopy of the well-developed and thriving deciduous forest of adjacent mesic areas. The under shrubs and herbage likewise are very scattered in their occurrence, and comprise a flora characteristic mainly of sterile, dry soils and open, fairly well-lighted habitats. Among the shrubs are New Jersey Tea (*Ceanothus americanus*), *Vaccinium vacillans, Polycodium stamineum, Rhus canadensis, Rhus quercifolia* and *Viburnum acerifolium.* Among the more important herbs are *Senecio an-*

tennariifolius, Phlox brittonii, Aster linariifolius, Viola pedata, Aureolaria variegata, Aster laevis and *Cheilanthes lanuginosa.*

It is interesting to note that where the conditions are most favorable on Short Mountain the lowermost ground layer is a dense lichen cover in certain areas, including a luxuriant development of the "reindeer mosses" *Cladonia rangiferina* and *Cladonia mitis,* together with colonies of *Cladonia verticillata* as well as various others of this genus; some species of moss also grow in scattered clumps here. While the *Cetraria* colonies in places may occur in almost pure growth, they usually intermingle freely with the two reindeer mosses mentioned, and sometimes appear to be growing through or over these. It is evident that exceptionally favorable conditions have engendered a very severe competition between the reindeer mosses and *Cetraria* colonies.

The *Cetraria* colonies are best developed where the slopes are not too steep, and appear to find conditions especially suitable around the base of the pine trees where there is afforded some shade, a better supply of moisture run-off from the trunk, and where rapid erosion and shifting of the soil is prevented by the larger, interlacing surface roots, sticks, leaf debris and entangling pine needles accumulated here.

On the Short Mountain shales steepness of slope appears rigidly to delimit the areas of *Cetraria* and the associated species of *Cladonia.* A study of the distribution of these in relation to pitch of slope would indicate that on these particular finely fragmented shales, these lichens grow well on a slope not much steeper than 22° or 23°, but are excluded when the steepness has become an angle of 25° to 30°. The pitch of slope which seems to limit the occurrence of these lichens appears to be near the angle of rest for this comminuted shale debris. As this angle is approached instability of the loose surface layers arises, and the lichens can gain no foothold to establish themselves. While a thin, herbaceous flora may be present, the steeper slopes of the more unstable shales are almost entirely devoid of a lichen form.

Wherever a fallen tree or limb has become lodged on the slope this acts as a dam to the sliding shale debris, which has accumulated and thereby decreased the slope over small areas; on these the lichens, perhaps fragmented and falling from above have succeeded in establishing themselves and building up their colonies. On the lower side of these obstructions, however, where erosional activity has continued to carry away the finely comminuted shale debris, the surface has remained entirely free from lichen growth.

It is quite obvious that deciduous leaf duff does not afford suitable conditions for *Cetraria.* Furthermore, the loose duff of deciduous woods burns freely and *Cetraria* and the associated reindeer mosses appear to be readily destroyed by fire, which has

been a frequent scourge of all wooded areas more especially since the advent of the white man.

In Virginia where *Cetraria* has been observed, the colonies have usually been associated with thin pine duff, and it is obvious that this duff has not been detrimental to the development of this lichen or the reindeer mosses growing in association with it. Usually on these steep barren shale slopes the pine duff itself is sparse and discontinuous, and the dry fallen leafage of the scattered deciduous trees occupying these slopes is readily blown to lower levels, so that these shales remain either bare or with only thin coverings of pine needles here and there. When one removes and examines a specimen of reindeer moss or *Cetraria* from these situations, it is found to be bristling with pine needles, mostly the short, stout needles of the Knob cone pine (*Pinus pungens*). There is good reason to believe that these often act like pins to fasten the loosely-held lichen colonies to earth or to the thin humified layers below.

It is quite apparent that on these barren shale slopes, there is little to support fire, and the protection they have found here has probably allowed these lichens to persist on these slopes, where they would have been destroyed elsewhere.

While some of the reindeer mosses and other species of *Cladonia* may be found in pine woods, *Cetraria* has never been met with in these situations, not only because it may not be as tolerant of as heavy shade, but perhaps here it is more susceptible to fire which burns readily in thick pine duff.

(b) Climatic factors

The distribution of *Cetraria* from these southern outliers of its range to the arctic tundra of the far north and the high alpine regions of cold mountain tops, would indicate that it has a very wide temperature adaptability. Even in summer this must range from actual freezing or even lower, in arctic and alpine regions to considerable over 100° F. on the exposed Massanutten shale barrens. As a matter of fact when the air temperatures at noon on a clear day gave readings of 75° to 76° F., the shale soils on which *Cetraria* grew at 1 cm. depth gave readings of 100° to 101°. These high temperatures and arid conditions are far removed from the cold or actually freezing temperatures experienced on Mt. Washington or Katahdin even in summer, where the soils are saturated most of the time and mist, rain, high winds and sometimes snow are prevailing features of the summer climate.

In arctic and subalpine regions, which appear to be more favorable to the best development of *Cetraria,* its growth is probably associated with the warmer summer months, for it is hardly

to be expected that temperatures ranging from 32° to 50° below zero F. such as it would often experience in winter here would be favorable to its metabolism and growth.

In the hot Virginia climate its season of greatest activity may be the reverse of this. There is reason to believe that it is mostly quiescent during the hot summer months here, when periods of great heat and drought prevail. Many of our lichens, perhaps more especially the species of *Cladonia,* give evidence of very active growth throughout the cooler weather which prevails from autumn to spring. At this season most conditions are favorable to their growth and reproduction. There is better illumination in the fields and leafless woods, and a more abundant and uniform moisture supply in the soil and air. It is probable, also that the cooler temperatures of this period are distinctly more favorable to the lichen association than are the intensely high temperatures that often prevail for long periods. *Cetraria* seems to be no exception in its response to these conditions.

It has been thought of some interest to compare the climatic habitat of *Cetraria* growing on Mt. Washinfton, New Hampshire, with that of colonies in Virginia, and for this reason, the tables following have been presented, for the summer months, May to October, on Mt. Washington, and for the cool season from October to April in Virginia.[1]

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[1]The writer wishes to express his appreciation of the courtesy accorded to him by Mr. F. N. Hibbard in charge of the Weather Bureau Office at Richmond, Va., who furnished the climatic data for the Woodstock area, and to Mr. J. B. Kincer, Chief of the Division of Climate and Crop Weather of the Weather Bureau at Washington, D. C., who furnished temperature records for Mt. Washington from 1873 to 1886 (Table II). The wind velocity data of Table III were obtained through the courtesy of Mr. Irving I. Zellon, Meteorologist of the Mt. Washington Observatory, Gorham, N. H.

TABLE I

WEATHER CONDITIONS AT WOODSTOCK, SHENANDOAH COUNTY, VIRGINIA
Altitude 875 ft., Temperature in degrees F.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Mean Monthly Temperature	56.1	44.8	35.2	33.9	34.4	44.1
Mean of Daily Maxima	69.3	56.4	45.5	44.3	45.4	56.1
Mean of Daily Minima	42.8	33.3	24.9	23.6	23.4	32.1
Absolute Maxima	98 (1927)	81 (1921)	80 (1932)	77 (1930)	85 (1927)	93 (1907)
Absolute Minima	20 (1917) (1930)	4 (1930)	—13 (1914)	—23 (1899)	—22 (1912)	—23 (1899)
Average wind velocity (miles)[2]	6.7	7.5	7.5	7.4	8.4	8.8
Maximum wind velocity (miles)[2]	41 (NW)	43 (SW)	39 (NW)	40 (NW)	47 (NW)	47 (NW)

[2]Wind velocity data for Washington, D. C., this being the nearest available wind velocity readings. This probably exceeds the actual velocity experienced at Woodstock, Virginia.

TABLE II

Weather Conditions on Mt. Washington, N. H.

Altitude 6284 ft., Temperature in degrees F.

	May	June	July	Aug.	Sept.	Oct.
Mean Monthly Temperature (1932-1937 inclusive)	35.4	45.5	49.3	48.3	41.5	28.9
Absolute Maxima (1873-1886 inclusive)	62 (1885)	71 (1878)	72 (1881)	72 (1876)	65 (1880)	58 (1882)
Absolute Maxima (1933-1937 inclusive)	63 (1937)	71 (1933)	67 (1933)	70 (1935)	65 (1937)	55 (1937)
Absolute Minima (1873-1886 inclusive)	—1 (1880) (1885)	15 (1878) (1879)	27 (1880)	20 (1876)	11 (1879) (1886)	—3 (1881)
Absolute Minima (1933-1937 inclusive)	3 (1936)	(1885) 21 (1936)	30 (1936)	26.5 (1934)	14 (1936)	—2 (1936)

TABLE III

Average Wind Velocity Miles Per Hour May to October, and Maximum Velocity for Each Month (for 5 minute period) at Mt. Washington, N. H.

Altitude 6284 ft.

Year	May	June	July	Aug.	Sept.	Oct.
)35.....	42.9 120-W; 1st	29.5 80-W; 11th	30.4 76-W; 12th	26.0 63-SW; 13th	39.5[3] 95-SE; 4th	47.2 99-W; 23rd
)36.....	42.1 95-WNW; 20th	27.9 78-SW; 18th	28.7 72-SW; 29th	25.4 72-W; 29th	25.3[3] 75-W; 8th	42.6[3] 87-N; 31st
)37.....	30.7 94-NW; 20th	28.5 80-SW; 10th	20.2 66-W; 26th	20.1 60-W; 19th	27.8 85-NW; 20th	32.5 81-S; 20th
)38.....	34.1 116-E; 15th	22.2 72-SW; 26th	24.8 54-W; 15th	25.7 60-NW; 24th	33.0 88-NW; 24th	34.9 98-W; 25th
verage.	37.4	26.7	26.0	24.3	31.4	39.3

[3]Average for September 1935, based upon records of 566 hours.

Average for September 1936, based upon record of 594 hours.

Average for October 1936, based upon record of 323 hours; remainder of record not available.

The climatic data presented in Tables I, II, and III would indicate that *Cetraria* growing in Virginia experiences a far more variable and trying climate in some respects than Mt. Washington affords in the summer time. The mean temperature for the period October to March inclusive at Woodstock, Virginia, is 41.3°, this is almost identical with the mean temperature on Mt. Washington, N. H., from May to October inclusive, with a mean of 41.2°. Hot waves are never experienced upon Mt. Washington, the absolute maximum temperatures here ranging from 50° to 72°, for the above period, as compared with a range of 77° to 98° for the October to March period at Woodstock, Va. The absolute minimum temperatures on Mt. Washington for the months considered range from —3° to 27°, while at Woodstock, Va., for the months in question the absolute minimum ranges from —23° to 20°, the extreme lows having been recorded in January, February and March.

In one respect the growing seasons of the two localities are strikingly different, since even in summer time, extremely high wind velocities prevail upon Mt. Washington, which would greatly affect the evaporative capacity of the air, and favor dessication, in spite of the higher humidities which may prevail here. Such great wind velocities[4] are never experienced in Virginia where the *Cetraria* colonies have been found, since winds even as high as 40 miles per hour are only occasional, and this is often less than the average for Mt. Washington for some months.

The distribution of *Cetraria* colonies on the Massanutten shales is unquestionably affected by the factor of light intensity, but variations in the temperature factor, the degree of humidity, mist, etc., must undoubtedly modify the light requirement in any region. In the far north or on alpine heights the prevailing low mean temperatures and the saturating mists appear to favor the growth of *Cetraria islandica* in full sunlight. On the hot, burning Massanutten shales in Virginia, full sunlight is shunned and likewise heavy shade.

It would thus appear that *Cetraria islandica* which in the southern mountains may represent survival remnants from the period of glaciation, has been able to persist in the forested regions of the south only because it has found dry and barren habitats here, which can not support the closed forest, with its consequent shade, and where the accumulation of the duff is so slight or discontinuous as to prevent the spread of destructive ground fires into the area. Such conditions in a warm humid region where forest is the natural climax, can occur only on ledges or upon dry steep, barren slopes such as the Massanutten shales afford. It is probably not the dry conditions which favor

[4]On April 12, 1934, a wind velocity of 231 miles was recorded.

the lichen, but the dry conditions which maintain an open, depauperate forest, and a sparse undergrowth. It can not adapt itself to the forest because it is unable to establish itself on the loose leaf duff of the heavy deciduous forest, where each autumn new crops of dry leafage would fall upon and cover it. Shade, also, appears to be an unfavorable factor, and it probably cannot compete with crowding herbaceous forms. It is thus apparent that this lichen in its more southern habitats has a rather precarious existence, whereas on the treeless arctic or alpine tundra it is quite at home and far more secure from the hazards of fire.

Here it appears to be closely associated with the pioneer arctic and alpine successions, or sometimes seems to occupy the position of a persistent subclimax or preclimax at times, owing to the vigor of its development.

In Virginia[5] it is not a pioneer in the xerach series, but must accept a very subordinate role under a thin forest cover to survive. Its associates *Cladonia rangiferina* and *C. mitis* in this area are far more general in their distribution and much more aggressive pioneer forms in the early stages of succession, occurring more or less generally even on fully exposed banks, often in abandoned cleared fields, and pastures in some instances.

Raymond H. Torrey has reported the occurrence of vigorous *Cetraria* colonies in New Jersey in his paper "*Cetraria islandica* in Sussex County", *Torreya*, Vol. 37, No. 6, 1937, pp. 124-125. He found this lichen likewise growing on slanting ledges of sandstone on the west side of a ridge near Montague, in association with *Cladonia uncialis, C. sylvatica* and *C. rangiferina*, as well as with grasses. He has suggested that the survival of these *Cetraria* colonies, the only ones known in New Jersey, has been favored by their escape from ground fires which could not reach the ledges.

WASHINGTON, D. C.

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[5]Cetraria material collected in Virginia is deposited in the collections of the United States National Herbarium under the writer's collection numbers as follows:

3276A	Elliot Knob, Alleghenies	July 19, 1937
3558	Short Mt., Massanutten Range, Va.	August 15, 1937
4475B	Short Mt., Massanutten	April 24, 1938
4476	Short Mt., Massanutten	April 24, 1938
4896	Short Mt., Massanutten	May 12, 1938
5054	Short Mt., Massanutten	June 14, 1938
5576	Three Top Mt., Massanutten	September 18, 1938

Ferns and Fern Allies of Amelia County, Virginia

J. B. Lewis and A. B. Massey

Amelia County is in the outer Piedmont region of the State. Its geographical center is about 40 miles from the Fall Line separating the Piedmont and the Coastal Plain. The soil is largely clay with considerable admixture of sand. Sand deposits are frequent along the streams and heavy red clay soil and clay loam are common. The rock is granite and granite gneiss. Outcrops appear along streams; in places, especially around "Rock Stable", large boulders and expanse of considerable bed rock appear. The forest is of pine and broadleaf types and mixtures of these. The topography is rolling, the greatest elevation being about 493 feet above sea level.

The following ferns and fern allies have been collected during the seasons of 1937 and 1938 by Mr. Lewis. The specimens are deposited in the Herbarium of the Virginia Polytechnic Institute. Numbers in parenthesis refer to mounted specimens.

Adiantum pedatum L. Maiden-Hair Fern.
Locally common, mostly on rocky, wooded stream bluffs in an oak-beech-hickory association. (1157).

Asplenium platyneuron (L.) Oakes. Ebony Spleenwort.
Fairly common and generally distributed. Most common in oak-beech-hickory associations. (1466, 1603).

Asplenium trichomanes L. Maiden-Hair Spleenwort.
One station known. A few plants in crevices of rocks on wooded bluffs of Appomattox River, just above the bridge on Route 49, on north border of county. (1142).

Athyrium asplenioides (Michx.) Desv. Lady Fern.
One of our most abundant ferns, growing in damp or wet woods all over the county, sometimes in open places. (882, 1145).

Dennstaedtia punctilobula (Michx.) Moore. Hay-Scented Fern.
One station known, on the wooded bank of the south branch of Smack's Creek about 2 miles south of Amelia village. (302).

Dryopteris cristata (L.) A. Gray. Crested Shield-Fern.
Very local, in deep, alluvial swamps, in woods. Large colonies are growing in the swamp on the west branch of Nibb's Creek about 3 miles west of Amelia village, on the south side of Beaver Pond, 9 miles southeast of Amelia near Route 38, and on the west side of Rowlett's Pond about 5½ miles east of Amelia. It is a tall, beautiful evergreen fern. (833, 928, 767, 1595).

DRYOPTERIS HEXAGONOPTERA (Michx.) C. Chr. Broad Beech Fern.
Locally common, mostly on rocky, wooded stream bluffs in an oak-beech-hickory association. (1158, 2056).

DRYOPTERIS MARGINALIS (L.) A. Gray. Marginal Shield-Fern.
One plant known. It formerly grew on a rich, wooded hillside on Sheppard's dairy farm at Winterham. Miss Emily Dinwiddie, then of Richmond, and the writer collected specimens of it very carefully on October 18, 1932. The next summer it died.

DRYOPTERIS NOVEBORACENSIS (L.) A. Gray. New York Fern.
Along woodland streams. (1671).

DRYOPTERIS SPINULOSA VAR. INTERMEDIA (Muhl.) Underwood.
In woods near Winterham, Sheppard's farm. (743, 351, 907).

DRYOPTERIS THELYPTERIS (L.) A. Gray. Marsh Shield-Fern.
Local, in swampy places, wooded or open. Not generally distributed. (967, 1041).

ONOCLEA SENSIBILIS L. Sensitive Fern.
Fairly common in wet soils in open woods and wet fields. (1228).

POLYPODIUM VIRGINIANUM L. Common Polypody.
Only three stations known. One on a rock outcrop on the bank of Flat Creek about a mile above the bridge on Route 636, near Grub Hill. Two groups about 200 yards apart at and above Weatherford's Glen, also known as "Lover's Leap", about 2 miles north of Maplewood on Route 639. (1156).

POLYSTICHUM ACROSTICHOIDES (Michx.) Schott. Christmas Fern.
Probably our most abundant fern, growing in well drained woods in almost all associations, all over the county. (1171).

PTERIDIUM LATIUSCULUM (Desv.) Hiero. Bracken.
Abundant on well drained soils in many locations. Seems to prefer sandy soils in open wood. (971, 990).

WOODSIA OBTUSA (Spreng.) Torr. Blunt-Lobed Woodsia.
Local and not common. Found mostly on wet, rocky, wooded hillsides in oak-beech-hickory associations. A small colony is growing on one of the rocks near Rock Stable, where a spring seepage keeps the moss wet and a small cedar furnishes shade. (507, 551, 689).

WOODWARDIA AREOLATA (L.) Moore. Net-Veined Chain-Fern.
Very local. Common in a few deep, wooded swamps. The largest colony known is in such a swamp on the headwaters of Smack's Creek, just south of Amelia village, in what is known as Eggleston's woods. (1279).

OSMUNDA CINNAMOMEA L. Cinnamon Fern.
Locally common in rich, damp to wet woods, occasionally in open swamps. (467).

OSMUNDA REGALIS VAR. SPECTABILIS (Willd.) A. Gray. Royal Fern.
Locally common in damp to wet woods. Sometimes in open, swampy fields. (585).

BOTRYCHIUM DISSECTUM VAR. OBLIQUUM (Muhl.) Clute. Grape Fern.
Locally fairly common in low grounds along streams, in red maple-tulip-poplar associations, rarely on rich, damp hillsides higher up. (1127, 1239, 1256).

BOTRYCHIUM VIRGINIANUM (L.) Sw. Rattlesnake Fern.
Fairly common on good soils in woods, in drier locations than the two preceding. Earliest of the group. May 20 through June. (85, 95, 293, 588, 1467).

OPHIOGLOSSUM VULGATUM L. Adder's Tongue Fern.
Rather rare, in rich, damp soils in open woods, preferring alluvium. Fairly common in a few restricted areas. (151, 744).

EQUISETUM ARVENSE L.
Appomattox River near Goode Bridge. (1431).

EQUISETUM PREALTUM Raf. Scouring Rush.
Large colonies in a few places in alluvial low grounds, in woods or fields. Not generally distributed, even in low grounds. (368).

LYCOPODIUM COMPLANATUM VAR. FLABELLIFORME Fern. Ground Pine.
Abundant in rich, well drained woods. (1257).

LYCOPODIUM INUNDATUM VAR. ADPRESSUM Chpm.
Tom Lynch bog, bog near Winterham and at Otterburn. Determined by Dr. Fernald. (2014, 2074, 2048, 2170, 1493, 1628, 1659, 1607, 1602, 1897).

LYCOPODIUM LUCIDULUM Mich. Shining Club-Moss.
In rich woods along a small stream, Sheppard's dairy farm near Winterham. (1532, 1359, 1669). Also a large colony on the bank of a small stream in a large tract of woods on east end of Hindle farm about two miles west of Amelia village.

LYCOPODIUM OBSCURUM L. Club Moss.
Very local in rich, damp low grounds. Common north side of Smack's Creek swamp, above "Butler Road". (1242, 1996, 1682). Also a colony on south side of Barksdale Pond, Haw Branch section.

SELAGINELLA APODA (L.) Fern. Creeping Selaginella. Abundant in wet woods and stream borders. (2039, 1471, 1650, 1587).

SELAGINELLA RUPESTRIS (L.) Spring. Rock Selaginella. Known only from the rock near Rock Stable. (748, 1216, 1013).

WILDLIFE RESEARCH UNIT,
VIRGINIA POLYTECHNIC INSTITUTE,
BLACKSBURG, VA.

Pteridophyta of a Bog near "White Pine Lodge," Giles County, Virginia

SAMUEL LEWIS MEYER

The bog in which this study was made is about a mile northwest of "White Pine Lodge", summer residence of Mr. John B. Laing, in Giles County, Virginia. It is approximately four miles northwest of Mountain Lake at an elevation of about 3100 feet. It lies in the same general basin as the "Cranberry Bog", previously studied, but is farther to the east. This basin lies in Romney Shale and is some three miles long by a mile wide.

A study of the Pteridophyta in this bog was thought to be of interest because of its relatively inaccessible location and the fact that it had not been previously worked. The present paper is regarded as a further contribution to the knowledge of the Pteridophyte flora of the region. The nomenclature of Virginia ferns suggested by Weatherby[1] has been followed.

The first Pteridophytes one sees on approaching the bog from the east are the Cinnamon Fern (*Osmunda cinnamomea* L.), the Sensitive Fern (*Onoclea sensibilis* L.), the abundant New York Fern (*Dryopteris noveboracensis* (L.) A. Gray), some extremely handsome specimens of the Royal Fern (*Osmunda regalis* var. *spectabilis* (Willd.) A. Gray), the Interrupted Fern (*Osmunda Claytoniana* L.), together with a few scattered plants of the cosmopolitan Lady Fern (*Athyrium asplenioides* (Michx). Desv.). An occasional Bracken (*Pteridium latiusculum* (Desv.) Hiero.) may be seen along the path. Of these, the Cinnamon Fern, the Interrupted or Clayton's Fern, and the Sensitive Fern occur abundantly throughout the bog.

On moving into the bog in a westwardly direction, several clumps of the beautiful Boott's Shield-Fern (*Dryopteris Boottii*

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[1]Weatherby, C. A. Nomenclature of Virginia Ferns. *Claytonia* 2: 41-45, 1936.

(Tuckerm.) Underw.) were located. A particularly fine specimen was found on a sphagnum hummock in the vicinity of which were observed the handsome fronds of the Crested Shield-fern (*Dryopteris cristata* (L.) A. Gray) and *Dryopteris spinulosa* var. *intermedia* (Muhl.) Undw., an ideal situation.

Isolated dry areas, some quite small, occur within the bog. On such drier patches, one finds the New York Fern (*Dryopteris noveboracensis* (L.) A. Gray) and the Ground Pine (*Lycopodium obscurum* L.).

As one proceeds toward the south to work out of the bog, numerous specimens of the Marsh Shield-fern (*Dryopteris Thelypteris* (L.) A. Gray) are located. Many of the species previously seen are observed again while on reaching the woods on the margin of the bog, the Trailing Ground Pine (*Lycopodium complanantum* var. *flabelliforme* Fernald) completes the Pteridophyte list.

This study was made during the second term of the summer session of 1938 at the Mountain Lake Biological Station of the University of Virginia, Giles County, Virginia, under the direction of Lieutenant-Colonel Robert Patrick Carroll, Assistant Professor of Biology, Virginia Military Institute, to whom the writer expresses appreciation for many helpful suggestions during the investigation.

MILLER SCHOOL OF BIOLOGY,
UNIVERSITY OF VIRGINIA.

The Sullivant Moss Society's 1939 Foray*

PAUL M. PATTERSON

The Sullivant Moss Society joined The Botanical Society of America, The American Society of Plant Taxonomists, The American Fern Society and The Southern Appalachian Botanical Club on its annual foray, June 15-18. The Committee on Flora of the Virginia Academy of Science arranged for the meetings and planned the field trips.

Most of the group attending, a total of sixty-five persons, were comfortably housed at the Mountain Lake Biological Station of the University of Virginia, Giles County, Va., while a few stayed in Blacksburg, a few miles away.

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*Reprinted from *The Bryologist*, XLII: 125-126, 1939.

Members of Sullivant Moss Society attending 1939 Foray.—From left to right: Fulford, Manley, Carroll, Sharp, Blomquist, Little, Patterson.

Bryologists attending were Dr. H. L. Blomquist of Duke University, Lt.-Col. R. P. Carroll of the Virginia Military Institute, Dr. Margaret Fulford and Miss Margaret Manley of the University of Cincinnati, Dr. Elbert L. Little of the U. S. Forest Service, Tucson, Ariz., Dr. Aaron J. Sharp of the University of Tennessee, and the writer. Rev. Fred. W. Gray and his sons, Frank and James, of Philippi, W. Va. were with the party the night of the 15th but left the next morning.

Field trips were planned for the 16th, 17th, and 18th, and evening programs for the 15th and 16th. The first evening Dr. Ivey F. Lewis of the University of Virginia presided at the program held at the Mountain Lake Biological Station. It consisted of the following papers:

Mixed Deciduous Forests of the Appalachians—E. Lucy Braun, University of Cincinnati.

The Bryophytes of the Southern Appalachians—Aaron J. Sharp, University of Tennessee.

Ferns of the Southern Appalachians—H. L. Blomquist, Duke University.

Trees and Shrubs of the Southern Appalachians—H. R. Totten, University of North Carolina.

The next morning the Sullivant Moss Society followed the trip planned for the whole group, who went over Big Mountain to the Big Stony Creek valley, on to Narrows, Va. for lunch, then back to Blacksburg via Eggleston for dinner. On Big Mountain, *Leptodon trichomitrion* in addition to the usual epiphytic flora was seen on the tree trunks. On rocky ledges, in addition to a profusion of more common forms, were *Herberta tenuis* and a tufted form of *Dicranum montanum.* The latter, noted by Dr. Sharp, reminds one in the field of *Brothera leana.* In a meadow along Big Stony Creek, Dr. Blomquist collected three *Sphagna* apparently unreported from the region.

The evening conference for the 16th was held at the Virginia Polytechnic Institute, where Prof. A. B. Massey of the Institute presided over the following program.

Some Old Collections of Southeastern Plants—M. L. Fernald, Gray Herbarium, Harvard University.

Plant Migrations and Vegetational History of the Mid-Appalachian Region—Earl L. Core, West Virginia University.

Continental Displacement and the Origin of the Southern Appalachian Floras—W. H. Camp, New York Botanical Garden.

On Saturday morning, the 17th, the bryologists and members of the American Fern Society went on a trip of their own to Mountain Lake, down its drainage branch to the valley below. By afternoon, the society's numbers were diminished by the departure of Drs. Sharp and Blomquist. The rest of the group went to the Cascades of Little Stony Creek. Here, in a profusion of hepatics and mosses, occur such forms as *Catharinea crispa, Porotrichum alleghaniense, Hookeria acutifolia, Gymnostomum calcareum, Mnium punctatum elatum* and many mosses common to the region; as well as *Trichocolea tomentella, Reboulia hemisphaerica* and many other hepatics.

Those attending enjoyed an unusually profitable and pleasant foray. The group dispersed on the morning of the 18th.

HOLLINS COLLEGE, VA.

GENERAL NOTES

Isatis tinctoria along Skyline Drive.—Dr. M. A. Chrysler of Rutgers University, New Brunswick, New Jersey, writes that in company with Dr. W. E. Manning of Smith College, he found this plant to be abundant along the edge of the Skyline Drive. He adds, "Professor Manning and I took specimens and submitted them to several, all of whom were as much puzzled as we were. Dr. M. L. Fernald however identified the plant as *Isatis tinctoria* L., a European plant belonging to the Cruciferae. Just how this plant got introduced I cannot say but at all events it is extremely common along the edge of the roadway in the northern part of the Skyline Drive. The plant is now (June 21, 1939) almost entirely in fruit, but when I first drove along the road on the 28th of May, the plant was in full flower and exceedingly conspicuous."

Request for Galax material.—For use in a cytogeographic study of *Galax*, J. T. Baldwin, Jr., Department of Botany, University of Michigan, Ann Arbor, Michigan, would greatly appreciate the receipt of three living plants of the genus from various locations throughout its range, together with definite information on the places of collection.

Micheliella Briq. in Virginia.—On a wooded slope about three hundred yards from the Meherrin River and about one hundred yards from Route 1, in Brunswick County, Virginia, the writer, in company with Mr. Ellis Rucker of the Matthew Whaley High School, Williamsburg, Virginia, on May 20, 1939, collected flowering specimens of *Micheliella verticillata* (Baldw.) Briq. There was a colony of perhaps seventy-five plants. Specimens (Baldwin 252) were checked by Dr. M. L. Fernald, who wrote that they are "very characteristic" of the species. The collection, therefore, extends the range of *Micheliella* northward into Virginia and, accordingly, into the area of *Gray's Manual*.—J. T. Baldwin, Jr., University of Michigan, Ann Arbor, Michigan.

The Virginia Academy of Science has no interest other than the advancement of science in Virginia. It has long felt the need of a periodical to help it accomplish these ends. It is hoped that this Virginia Journal of Science may become the local organ of the various scientific groups in the State, and thus serve as an integrating influence on science in Virginia. It will also represent Virginia science wherever it goes, and if we all cooperate, it can be made a worthy representative of which we may all be proud. I bespeak your help.—E. C. L. Miller, *Secretary*.

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Snakes of the Allegheny Plateau of Virginia

PAUL R. BURCH

Snakes have been objects of perennial interest from time immemorial, either through fear or curiosity. No subject seems to draw more attention and almost everyone has some pet snake story vouched for by some relative or friend who is claimed to have been an eye-witness of the events described. With the exception of a few woodsmen and naturalists most people seem to be interested in snakes from some other part of the world such as they may have seen in a passing circus. They have seldom heard of more than a few kinds found in the woods and streams near them. For the most part these to them are just "snakes" and the "lowest form of life that lives". Some have heard of "blacksnakes", "water moccasins", "rattlesnakes" or "spreadhead moccasins". Very few can distinguish them. An almost unreasoning fear seems to blind most of us when an actual snake appears. Many otherwise experienced woodsmen cannot distinguish the harmless hognosed snake from the poisonous copperhead. Every year many curious stories appear in the daily press allegedly true but actually based on faulty observation, misinformation and imagination sometimes told with a desire for publicity. There are many excellent books dealing with snakes, such as "The Reptile Book" and "Snakes of the World" by Raymond Ditmars, "Snakes Alive" by Clifford Pope, and "Manual of the Vertebrates of the United States" by H. S. Pratt, as well as others, but they seem not to be very well known. The account here is given with the hope that those who live in the mountains of Virginia or who visit them in the summer will come to think of snakes as a normal part of the fauna of the State, take them as a matter of course, think of most of them as allies and the poisonous as relatively few in number, to be respected but not feared. A knowledge of one's community should be considered incomplete without some definite knowledge of its snakes. Known snakes of the world total approximately 1800 species, of the United States, 111, of Virginia, 35 and of the Allegheny plateau, 18.

The Common Garter Snake, *Thamnophis sirtalis,* is the most common snake and may be seen earlier in the spring and later

in the fall than any other. It is a harmless black and green striped snake which lives mainly on grasshoppers and other insects and earthworms. It will sometimes strike when cornered but is easily caught and the worst it does is to secrete an evil-smelling viscous yellow fluid from anal glands. It is messy but not harmful. A sub-species of this snake resembles it very much except that it has several rows of checker-board-like black and green squares on either side of the mid-dorsal line. It is known as the Spotted Garter Snake, *Thamnophis sirtalis ordinatus*. It measures two to three feet in length at most. It is ovo-viviparous, that is, the eggs hatch in the oviducts and the young snakes are born alive.

The Hognosed Snake, *Heterodon contortrix,* known as "spreadhead moccasin", "puff-adder" or "blowing viper" is second in order of numbers seen. It varies in color from light yellow to dark brown with irregular splotches of black and is often mistaken for the Copperhead Moccasin. A black species, *Heterodon contortrix niger,* is occasionally found. Both flatten out and hiss when disturbed and are greatly feared. Their acting is bluffing but it makes them look most dangerous to the uninitiated. When their bluff is called they soon give up, pretend to be in agony, writhe, open the mouth, hide the head and finally turn over on the back, remain motionless and appear to be dead.

Again the uninitiated are fooled but if the snake is turned right side up it immediately turns back and thus gives itself away. If left alone for a few minutes it will right itself and if the coast appears to be clear it will crawl quickly out of sight. If it can be induced to strike it hits the object with its snout and not with its teeth. It has no fangs. One of the stories told about this snake is that when teased it becomes so angry that it bites and kills itself and turns over on its back, dead. It averages less than three and one-half feet in length. The animals are oviparous, the eggs being laid. They hatch in late summer when the young snakes from six to ten inches in length may be found.

The water snakes are more common along the rivers, creeks and branches and one of them, the Common Water Snake, *Natrix sipedon,* has a reputation almost as bad as *Heterodon.* It is known almost everywhere as the "Water Moccasin", even though it is not a moccasin at all. It is also called the "Dry-Land Moccasin". (The Water Moccasin, *Agkistrodon piscivorus,* is not found in Virginia except, possibly, in the Dismal Swamp.) The swelling which sometimes follows the bite of the water snake may be due to infection or to the snake's saliva, but not to venom for the snake produces none and is not considered a poisonous snake. On land the snake is a rusty brown with scarcely observable markings but in water and especially when young it has the variable black and white on brown patterns. It is a vicious oppon-

ent but here is seldom longer than three and one-half feet. It is ovo-viviparous. The other water snake, *Natrix septemvittata,* the Queen Snake, or Striped Water Snake, does not have the former's reputation for viciousness nor size. It can be recognized by the narrow black and yellow stripes on each side. Like the preceding it is ovo-viviparous and has keeled scales.

Next in frequency are the "blacksnakes" of which there are three species belonging to as many genera which are confused in actions and in identification to such an extent that the most naive tales are told about them, namely, that parents swallow their young when the latter are in danger, and that the common blacksnake fights and kills rattlesnakes and copperheads, and that the common blacksnake entwines and strangles unprotected women and children. The Mountain Blacksnake or Pilot Snake, *Elaphe obsoleta,* is the largest of the snakes. It is black in color, its keeled scales give it a rough appearance when compared with the Common Blacksnake or Racer, *Coluber constrictor* (not a constrictor at all) which has smooth satin-like scales and a very slender tail which vibrates rapidly when the snake is cornered or excited. Usually the latter moves so fast that one gets hardly more than a fleeting glimpse of it. The Black King Snake, *Lampropeltis getulus nigra,* has cross-bars which are almost invisible, and therefore resembles the other blacksnakes superficially. It moves slowly and can be approached more easily than the others. Only the King Snake is powerful enough to cause discomfort by constricting some part of the body, unless that part be the neck, but this snake does not attack man. None of these snakes attack man except during the mating season or when attacked themselves. Then they have been known to follow an intruder for twenty-five feet. The King Snake may attack any snake it meets, strangle it and swallow it whole. This action may be the basis for the stories about mother snakes swallowing their young to protect them when danger threatens. Snakes however, pay no more attention to their young than to any other snakes, even though they are found near each other. The interpretation is also probably supported from imagination and the finding of young in the oviducts of ovo-viviparous snakes like the water snakes, rattlers and copperheads, when one of these snakes has been cut open with a hoe or other sharp instrument. It is the King Snake which attacks the venomous rattler and copperhead and not any of the other "blacksnakes". It is immune to their venom and needs no "snakeweed" for the healing of its wounds. It strangles its victims and swallows them whole. *Lampropeltis getulus,* the Common King Snake, or Chain Snake, is similar to the black species but has well defined white cross-bars connected in such a manner as to resemble a chain. *Lampropeltis triangulum,* the so-called Milk Snake, is a king snake

with a brown chain on a tan background. *Lampropeltis clericus,* the so-called Red Milk Snake, has a black chain on a red background, each link edged with white. These snakes do not milk cows. They do not have the proper mouth structure, and if they did, the farmer would not miss the small amount of milk one could secure. All the "blacksnakes" attain lengths of from six to eight feet, the Common King Snake six feet, *L. clericus* one and one-half feet and *L. triangulum,* three feet.

None of the snakes mentioned below is very common, partly on account of secretiveness, partly because they have been killed off. The copperhead and the rattlesnake only are poisonous. The Ring-necked Snake, *Diadophis punctatus,* and the Worm Snake, *Carphophis amoenus,* are secretive, usually being found in or under rotten logs or in soft mossy banks (although four of the latter species crawled into my basement laboratory one morning and became martyrs to science.) The Ring-necked Snake attains a length of one and one-half feet, has a yellow band around the neck and an orange colored belly. It is harmless and liked as a pet by some. The Worm Snake is seldom over ten inches in length and the size of a lead pencil in diameter. It is a brownish grey in color, oviparous and dark-loving.

The Green Whip Snake, *Opheodrys aestivus,* green in color, and therefore hard to find, with prominent scales which give it the appearance of a plaited whip, is greatly feared. However, it is harmless. In the thinking of many people green seems to be associated with poison. It attains a length of about two and one-half feet.

The Corn Snake, *Elaphe guttata,* is a large snake resembling the mountain blacksnake except in color markings which are a light tan background with black and white patterns. This harmless snake is usually confused with the poisonous copperhead but is probably one of the farmer's best allies among the wild animals for it is a first class mouser and is found in cornfields because mice, its natural food, are found there in great numbers.

Recently, another large harmless snake has been found in Craig and Giles counties, the Pine Snake, *Pituophis melanoleucas.* This snake has a large brown body with indistinct markings, a tail crossed with red bars and tipped with a spine and a blunt head. It is oviparous.

All of the above named snakes are harmless and on account of the rodents they kill, even the large ones which eat some quail eggs are more helpful than harmful. The next and last two to be mentioned are the poisonous ones. The rattlesnake, *Crotalus horridus,* the Banded or Mountain Rattlesnake, is limited to the mountains, having been almost exterminated elsewhere in Virginia. The largest on record measured six feet in length but the largest I have seen, only four and one-half feet. Most are shorter.

They hibernate in "dens" in winter, entering by September 15th and leaving about May 15th. These dens are on rocky mountain sides with a southern exposure and are usually near the tops. Cracks between the rocks allow the snakes to crawl below the frost line. Here rattlers, copperheads and "blacksnakes" may be found together. Mating takes place before the snakes leave the den in spring and the young are born (not blacksnakes) during the late summer before or after the females return. The outer corneous layer of the skin is shed in early spring, in the fall, and if the snake has been prosperous, once in between—three castings of skin. Each time it sheds, a part of the skin remains as a "rattle", making possible the addition of three rattles per year. The first is called the "button" and is on the end. After eight or ten rattles have been added some may be torn off as the snake crawls through the underbrush. When the snake is excited its tail vibrates and in so doing shakes the rattles which produce the characteristic whirring sound. This sound acts probably as an unintentional warning that the snake is ready to strike. It can strike without coiling. Coiled or not it can strike fairly accurately one-half its length forward, but two-thirds its length is its maximum striking distance. It does not leave the ground when it strikes and seldom plants its fangs higher than six inches above the ground. It strikes with its mouth wide open and its fangs directed forward. The hypodermic needle-like fangs are five-eighths inch long and connected to poison sacs in the head. These sacs are squeezed when the fangs make contact, thus introducing the venom into the wound made. The venom is used mainly to kill animals for food and after having been used requires some days for replacement. For this reason the sacs are only partly filled during most of the summer and the snake is correspondingly less dangerous. A person who has been bitten has four chances out of five to recover whether or not he has received medical attention. The use of the tourniquet, suction cup or antivenin, increases the chances of recovery. The use of alcohol may decrease it. Relatively few people will ever see a poisonous snake out of captivity and less than one out of a hundred of these will be bitten. The author has roamed the mountains all of his life and has yet to find one himself although on two occasions within five years a member of his party has been successful. The most recent was found by Colonel Robert P. Carroll on the fauna foray of the Virginia Academy of Science in May, 1939 near Stuart.

The copperhead, or Copperhead Moccasin, *Agkistrodon mokasen,* although feared more than the rattlesnake by some, is less dangerous because its fangs are shorter and its poison sacs smaller. It seems to strike more quickly, and of course, without a warning like the former. It is less common in the mountains and more common in the lowlands. Its average length is less than

three feet and the longest recorded less than four feet.

A specimen of each of the above mentioned snakes is preserved in the Biology Museum of the State Teachers College, Radford, Virginia. A list of these follows:

1. *Agkistrodon mokasen*.....Copperhead Moccasin
2. *Carphophis amoenus*.....Worm Snake
3. *Coluber constrictor*.....Blue Racer
4. *Crotalus horridus*.....Rattlesnake
5. *Diadophis punctatus*.....Ringnecked Snake
6. *Elaphe guttata*.....Corn Snake
7. *E. obsoleta*.....Mountain Blacksnake
8. *Heterodon contortrix*.....Hognosed Snake
9. *H. contortrix nigra*.....Hognosed Snake
10. *Lampropeltis getulus*.....Common King Snake
11. *L. clericus*.....Red Milk Snake
12. *L. nigra*.....Mountain King Snake
13. *L. triangulum*.....Milk Snake
14. *Natrix septemvittata*.....Queen Snake
15. *N. sipedon*.....Common Water Snake
16. *Pituophis melanoleucas*.....Pine Snake
17. *Thamnophis sirtalis*.....Common Garter Snake
18. *T. sirtalis ordinatus*.....Spotted Garter Snake

STATE TEACHERS COLLEGE,
RADFORD, VIRGINIA.

Significance of Geological Features In Jackson's Valley Campaign

by the late

HENRY DONALD CAMPBELL

Foreword

by

MARCELLUS H. STOW

It is appropriate that Volume One of the VIRGINIA JOURNAL OF SCIENCE contain a selection from the unpublished writings of one of Virginia's foremost students of Geology, the late Henry Donald Campbell, formerly Professor of Geology and Dean of Washington and Lee University. Many of the readers of this new periodical of Virginia science will be aware of the interest he would have shown in the future success of the Journal.

Knowing that he would wish to contribute to the progress of scientific and cultural education in the South, part of a paper on "The Valley of Virginia", read before the Fortnightly Club of Lexington, Virginia, a few years before his death in 1934, has been revised somewhat for publication in the Journal.

The complete paper represented a study of the history of the settlement of the Valley; that part treating of the geological history of the region and the significance of certain geological features in the strategy of "Stonewall" Jackson's Valley Campaign of the Civil War is herewith presented.

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Geologically speaking the Valley of Virginia is of recent origin, but the Sculptor has been at work for millions of years in the carving of this landscape of exquisite beauty from a great featureless plateau. You will need to draw on your imagination while I attempt to tell the origin of the plateau from which the Valley and the river gorges and the windgaps have been chiseled.

The marine fossils in the sandstones, shales and limestones of the Appalachian region tell us that these rocks were deposited as sediment in a sea which for long periods of time covered this area. After the close of the Carboniferous period, the period during which the coal beds and associated sedimentary rocks of the Appalachians were deposited, this whole Appalachian region was subjected to enormous lateral pressure with the result that the horizontal sedimentary rocks, from the Allegheny Escarpment to the Blue Ridge and beyond, were compressed into folded mountains whose crests ran northeast and southwest. So soon as these mountains were raised above the sea the agents of destruction went to work on them. Sunshine and shadow, wind and rain, frost and dew, freezing and thawing, percolating water and the gases of the atmosphere, began to disintegrate the rocks and caused them to crumble into mantle rock and soil, and then, running water, picking up the loose material, carried it down to the ocean. Some parts of the land surface were naturally worn away faster than others, but ultimately the whole area, except for a few remnants, was brought down to a gently undulating peneplain, traversed by sluggish, meandering streams.

After the crests of the folds had been truncated to the level of the peneplain the edges of the beds of sedimentary rock of varying composition and hardness, which made up the limbs of the folds, appeared at the surface of the plain as bands running in the direction of the longitudinal axes of the folds, which was northeast-southwest.

Now imagine this low lying peneplain to be uplifted several thousand feet and warped so that it sloped from what is now the top of the present Allegheny escarpment toward the Atlantic Ocean as well as westward and southward. The dormant forces of nature were again aroused. A new drainage system was in-

augurated, and another cycle of erosion began. It was during this second cycle of erosion that our mountain gorges and wind-gaps were cut.

If you will notice that Jump Mountain, Hog Back, House Mountain, Green Hill and many parts of the Blue Ridge have approximately the same elevation you can visualize the surface of the old plateau. If you will follow the crests of the Blue Ridge and the Alleghenies toward the Potomac River, and note the skyline of the Massanutten as you go, you will see that the crests become gradually lower and that they are cut by numerous gaps. The peaks which here and there rise to greater elevation are supposed to be remnants of the peaks which stood above the old plateau. Imagine the Valley of Virginia, and the narrow valleys between the mountain ridges to the northwest, to be filled to the elevation of the mountain crests with beds of rocks such as have been disintegrated and carried away and you will have a mental picture of a plateau sloping from the crest of the present Allegheny mountain toward the Atlantic Ocean, as well as westward and southward. Down the even slope toward the Atlantic ran the Potomac, the James and the Roanoke Rivers and other streams across the edges of the underlying beds of rocks of varying degrees of resistance. The speed with which the streams would lower their channels would be determined by the thickness and resistance of the beds they would encounter, and the velocity and volume of the streams, and the character of the abrasives that they carried along as corrosive agents. The effective cutting tools of a stream are boulders, pebbles, and sand. The channels cut through hard, tilted, sandstone remain narrow, because their sides do not readily yield to the processes of solution or decay; but the banks of a stream that runs across limestone and shale gradually crumble and the channel is widened. Such hard sandstone ledges were soon encountered by the young streams as they cut their way through the soil, which must have accumulated to considerable depth over the surface of the old plain before it was uplifted. Heavy ledges of sandstone, tilted at steep angles, had their edges exposed from the Roanoke to the Potomac and beyond. Similar tilted ledges, sometimes in the position of arches which were the cores of old folds, still existed underground as broad belts running northeast-southwest. Between these hard belts of sandstone were less resistant belts of limestone and shale.

When the Potomac River was beginning to cut its notch across the hard sandstones at Harper's Ferry there was no Valley. A smaller stream to the southwest, having its source higher on the plateau, was running in the same direction and cutting a gap of its own, and continuing to the east of the gap in the channel of Beaverdam Creek. The Potomac was, however, a larger stream,

and was able to cut down its gap more rapidly than Beaverdam Creek. Upstream from the resistant ledges of sandstone water flowed into the Potomac, transverse to its course, cutting gullies and ravines as the weaker shales and limestones yielded more rapidly to weathering. Thus began the Shenandoah River. It gradually cut its way upstream and deepened its channel as the bed of the Potomac was lowered. After a while it cut back to Beaverdam Creek and diverted its head-waters to the Potomac, leaving Snicker's Gap without a stream flowing from the west of the Blue Ridge. The geologists call this act piracy, and they say that Beaverdam Creek was beheaded by the Shenandoah River. A gap of this kind that was cut by a stream that was afterwards beheaded is called a Wind Gap as distinguished from a Water Gap. The Shenandoah, thus reinforced, continued its progress to the southwest and beheaded many more streams, leaving Ashby's Gap, Manassas Gap, Thornton's Gap, Brown's Gap, Rockfish Gap, and possibly others as Wind Gaps to record the southwest progress of the Shenandoah. The north fork of the Shenandoah beheaded the stream that flowed east through New Market Gap in Massanutten Mountain.

The weaker rocks along the course of the Shenandoah and its tributaries were thus carried away and the mountains' harder rocks were left standing in bold relief. A similar story can be told of other streams in the Valley and in the narrower valleys between the mountain ridges of the Alleghenies. The process of downward cutting in the Valley finally came to a halt when a level had been reached where the velocity of the main streams was too slow to do the work. These streams were old and sluggish and they swung from side to side, developing meanders in their course like those in the Mississippi River. The smaller streams finished the job of cutting down the minor elevations in the Valley, with the exception of a few hills. Thus the Valley was reduced to a peneplain and another cycle was ended. North River was meandering across a nearly level plain several hundred feet above its present bed. How long this quiescent period lasted we do not know, but after a while the region of the Appalachians was again slowly elevated and warped and the streams were rejuvenated, their velocity increased and they began to renew their cutting, with the result that they are now entrenched several hundred feet deep in their old meandering courses.

The topographical features, the origin of which I have attempted to outline, played a very important part in the strategy of Jackson's Valley Campaign. He was fortunate in having on his staff as topographical engineer Major Jed Hotchkiss of Staunton, Virginia, who was very familiar with the Valley and the mountain gaps, and was an expert draftsman.

Winchester was the key to communication with the north-

west. From Winchester two highways led westward to Romney and Moorefield; four highways crossed the Blue Ridge to the east and southeast through Wind Gaps, viz., Snicker's, Ashby's, Manassas, Chester's. It was through Ashby's Gap that the troops under Jackson marched from Winchester on July 18, 1861, to engage in the first battle of Manassas on July 21. Part of the Confederate troops under General Kirby Smith went by rail through Manassas Gap.

During the spring of 1862 the Massanutten Mountains, which divided the Valley from Strasburg to Harrisonburg, gave great concern to General Banks of the Federal army, who feared that Jackson, who was retreating up the Valley, might go down the other fork of the river and attack him in the rear. So Banks went slowly and cautiously up the valley toward Harrisonburg. Seeing that Banks, having the road over New Market Gap in his possession, would move into Luray Valley and occupy the strategic pass at Swift Run Gap, Jackson, by a forced march around the south end of Massanutten Mountain, making over fifty miles in three days, camped in Elk Run Valley at the foot of Swift Run Gap. When on April 26, 1862, Banks moved up to Harrisonburg, Ewell, who, although across the Blue Ridge, was prepared to unite with Jackson, was called up to Stanardsville, 12 miles southeast of Swift Run Gap. On April 29 Ashby made a demonstration in force toward Harrisonburg. On the 30th he drove the Federal cavalry back upon their camp, and the same afternoon, leaving Elk Run Valley, which was immediately occupied by Ewell, Jackson started on his march by way of Port Republic to join General Edward Johnson, who was near Staunton, in an attack on Milroy, who was threatening to march on Staunton by way of Monterey. Instead, however, of crossing the Valley toward Staunton, Jackson crossed the Blue Ridge through Brown's Gap, (a Wind Gap), to the railroad station at Mechum's River and went by railroad over Rockfish Gap to Staunton, joined General Edward Johnson, marched through Jennings Gap to McDowell, seventy miles distant, defeated General Milroy, and returned to the Valley at Mount Solon on May 17th. Here he was met by General Ewell, who informed him that Banks had fallen back from Harrisonburg to Strasburg. While Jackson was at McDowell, Major Hotchkiss, with the aid of a squadron of Ashby's cavalry, had blocked the passes by which Fremont could cross the Allegheny Mountains and support his colleague, Banks. "Bridges and culverts were destroyed, rocks rolled down, and in one instance, trees were felled along the road for nearly a mile." The McDowell expedition had neutralized for the time being Fremont's twenty thousand men. Ewell went back to Elk Run and marched down the east side of the Massanutten Mountain to Luray, and Jackson to New Market on the west side. Unexpected-

ly to his men, Jackson marched across New Market Gap to Luray and joined Ewell and they proceeded down the Shenandoah River to Front Royal, where they were met by Federal troops under Kenly, who was defeated and cut off from Banks at Strasburg and completely isolated. Banks was incredulous, astonished, and electrified, and beat a retreat to Winchester and beyond, followed by Jackson's army.

Henderson says, "From the morning of May 19th to the night of June 1st, a period of fourteen days, the Army of the Valley had marched 170 miles, had routed a force of 12,500 men, had threatened the north with invasion, had drawn off McDowell from Fredericksburg, had seized the hospital and supply depots at Front Royal, Winchester, and Martinsburg, and finally, although surrounded on three sides by 60,000 men, had brought off a huge convoy without losing a single waggon. The loss of 613 officers and men was a small price to pay for such results."

When Jackson had advanced as far as Harper's Ferry, he learned that he was threatened in the rear by two armies, one coming from the west and one from the east. He made an orderly retreat up the Valley turnpike, sending men across Massanutten Mountain at New Market Gap to burn bridges in front of the Federal troops, under General Shields, who were advancing up the Luray Valley. General Fremont was following Jackson up the west side of Massanutten Mountain. Jackson went around the south end of Massanutten Mountain, whence a good road led across Brown's Gap into Albemarle, offering him a safe outlet in case of disaster, and a means of drawing supplies from that fertile country.

Then followed the battles of Port Republic and Cross Keys and the retreat of two Federal armies. Jackson was then transferred to eastern Virginia and his Valley Campaign was ended.

It has not been my object to describe in any detail Jackson's Valley Campaign and its results, but merely to illustrate the decisive part played by the wind gaps made by ancient rivers and by the old monadnock left standing on the Valley Peneplain, now called Massanutten Mountain.

Heavy Mineral Separation

Marcellus H. Stow

Introduction

Descriptions of the laboratory procedure for the preparation of samples of sediments for microscopic study have been published from time to time; most of these are published in volumes that may not be available to the individual wishing to make some

preliminary or elementary examinations of consolidated or unconsolidated sediments. There seems to be a demand for a short, concise description of a complete laboratory procedure that will enable the beginner in the study of sediments to make rapid separations of the heavy and light minerals without the necessity of consulting complete treatises that involve the more complex phases of mechanical and statistical analyses.

Herewith is presented a technique that has been found to be rapid in execution and sufficiently accurate in results for any qualitative study of the heavy and light constituents of sediments. The apparatus and materials used are simple and easily obtained, and can be compactly arranged for transportation or for use in the field. (Fig 1.)

Collection of Samples

It is beyond the scope of this summary to discuss the mathematics of sampling, either in the field or in the laboratory, hence, if quantitative results of high accuracy are desired it is essential that the intricacies of sampling be thoroughly understood. However, it has been found that for ordinary qualitative studies it suffices to collect about a quart of unweathered chips from an area of several square yards of outcrop. Of course the number of samples and distribution thereof will be determined by the type of problem under investigation.

Heavy Kraft paper sugar bags of three pound size are con-

Figure 1.
Laboratory apparatus for the preparation of sediments for microscopic examination.

venient for field collecting; if used double these are strong enough for fragments of consolidated rocks as well as for sands. Field sample numbers should be written on the outside of the bag in about four places, with a soft pencil. If the bags are about half filled, the tops securely folded down, and the whole placed in another numbered paper bag, they will withstand transportation without damage when packed tightly in heavy cardboard cartons.

Storage of Field Samples

Upon arrival in the laboratory, each sample should be transferred to a permanent container and numbered or labeled, on both top of lid and side of carton, to correspond with the field numbers. Cylindrical, waxed cardboard, ice cream containers, quart size, make adequate and cheap storage receptacles.

Disintegration

Various techniques for the disintegration of consolidated sediments have been devised and described; each of these is suitable for a particular set of conditions. One that is rapid, convenient, and simple is crushing the sample in a steel mortar with a steel pestle. If available, a small jaw crusher can be used to advantage to break the larger fragments. Since the object of crushing is to reduce the consolidated rock to the original grain size of its constituents, a grinding motion of the pestle is to be avoided; likewise, long-continued pounding on the same material should be avoided. During the crushing process, the material should be sieved on a 20-mesh screen at frequent intervals. Fragments coarser than this should be returned to the mortar for further crushing—if composed of aggregates of smaller grains. About one half of the chips of the original quart sample should be crushed. Pint ice cream containers numbered to correspond with the field samples are handy for storing the disintegrated material.

Obviously, if samples of unconsolidated sediment have been collected, the crushing procedure is not applicable.

Washing

The crushed, or original unconsolidated, sample is reduced in volume to about 100 cc., either by simple quartering or by some apparatus such as the Jones sample splitter. This fraction is put into an 800 cc. beaker and water added with sufficient vigor to agitate the sediment thoroughly. When the depth of the water has reached 10 cm. the agitation is stopped and the sediment allowed to settle for one minute; at the end of this time the water and suspended sediment are decanted. This preliminary washing

is repeated once or twice, thus removing much of the material too fine for convenient identification with the microscope. The sediment in the beaker is then covered to a depth of about 2 cm. with dilute (6N.) hydrochloric acid and boiled until all limonite stain has been dissolved, after which the washing process described above is repeated, with settling periods of 30 seconds instead of one minute, until the water is clear at the end of a 30 second interval. The sediment is next transferred to a large aluminum pie pan (conveniently done by washing from beaker to pan with a laboratory wash-flask). After drying (on hot-plate, or merely in room), the washed sediment may be stored conveniently in manila envelopes (size: 3 inches by 5¼ inches, end opening) labeled with original sample numbers.

Sieving

When ready to make the heavy mineral separations, the washed acid-treated sample is sieved on a bolting cloth screen. Bolting cloth has the distinct advantage over wire screen in that it is readily cleaned between the fingers, thus eliminating danger of sample contamination. A short metal cylinder, about 8 cm. in diameter and 4 cm. deep, with a tight-fitting collar for holding the cloth is easily constructed. Bolting cloth with approximately 58 meshes per inch is most suitable and can be obtained from any flour mill. Grains retained on this screen are too large for convenient study and, furthermore, few heavy minerals are ordinarily found in sand as coarse as this. Grains settling through a 10 cm. column of water in 30 seconds and passing through a bolting cloth screen of 58 meshes per inch are the most desirable size for microscopic study and identification.

That portion of the sample passing through the bolting cloth should be reduced in volume to about 7 cc. before being separated into heavy and light fractions. This may be done by simple quartering, or more accurately by use of the Otto microsplit.

Heavy Liquid Separation

Separation into heavy and light fractions is speedily accomplished by means of the heavy liquid, bromoform ($CHBr_3$). This liquid may be purchased in the practical grade, having a specific gravity of 2.6, from the Eastman Kodak Company. In order to increase the density to 2.8, about 150 cc. of bromoform are put in a large beaker or jar and ten times this volume of water added and agitated vigorously for a few minutes, allowed to stand for a few hours, or until the bromoform has settled and the water is not cloudy; the water is poured off and the bromoform filtered through a coarse filter paper. The specific gravity of the bromo-

form may be determined exactly by means of a Westphal balance or approximately by some mineral with a density of about 2.8.

Numerous devices have been described for the separatory apparatus; of these, either of two simple ones are readily available and are easily manipulated. The most desirable one consists of a separatory funnel about 8 cm. in diameter at the open top with a glass stop-cock at the bottom. If the walls of the funnel are too steep, a large volume of bromoform is necessary per unit of surface area; if the walls are too flat, the heavy grains will come to rest on the sides before reaching the bottom of the funnel. Hence a funnel with an angle of slope of about 70° seems to be a good compromise. However, it is not a serious handicap if the exact type of funnel is not available.

The simplest of all types of separatory apparatus consists of an ordinary laboratory funnel about 8 cm. in diameter at the top, which has had the stem cut off to about 2 cm. in length, with a 5 cm. length of rubber tubing attached to this short stem. Flow through the funnel is controlled by a spring pinch-cock. When operating this apparatus, care must be used to prevent the retention of a few grains of the sample within the rubber tube, thus contaminating one sample with another.

Either type of apparatus should be supported in a ring-stand, the stop-cock closed, and the funnel filled to within about an inch of the top with bromoform (Sp.G. 2.8+). The small fraction of sand resulting from the final quartering of the sieved sample should be sprinkled slowly on the surface of the bromoform; gentle stirring with a glass rod will hasten the separation of the heavy minerals from the light ones. The former will sink through the bromoform and the latter will float on the surface. After an occasional careful agitation of the floating grains, the residue at the bottom of the funnel should be drawn off onto a coarse filter paper, previously labeled, folded, and inserted in a funnel. The bromoform passing through is allowed to collect in an Erlenmeyer flask, or wide-mouth bottle, for use in the next separation. This flask, funnel, and filter paper are removed and a duplicate set placed under the separatory funnel, after which the remaining bromoform and light grains are allowed to drain onto this second filter paper. After the bromoform has drained through the filter and into the flask, this flask is removed and an empty one substituted. Alcohol (90% ethyl), if available at low cost, or acetone, is then used to wash adhering light grains from the sides of the separatory funnel and to dissolve the bromoform from the grains and filter paper in the funnel below. This washing process is applied likewise to the filter paper containing the heavy minerals. Great care must be used to prevent any of the alcohol (or acetone) from entering the flasks containing the pure bromoform. The bromoform-alcohol (or bromo-

form-acetone) washings are collected in a large bottle for later purification. As bromoform is relatively expensive and both of the wash media are cheap, it is advantageous to wash funnels, filter papers, and sediments thoroughly. The washing process is best accomplished by the use of a laboratory wash-bottle containing the alcohol or acetone.

The bromoform can be recovered from the accumulated washings by the process previously described to raise the specific gravity of the commercial grade of bromoform. Because of its decomposition when exposed to light, the pure bromoform and bromoform washings should be stored in brown bottles.

Storage of Separates

The heavy and light separates are dried and carefully brushed from the filter papers into glass shell-vials to which have been glued small labels showing sample numbers. For sample sizes described herein, vials 7 mm., inside diameter, by 15 mm. in length, are convenient for the heavy separates and vials 12 mm. by 60 mm. for the light separates. These can be obtained, fitted with stoppers, from any laboratory supply company. They are easily filed, for future reference, in flat cardboard trays.

Mounting of Separates

Mounting of grains in Canada balsam requires some practice and careful technique. A few suggestions may be helpful to the beginner. The slides used should be the 25 mm. by 45 mm. size, the cover glasses round, 20 mm. in diameter, number 1 thickness. Several slides and cover glasses are placed on a moderately warm hot-plate and a small amount of liquid Canada balsam put in the center of each of two slides. By means of a tiny spatula a fraction of the heavy minerals of a sample is sprinkled uniformly over the surface of the balsam on one slide and a fraction of the light minerals over the balsam on the other. As volatilization of the balsam continues, the prongs of a pair of forceps should be inserted at intervals and the adhering balsam tested until it has a tacky consistency (not sirupy and not brittle) on the forceps. When this stage is reached, a warm cover glass should be grasped with another pair of forceps, the edge inserted at the edge of the balsam, and carefully lowered into place. The slide should be removed from the hot-plate immediately to prevent the formation of bubbles in the balsam. Gentle pressure with the finger on the cover glass will squeeze out excess balsam and distribute the grains uniformly. It is important that the balsam on the hot-plate does not become so warm that bubbles are formed and it is essential that it be warmed long enough to bring it to the proper consistency, tacky. Practice alone can make the beginner adept at mounting grains properly.

After the cover glass has been placed on the balsam and pressed into position, the slide should be labeled with the original sample number and appropriately designated L. M. (light minerals) or H. M. (heavy minerals). A diamond pencil is most satisfactory for this purpose.

When thoroughly cooled, the surface of the slides can be cleaned by scraping off most of the balsam with a knife blade and removing the remainder with a cloth moistened with benzene.

The slides are now ready for examination with the petrographic microscope.

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(# contains extensive bibliography.)

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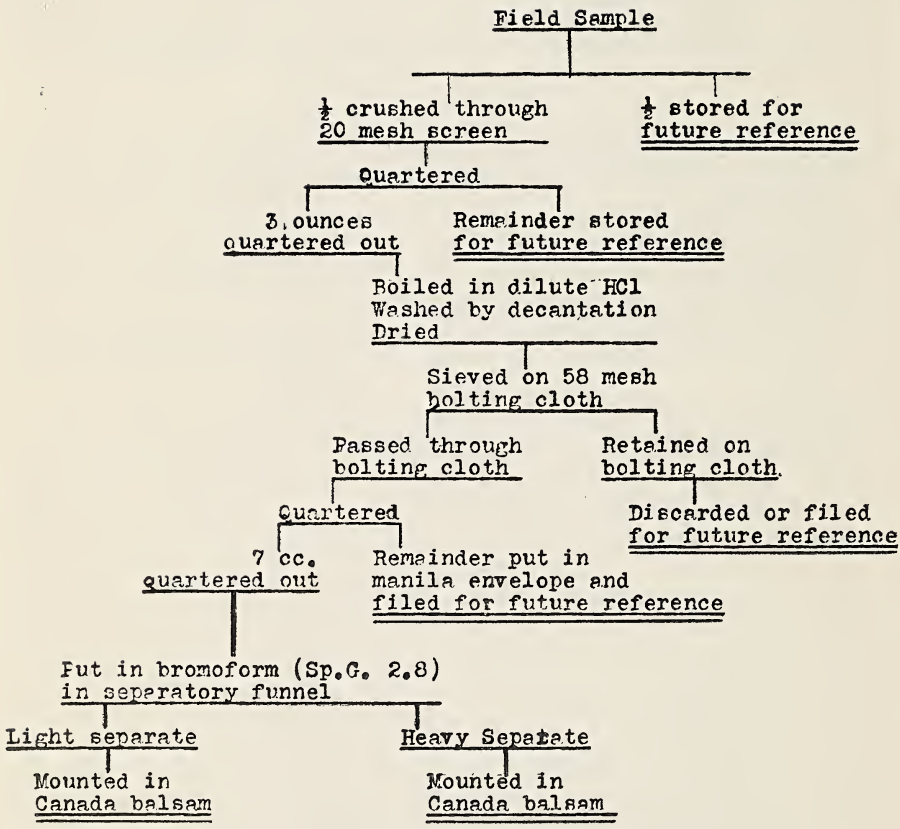
FLOW SHEET.


Field Sample
½ crushed through 20 mesh screen
½ stored for future reference
Quartered
3 ounces quartered out
Remainder stored for future reference
Boiled in dilute HCl
Washed by decantation
Dried
Sieved on 58 mesh bolting cloth
Passed through bolting cloth
Retained on bolting cloth.
Quartered
Discarded or filed for future reference
7 cc. quartered out
Remainder put in manila envelope and filed for future reference
Put in bromoform (Sp.G. 2.8) in separatory funnel
Light separate
Heavy Separate
Mounted in Canada balsam
Mounted in Canada balsam

The Faunal Zones of the Southern Appalachians*

J. J. Murray

One fine June morning about ten years ago three bird enthusiasts set out to climb Thunder Hill Mountain in the Blue Ridge of Rockbridge County, Virginia. We had two things in mind that early summer morning. In addition to the simple enjoyment of the multitude of mountain birds, with their appeal of color, song and moving grace, we proposed to make a survey of the changes in their distribution from the valley along the waters of the James to the rocky knob where at 4,000 feet Thunder Hill shoulders to the sky. This climb presents in five and a half miles of air line an amazing change in altitude of 3,250 feet.

By the time the sun begins to show over Piney and High Cock we are well on our way, field glasses slung about our necks and note books ready for the first entries. Birds have been busy since four o'clock but the first slanting rays of sunlight put new vigor into the morning chorus. In the wet thickets along Arnold's Creek the Red-winged Blackbirds, as if knowing that there is no more striking combination than a touch of color on plain black, are flashing scarlet epaulettes for their sober mates and singing a sweet, gurgling '*conkaree*'. Cardinals, the bit of black on their faces heightening rather than dimming the brilliance of the rosy plumage, are chanting their hymns to the sun, while their females, dressed more quietly but no less attractively in ashes of roses, appreciatively watch them. From every thicket comes the lilt of a Song Sparrow, and from every brush pile the ringing '*teakettle, teakettle, teakettle*' of a Carolina Wren. In a maple in a cabin yard a Yellow Warbler sings, '*sweet, sweet, sweet, sweeter than the sweet*'. On a dry hillside a Yellow-breasted Chat, clown of the bird world, is putting on a performance of shrieks and groans and whistles and cat-calls. Time would fail to tell of all the birds of the open valley country—sober Robins with brick-red breasts, Wood Thrushes and Indigo Buntings, respectable Towhees in black and brown and white, and, along the creek, Acadian Flycatchers and Louisiana Waterthrushes.

We pass Camp Powhatan and turn into the woods and up the mountain. At this point the altitude is about 1,200 feet. At once there is a change in the bird life. Naturally we leave behind the Red-winged Blackbirds of the marshy glades and the Song Sparrows of the thickets. We are in the woods now, and

*This paper, in its original form, was prepared for the Fortnightly Club of Lexington, Virginia, which accounts for the Rockbridge County localizations. Free use has been made of material from earlier papers on the same subject which have appeared in *The Raven*, journal of the Virginia Society of Ornithology.

those are birds of the open. Naturally, too, we meet the woods birds, the Red-eyed Vireo, the Hooded Warbler, the Black and White Warbler and others. We would have seen them down in Arnold's Valley, if we had turned aside into the forest. But another factor seems also to operate. We are beginning to climb now; and altitude seems to make a great difference. As we reach the 1,500 foot level the change is very noticeable. There are no Acadian Flycatchers or Louisiana Water-thrushes along the stream. We rarely see a Cardinal now. Some of our valley birds are still with us. Four of the most common—Indigo Bunting, Towhee, Brown Thrasher, and Ovenbird—will stay with us all the way to the summit. Two other common friends—Wood-Thrush and Red-eyed Vireo—will be with us nearly all the way. On still another, the Hooded Warbler, we can count for a thousand feet yet. To make up for our friends which do not have the stamina for this rough mountain country we now begin to make new acquaintances. As we step out into a little opening at the top of a cliff, where we can hear the tumbling stream far below and where we can smell the aromatic fragrance of the hemlocks, there comes from one of the evergreens a lazy, drawling song, '*zee, zee, zee, zu, zee*'. It is a little Black-throated Green Warbler, with yellow head, black throat, and greenish-yellow back. Suddenly a movement catches our eyes. We look up, and there, balancing on the topmost twig of a hemlock tree, is one of the most vivid of all birds, a Scarlet Tanager. He begins to sing, a loud, rather sharp and somewhat monotonous warble. The sight of that bird, brilliant scarlet but for black wings and tail, singing in the bright sunlight at the top of the evergreen none of us will ever forget.

Now we plunge into the cool, dark woods again. The trail, worn by many generations of mountaineer feet, is sunk deep between rocky, fern-covered banks. We turn aside for a few minutes to rest and to drink at Hunting Spring, where the cold water pours out from the roots of a giant dead chestnut and makes a pool almost big enough to bathe in. In places the trees thin out overhead to drop great blotches of sunlight on the trail. At such sunny spots birds are more common. At 2,000 feet we walk out into one of the loveliest spots in all this mountain country. A little stream that has just come rushing down from Petite's Gap is quieted here as it enters a level reach. There is just fall enough to make the water bubble about the big rocks and not too much for quiet pools where a pair of Wood Thrushes can bathe while they watch the nest in a nearby maple. Under the big hemlocks in the glade where a hundred men might camp there is a cathedral dimness and on the thick carpet of needles no footstep can be heard. The little stream plays a subdued air while a dozen different bird songs weave an obligato overhead.

New friends appear in the trees. Just overhead is the sharply inquiring but attractive warble of the Mountain Vireo, *'Yes; who are you; why are you here; what do you want?'* We are now at the place on this trail where the rhododendron begins to appear, and so we now hear the song of the Cairn's Warbler, the southern mountain race of the Black-throated Blue Warbler of the north. The song is energetic enough in the words of our translation, *'buzzzy-as-a-bee'*, but its lazy quality denies the words. More beautiful still is the sight of a Blackburnian Warbler, black and white, with flaming orange throat and breast. He is perched on a high branch of a dead chestnut tree, and, like the Tanager below, in bright sunshine.

We should like to spend the morning in this temple of the out-of-doors, but there is a long way to go and the hardest part of the trip is just before us. We climb the steep half-mile from the stream to Petite's Gap, turn to the right at the young white pine grove, and then begin the hard scramble through the brush to the shoulder of the big mountain. We have not left the gap before we add to our list the Rose-breasted Grosbeak, one of the finest of the mountain birds. The color combination is striking. Head, back and wings are black, but the spread black wings show large patches of white. Between the black head and the white lower breast is a rosy patch, from the center of which like dripping blood a streak of rose runs into the white below. The song is as notable as the plumage, a brilliant warble, intricate and beautiful and strong enough to be heard a quarter of a mile across a mountain hollow. Above here, probably because of the absence of evergreens, the Black-throated Green Warbler is scarce. The Hooded Warbler, too, is much less common now. The Cairn's and Blackburnian Warblers from here on are abundant.

At 3,000 feet we stop again, not only because it is lunch time and we need a rest, but because we cannot resist the beauty that halts us at a turn in the trail. Here the trees are larger and the shade more dense. Here the trail widens and nature has paved it with flat stones. Here a tiny spring breaks from a pile of moss-covered rocks and spreads by the path into a pool where glints of blue sky are reflected when the branches above open in the breeze and where the little creatures of the forest come to drink. And here all about us the rose-colored rhododendron is now in full bloom. We forget that we are trying to make a scientific study, and for an hour we sit and eat and rest and enjoy the beauty of foliage and color and song. Directly, from a tangle of rhododendron we hear a new song, light, tinkling, very intricate, very sweet. We sit perfectly still, while a little Canada Warbler comes out to the spring to drink and to bathe. During migrations this bird can be seen almost anywhere, but in

June when all Canada Warblers are nesting it would never be found much below the altitude of this spring.

Finally, a mile farther along the trail, a few hundred feet higher than the spring, and not long before we reach the top, we make the last two significant additions to our list, two birds of our highest mountain country. One is the Carolina Junco, or southern Snowbird. Some people think that the coming of the "snowbird" means the coming of snow, but nests of young Carolina Juncos can be found in June on almost any of our mountains above 3,000 feet. The last bird is the Veery, or Wilson's Thrush, found in Rockbridge only near the tops of the very highest mountains. In Camping Ridge Gap, between Thunder Hill and Apple Orchard, is another alluring spring, more in the open than the little spring we have just left. Here under the scattered oak trees the ferns and the high grass furnish a bed to the tired hiker. Here, stretched out at his ease, he can hear in the oaks about him from a half-dozen birds at once that most haunting and most ethereal of all our bird songs, the song of the Veery.

And now, to the point of all this—that is, in addition to the delight of a day in such places and with such birds—to the scientific point of all this. When we came to classify our notes for the day it became evident that Thunder Hill presents a very definite altitudinal succession of bird life. Some birds, such as the Indigo Bunting, Brown Thrasher, Ovenbird, and Towhee, are found in the valley and on the mountain top. Some, the Mockingbird and Cardinal, for example, are found only in the valley. The Acadian Flycatcher and Louisiana Water-thrush are found in the valley and on only the lower mountain reaches. The Hooded Warbler and the Redstart go from the valley about half-way up. The Wood Thrush and the Red-eyed Vireo go from the valley all or most of the way up. The Black-throated Green Warbler and the Scarlet Tanager begin on the lower reaches and continue most or all of the way up. Others, such as the Cairns's Warbler, Blackburnian Warbler, Mountain Vireo, and Rose-breasted Grosbeak, begin about half-way up and go then all of the way. Still others, particularly the Canada Warbler, Carolina Junco and the Veery, are found only near the top. This idea of an altitudinal succession in bird life became increasingly evident as during the succeeding years I took a score or more of climbs to the tops of other high mountains, to Apple Orchard, Rocky Mountain and Mt. Pleasant in the Blue Ridge; and to House Mountain, White Rock, Dale, Hogback, Jump, North Mountain and Elliott's Knob in the Alleghanies. Later on other and still higher mountains in Highland County, in Southwest Virginia, and in western North Carolina were explored, until I became familiar with the external facts of this altitudinal succession.

The next question is as to the *Why?* of this succession. Why are certain birds found only at certain elevations? The first and most obvious and in part correct answer is that as one climbs a mountain he passes through different kinds of territory—marshy stream margins, scrubby fields, open pastures, and woods of various types, conifers, hardwoods and low second growth. Obviously one does not find a Red-winged Blackbird on a dry wooded mountain shoulder; nor a Cardinal in primeval forest; nor Veeries in open pasture. One finds each bird in the habitat for which it is suited and which, therefore, it prefers. So true is this that it may be said that the number of birds which I can expect to find on any mountain trip, and the reason, for example, why I expect to find fewer birds on House Mountain than on Apple Orchard, was settled a million years ago in some past geological era. But this answer from type of habitat, while obviously true, is not at all sufficient. If it were, why, to mention but a few out of a hundred possible objections, is the Yellow Warbler so common in yards and parks at the foot of the mountains and yet not found in similar spots at Camp Kewanzee at 3,600 feet on Apple Orchard; or why is the Veery not found in the open type of oak woods which it loves when these woods occur down in the valley; or why is it that on Brushy Hill the two tanagers meet at a line drawn at about 1,500 feet, the Scarlet Tanager not straying far below that line and the Summer Tanager not venturing far above it, even though the type of woods which they both like are found on both sides of this invisible barrier? This habitat explanation is very important within the zones, which we shall discuss in a moment, but altogether insufficient as an explanation of the fact that there are zones. If a man familiar with the facts in the altitudinal distribution of birds were taken blindfolded to any place on any of our mountains and left there, still blindfolded, for half an hour, he could, just by listening to the singing of the birds about him, come very close to giving you the altitude of the spot. It is further interesting to note that one can get this same succession of bird life by travelling northward as by travelling upward. Longer distances must be travelled, to be sure. In order to find the birds one would get here by climbing the 1,000 feet to Petite's Gap, one must go to northern Pennsylvania; and in order to see Juncos or to hear Veeries sing one must go into New York or New England. As one discovers how closely the north and south distribution of birds can be correlated with their up and down distribution, and as one remembers that the chief thing that changes as one travels altitudinally or latitudinally is temperature, one is forced to wonder whether temperature is not an important, possibly even the dominant factor, in the distribution of birds and other animals.

Fifty years ago a scientist in government service in Washington was asking these same questions. And because his answers were so original, so comprehensive, so important, and yet at the same time so unsatisfactory in some respects a major section of this paper will be devoted to a discussion of his theories before coming back to Rockbridge County and the southern mountains. This man, Dr. Clinton Hart Merriam, was Chief of the Division of Ornithology and Mammalogy in the Department of Agriculture. Shortly afterwards, while he was still chief, this division became the Bureau of Biological Survey. In his field work in the mountains and particularly in the West he was impressed by this altitudinal stratification and determined to make a study of its nature and causes. In part his motive was practical, as it was felt that a knowledge of natural climatic areas, or zones, as they soon came to be called, would be of great assistance to farmers in planning their crops. Up to this time there had been great confusion in the minds of botanists and zoologists in regard to the biotic areas of North America. About 50 papers had been published, each one proposing its own zoogeographic scheme. Merriam, in summarizing these, was able to find at least a rough agreement on the division of North America into four biotic provinces: a Boreal province, stretching across the northern part of the continent; and three provinces reaching north to south, the Eastern, or Atlantic; the Central, from the eastern edge of the plains to the Sierra Nevada and Cascade Ranges; and a Western, or Pacific. To his mind, this classification was altogether unsatisfactory, and he set to work to study the question anew.

Merriam's work went through three phases, exploration, description, and theoretical explanation, although in a measure the three ran concurrently. The two classic papers for the study of this work are, first, "Results of a Biological Survey of the San Francisco Mountain Region in Arizona" (1890), an historic paper in the annals of North American zoogeography; and, second, 'Life Zones and Crop Zones of the United States" (1898). Each of these booklets had a colored map of life zones, a comparison of which is most interesting, both because of the development in the theory of life zones which is indicated and because of the curious fact that the first map, less under the influence of his idea of the transcontinental character of the zones, is more acceptable than the later to modern ecologists.

(1). Exploration. In 1889 Merriam and his assistants made a thorough biological survey of the San Francisco Mountain and nearby territory in Arizona, not far from the Grand Canyon. This mountain was chosen because of its southern position, isolation, great altitude, and proximity to an arid desert. Between the deserts of Arizona about its foot and its 12,794 foot

peak, covered most of the year with snow, are found all types of climate and of animal and vegetable life known from the west. Specimens were collected, with the result that some twenty new species and subspecies of mammals and many new plants and reptiles were discovered. Lists of all plants and animals found were carefully plotted according to altitude and type of locality. Seven distinct belts or zones were recognized on the mountain—an arid desert region, a pinon belt, a pine belt, a Douglas fir belt, an Engelmann's spruce belt, a narrow zone of dwarf spruce, and the bare area around the summit. The following year a much larger area of 20,000 square miles in Idaho was studied in similar fashion. In 1891 the so-called Death Valley Expedition surveyed an area of 100,000 square miles, which contained the lowest (Death Valley) and the highest (Mount Whitney) points in the United States.

(2). DESCRIPTION. As a result of these studies Merriam came to certain conclusions about the distribution of plants and animals. (a). There are in the mountains of the West certain life zones like the zones long recognized in the eastern part of the country. Each zone is characterized by a group of plants and animals not found *as a group*, even though some of the individuals might occur, in any other zone. (b). These zones are of transcontinental extent. This involved a radical change in the conception of the principles involved in faunal areas. Divisions are properly made not as one goes from east to west but as one goes from south to north. This implies a basic value in the temperature factor in the origin of zones. (c). The faunas and floras of North America are properly divisible into only two primary groups, and therefore into only two primary zoogeographic regions, a northern or Boreal, and a southern or Austral. (d). The final effort in the descriptive part of his work was the more accurate charting of the various life zones. In the paper of 1898 he made his final statement as to the limits and nomenclature of these zones. He recognized two primary regions, Boreal and Austral, each divided into three life zones, with an additional Tropical Zone covering only the tip of the Florida peninsula from Lake Okeechobee south.

In the *Boreal Region* there are three zones—the Arctic-Alpine, the Hudsonian, and the Canadian. (a). The *Arctic-Alpine Zone* includes the country, both latitudinally and altitudinally, which is above the limit of tree growth. (b). The *Hudsonian Zone* covers the northern parts of the great transcontinental coniferous forest, from Labrador to Alaska, and small areas at the tops of the higher mountains of the West. (c). The *Canadian Zone* covers the southern or lower parts of the transcontinental coniferous forest, reaching as far south as northern Michigan, Vermont, New Hampshire and Maine, and

along the summits of the higher Appalachians to the Great Smoky Park region. There are also extensive Canadian areas on the middle stretches of the western mountains. There are only traces of this zone in Virginia. This is the most northerly of the agricultural regions, where turnips, white potatoes and the hardiest cereals grow. Characteristic birds of this zone are the Brown Creeper, Golden-crowned Kinglet, Winter Wren, and Red-breasted Nuthatch; and in the north the White-throated Sparrow and Myrtle Warbler. The red squirrel is one of the characteristic mammals; and in the north the porcupine and the varying hare.

The *Austral* or Southern Region also has three zones, and since they concern us more nearly they will be described in more detail. The nomenclature of the Austral Zones is somewhat complicated by the fact that each zone has a general name and also specific names for the eastern humid and the western arid sections of the zone. (a). The *Transition Zone,* known in the east as the *Alleghanian,* covers the greater part of southern Michigan, Wisconsin, New York, New England, parts of Pennsylvania, the territory south along the mountains into northern Georgia, and large sections of the lower slopes of the western mountains. Practically all of the strictly mountain territory in Virginia belongs in this zone. As its name indicates, it is a transition region where boreal and austral elements overlap but where, however, the austral predominate. Into this zone the oak, hickory, chestnut and walnut push from the south to meet the hardy maples, the beech, birch and hemlock of the north. Here the Oriole, Catbird and Wood Thrush meet the Veery, Mountain Vireo and Junco. Here the gray squirrel, the southern mole and the cottontail meet the red squirrel, the jumping mouse and the star-nosed mole. Here apples and cherries, white potatoes, barley, oats and hay crops are at their best. (b). The *Upper Austral Zone* is known in the West as the *Upper Sonoran* and in our section as the *Carolinian Zone.* It is the zone of the middle states outside the mountains, reaching from the mouth of Chesapeake Bay to southern Connecticut, still farther north in the valleys of the Hudson and Connecticut Rivers, still farther south in the Piedmont country. Practically all of Virginia outside the mountains is in the Carolinian Zone; and it includes the floor of the larger mountain valleys. This is the country of the sassafras, the tulip tree (poplar), hackberry, and, away from the mountain influence, of the sweet gum. It is the country of the peach, apricot and quince, of tobacco and the sweet potato. Here the highest yielding varieties of corn and winter wheat flourish. Characteristic mammals are the opossum, gray fox and fox squirrel; while characteristic birds are the Cardinal, Carolina Wren, Titmouse, Gnatcatcher, and Yellow-breasted Chat. (c).

The last of these Austral zones is the *Lower Austral,* known in the west as the *Lower Sonoran,* but with us as the *Austroriparian.* It covers the greater part of the South Atlantic and Gulf States. It is further subdivided into *Louisianan* and *Floridian* sections, the latter being peculiar to Florida. In Virginia only the extreme southeastern corner of the state, around Norfolk and the Dismal Swamp, comes within this zone. Here the long-leafed pine grows in the sandhills, the live oak fringes the lowland rivers, cypresses shade the deep swamps, and the magnolia blooms in the cabin yards. Here the singing of the Mockingbird and the fragrance of the scuppernong on the heavy night air stir nostalgic longings in the heart of the expatriate who has come back for an autumn week. On the broad plantations flourish cotton, sugar cane, rice and peanuts. The Mockingbird, the Painted Bunting, the Red-cockaded Woodpecker, the Chuck-will's-widow, and the Prothonotary and Swainson's Warblers are characteristic birds.

(3). The last, and to his mind, most important part of Merriam's work was the THEORETICAL EXPLANATION. From the beginning he had felt that the factor of temperature was the critical one. Even in his first paper he could say that "temperature and humidity are the most important causes governing distribution, and that temperature is more important than humidity" (Merriam, 1890). His later work served only to develop that theory. Earlier workers who had tried to work out the outlines of zones by use of the temperature factor had failed because they studied the distribution of animals as if their spread had been in only one direction. The new element in Merriam's researches was the recognition of the fact that certain boreal species have been dispersed from the north southward, while Austral species have been dispersed toward the north. From this he inferred that the southward and northward dispersals, and therefore the southern and northern limits of any zone, are governed by two different sets of temperature factors. He selected almost *a priori* two sets of temperature factors, and then proceeded to check them with the known facts of distribution. They checked out so well that he did not find it necessary to make any drastic revisions in his assumptions. This in itself should have struck him as a suspicious circumstance that might well have cast doubt on his whole method. To put his line of attack in his own words, "the temperature selected as probably fixing the limit of northward distribution is the sum of the effective heat for the entire period of growth and reproduction . . . a minimum of 6° C. or 43° F. was assumed to represent the inception of the period of physiological activity in spring. . . . Beginning at 43° F., all mean daily temperatures in excess of this were added together. . . . When the sums of the positive temp-

eratures for a large number of localities in the United States were plotted on a large scale map it was found that isotherms (lines showing an equal quantity of heat) could be drawn that corresponded almost exactly with the northern boundaries of the several zones" (Merriam, 1895). In similar fashion in fixing the southern boundaries he assumed that the mean normal temperature of the hottest six consecutive weeks of summer was the critical temperature factor. From these assumptions, checked as best he could and platted with infinite pains, Merriam propounded his two Laws of Temperature Control of the Geographic Distribution of Animals and Plants: First, "The northward distribution of terrestrial animals and plants is governed by the sum of the positive temperatures for the entire season of growth and reproduction." Second, "The southward distribution is governed by the mean temperature of a brief period during the hottest part of the year" (Merriam, 1894).

For nearly fifty years these zone outlines and these temperature laws have been all but accepted as final by field naturalists. When one realizes the importance of the subjects and the magnitude of the assumptions involved, there is an amazing paucity of titles dealing directly with Merriam's work. There were good reasons, to be sure, for letting his work go unchallenged. It was a great accomplishment, and whether perfect or not a major piece of biological theorizing. It was of very practical value in field work. It had the weight of government support behind it. Then, too, testing Merriam's conclusions was made most difficult by the fact that he only gave the bare conclusions and nowhere published his computations. Although it is only within the present decade that definite attacks have been made upon his work, evidence was accumulating from many sources, primarily from the work of ecological botanists, to indicate that a reexamination of his conclusions was past due. For the purpose of such an examination we may arrange the details of his work into three groups: first, the temperature laws; second, the transcontinental character of the zones; and, third, the significance, if any, of his zones. I am arranging these three groups in what seems to me the order of their vulnerability.

The weakest part of Merriam's work is probably to be found in his temperature laws. Prof. Rexford F. Daubenmire of the University of Idaho (1938) has so well summed up the defects of this part of the work that we may quote some of his criticisms. "Neither field nor laboratory tests were made to substantiate the temperature hypotheses used as bases for the explanation of distribution. Inferences drawn from the very meager studies of a few organisms were assumed to hold true for all forms of life. The same threshold value (6° C.) was used for all species of plants and animals. . . . Each degree of temperature is assumed

to have the same significance. . . . The few detailed studies of temperature summation which have been made in recent years indicate that this idea is of no great significance in connection with plant growth." Kendeigh (1932) has shown that most temperature data give isotherms which roughly parallel latitudinal or altitudinal lines, so that Merriam could probably have gotten his correlation with biotic zones from almost any set of temperature data he had chosen. It has become increasingly clear that these particular temperature laws have little meaning.

Aside altogether from his specific temperature laws, the emphasis placed by Merriam upon the importance of temperature in general as a factor in distribution has been sharply attacked. It seems to me clear that he gave too much place to temperature as a solely regulative factor in distribution. The ecological relationships of any biota are entirely too complex for any one factor to be determinative. As an example, on twin mountains like White Top and Mt. Rogers, only a few miles apart in Southwest Virginia, with almost exactly the same altitude and therefore with the same temperatures, the same birds would be expected. Yet in several trips to this region I have found only one of three characteristic Canadian Zone birds on White Top, while all three were present in abundance on Mt. Rogers. The explanation seems to be that Mt. Rogers holds its moisture, while White Top is dry. E. N. Transeau (1905) has shown that centers of distribution are correlated with variation in the precipitation/evaporation ratio. My experience in trying to delimit the Canadian Zone in the Virginia mountains would certainly bear that out. However true all this may be, I believe that, as is so often the case in criticism, the pendulum has swung too far in the other direction, and that modern ecologists are disposed to minimize unduly the part played by temperature in geographical distribution. Temperature is clearly not the solely regulative factor. I still believe it to be a dominant factor.

Another feature of Merriam's work which has come in for a good deal of criticism is his insistence that these faunal zones are of transcontinental extent. This is undoubtedly true and easy to see as far as the Boreal zones are concerned, the Arctic-Alpine, Hudsonian and in lesser measure the Canadian. Is not that because these zones follow definite types of climatic climax vegetation? In the case of the Austral zones the transcontinental character is not so obvious. When it comes to carrying these Austral zones across the flat country of the Plains and of the Mississippi Valley, we reach an unnatural situation. As Daubenmire (1938) has pointed out, "if we compare the central grassland province of North America (as mapped by Weaver and Clements, 1929) with Merriam's map, we are immediately struck with the fact that this biotic entity is severed by Merriam into

three parts, each of which is linked up by him with one or more distinctly different types of climatic climax vegetation." In short, the zone idea cannot be unduly pressed. Particularly in broad, level regions, it must be supplemented by the sociological conception of plant-animal communities of modern ecology.

The last of Merriam's work to be examined is the significance of the idea of zones and the reliability of the maps made by him and his successors. None of the criticisms cited affect the practical value of the zone concept. Its correctness and its usefulness, particularly in mountain regions, is incontrovertible. Zonal maps, however, may call for considerable modification. Such maps are dependable only where they have been made on the basis of actual field work. It happens that this is the phase of faunal zone work of which I have most personal knowledge. Reliance on the temperature factor and its attendant factor of altitude alone has tempted workers to draw hypothetical maps, and thus has brought about the danger of error. As an example, a few years ago (in 1929) an expert field naturalist, who was Merriam's assistant in the first work on the San Francisco mountain, came to Virginia to make a deer survey of Bath and Highland Counties for the Virginia Commission of Game and Inland Fisheries. In his report he discussed the life zones of the two counties. He assigned about 75 per cent of the area to the Alleghanian Zone, as was quite correct. But he assigned the other 25 per cent to the Canadian Zone, as altitudes would lead one to expect, while he allowed only traces of the Carolinian. As a matter of fact any one who spends much time in these two counties will discover that the 25 per cent should have been assigned to the Carolinian Zone, while there is no Canadian at all in Bath and only a trace in Highland.

All of these criticisms and all of these reservations do not touch the importance and value of Merriam's work. He was a pioneer. His work, like the work of most pioneers, was faulty and premature in many respects. But it was a great, probably the greatest single contribution to zoogeography ever made in the United States. Where faulty it has stimulated other men to more thorough work. And, while his theoretical explanations have not stood the test of time, his descriptive work and his outline of faunal zones still have significance for field workers in America.

Some further discussion of these faunal zones as they affect Virginia and the southern Appalachians may have some interest. In Virginia and in the southern Appalachians generally the floor of the lower and broader valleys lies in the Carolinian Zone, which is the middle of the three zones of the Austral Region. In these valleys the Carolinian is not quite pure in character. Being separated from the main territory of the Carolinian by the

Blue Ridge, some of the characteristic but less hardy Carolinian birds, such as the White-eyed Vireo and Blue Grosbeak, are missing, as, of course, the many border-line Carolinian birds like the Prothonotary and Yellow-throated Warblers. It may be said roughly that the Carolinian Zone covers the valley floors up to 1,500 feet, and in open places sometimes rises to 2,000 feet, while in wooded ravines it may not extend higher than 1,200 feet. The upper boundary of this zone is tremendously affected by the density of vegetation and by the degree of the compass toward which the area faces. Along zonal boundaries the presence of any species of bird is much more dependent upon exposure and plant growth and upon the amount of sunlight received than upon altitude alone. The territory along the lower reaches of the mountains is a sort of no-man's-land where almost any of the birds, except the most high-ranging Alleghanian species, may be met with. In fact, the boundary line of any zone in a region like the southern Appalachians is a saw-tooth line rather than a straight-edge line. This complexity seems to be due to two characteristics of our territory: on the one hand, the occurrence even high on the mountains of cleared and inhabited places where crop land, open fields and scrub attract the open-land Carolinian birds; and, on the other hand, the occurrence of deep, dark, cool ravines, bordered by conifers, reaching down from the mountains to the borders of the larger lowland streams. As a consequence the boundary between the Carolinian and Alleghanian Zones is sometimes not so much a line as it is a cross-word puzzle. Roughly it may be said that the valley floor and the open country in Virginia is Carolinian, while all the mountain country except a few high summits is Alleghanian. Theoretically, judging, that is, by the altitude at which this zone ends in some of the states to the north of us, the Alleghanian should not go much over 3,000 or 3,500 feet at our latitude; but actually it goes as high in the central part of the valley as Apple Orchard and Elliott's Knob, which means close to 4,500 feet.

For some years in studying the faunal zones of the Virginia mountains my preoccupation has been with the Canadian Zone. In part this is because of all the zones which touch the South this zone is in our territory the most limited in extent. Also, it is because more misconceptions have been held about this zone in the South and more errors made in the effort to outline its boundaries than is the case with any other zone. In part, it is because the difficulties connected with studying this zone are greater. And, finally, it is because the wasteful activities of men have affected this zone more than any other. Virginia is in a particularly unfortunate position as regards a share in this interesting Canadian Zone. While there is a good deal of Canadian Zone territory on the high Alleghany plateau of West

Virginia, and a fair area of it on the great peaks of the Smokies along the North Carolina-Tennessee line, there is little or no territory in Virginia which can really be called pure Canadian. On White Top and Mt. Rogers, the two highest mountains of Virginia, which reach 5,519 and 5,720 feet respectively, and possibly on a few other high mountains in Southwest Virginia, we have some small areas which are practically Canadian; and on Middle Mountain in Highland County we have some territory which approaches it. That is about all we can boast.

The Canadian Zone, as seen in Virginia and in the southern Appalachians generally, is by no means a pure type of the Canadian. It should rather be recognized as a Southern or modified Canadian. It has often been pointed out that island spots or finger-like extensions belonging to any faunal zone are rarely typical. It has not been sufficiently well recognized that this is true of the whole southward extension of the Canadian Zone and even of the Alleghanian Zone along the mountains through Maryland, West Virginia, Virginia and the states farther south. As an indication of the modified character of the southern Canadian it may be pointed out that of the twenty-seven birds named by Dr. Frank Chapman as characteristic of the Canadian Zone there are fifteen which do not occur as far south as the West Virginia plateau.

Virginia once had considerably more Canadian Zone territory than she now has. The presence of northern conifers of the spruce-fir type seems to be a limiting factor in the presence of this zone. Since man has appropriated almost all of the original spruce areas for purposes which seem to some of us of less importance than the production of Hermit Thrushes and Winter Wrens, we now have only spots of this zone where we once had wide areas. That process of diminution is evident in the contrast between conditions on White Top as reported for us by naturalists who visited the mountain fifty years ago and the dryer, more open, and, therefore, less Canadian conditions to be found there now. On Middle Mountain the contrast is still more painfully evident between the magnificent spruce forest that stood there in 1900 and the pitiful remnants now to be seen. It may be noted that in the Southern mountains the influence of man, with his heavy foot and his sharp axe, is definitely to raise the altitude for both the Carolinian-Alleghanian and the Alleghanian-Canadian boundary lines, and thus definitely to lower the beauty content of our mountain country. As he clears the heavy forests on the mountain-sides and then burns the mountains over, he changes the character of the flora, reduces the ability of the soil to hold moisture, exposes the ground to the sun, and raises the average temperature; and all these changes together swing the pendulum from boreal toward austral conditions, and the more unfortunately not toward a natural austral

condition, which has its own characteristic beauty, but toward a crude and second-rate austral. Unhappily, man's destructive power is greater when he blunders into Canadian territory than anywhere else. Winter Wren habitats, those dark, wet moss-banks and fern brakes under the spruce woods, can be destroyed in a few days. They cannot be recreated, if indeed they can be restored at all, short of generations. Happily the United States Forest Service is doing something now to weight the balance in the other direction. Happily, too, a new attitude toward nature is beginning to develop in America. We are getting a new appreciation of our natural beauties of mountain and forest, of swamp and marsh and water, and a new sense of the value of living things, plant and animal, not only as they bestow food for our tables and clothing and shelter, not only as they furnish sport for our hunters and fishermen, but also as they provide color for those who have eyes to see, music for those who are sensitive to nature's melody, and that beauty of nature which next to faith and kindness brings peace and healing to spirits too long harassed by the tensions of civilization.

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Contributions of Virginians to the Geology of the State

Joseph K. Roberts

In this brief paper only the salient facts regarding native Virginians who have helped to mold geological thought of their state will be included, and contributions by those still living will be omitted. It is better to let some one at a future time report on the achievements of those who still live and work among us, for a complete record is essential for drawing proper retrospective and conclusion. It is best at the beginning to call to the attention of the reader that the present status of geological thought in Virginia has an historical background of something like two centuries. During this time there has been a gradual change in ideas modified by field studies and a better understanding of natural processes. Geological progress has been slow and especially so in the early years of America. It was impeded by many difficulties, and even today our opinions are not entirely purged of the doctrines of catastrophism and cataclysm. Many persons not native Virginians have made valuable contributions, surpassing some of our own geologists, but it is only possible to mention the names of a few of these without comments upon their achievements.

The progress made in geological thought in Virginia for the past two hundred years, as reflected by the literature, may be considered under four periods. The earliest of these periods may be well termed the Colonial period, which extends from the early days of the Virginia colony up to about 1835. The second is the Rogers period from 1835 to about 1880, the third is the Fontaine period from 1880 to about 1910, and the fourth is the Watson period from 1910 to the present. The discussion will not be concerned with the literature later than 1925. During the Colonial period the few opinions held by the better informed Virginians were those commonly accepted in England and continental Europe. Writers of this early period who have left us records are Col. William Byrd, Andrew Burnaby, Thomas Hutchins, Gen. Benjamin Lincoln, Marquis de Chastellux, Thomas Jefferson, James Greenway, Benjamin S. Barton, Henry Latrobe, Jonathan Williams, and Francis W. Gilmer. Among all the writers only two held anything like modern opinions as to the operation of natural processes; these were Latrobe and Gilmer. Thomas Jefferson who was a well-informed person of his time on geological thought is a fair exponent for study. His opinion as to the origin of the Natural Bridge of Rockbridge County clearly belongs to the age of catastrophism; he stated that this bridge was due to "convulsions of nature". Two decades later Francis

William Gilmer far in advance of his time, and at the age of twenty-six years, stated that this bridge was the result of solution and erosion of underground waters, an opinion accepted today with some details added. In 1799 Latrobe explained the origin of the Aquia sandstone as being formed by somewhat the same process as the sand dunes at Cape Henry, and it was he who first stated that the strand line had been as far west as Richmond. With the exception of these two writers, the ideas on causation in this Colonial period were mediaeval; all surface features were accounted for by sudden and revolutionary changes, acts of divine providence, and any cause other than by natural forces.

The year 1835 marks the turning point in geological progress not only in Virginia, but in America. In this year William Barton Rogers was chosen state geologist of Virginia, and accepted the appointment to the chair of Natural Philosophy at the University of Virginia. This unusual person directed geological investigation and dominated geological thought in Virginia for almost the remainder of the 19th century. With his unparalleled field work, and many contributions, the period of 1835-1880 has been named in gratitude to him. His joint work with his brother, Henry Darwin Rogers, on the origin and structure of the Appalachian Mountains, geological nomenclature, and origin of the heat in Warm Springs, these alone would have entitled the use of his name for this interval of time in the geology of the state. Other prominent contributors of the Rogers period were John Lyle Campbell, Timothy A. Conrad, Edward D. Cope, Major Jed. Hotchkiss, Sir Charles Lyell, Benjamin Silliman, Sr., and Michael Tuomey. During this period rational geology based upon observations gained the upperhand of catastrophic doctrines.

From 1880 to 1910 geological thought made little progress even with the good foundation set by Professor Rogers. Just a short while prior to 1880 the U. S. Geological Survey was organized, which was the turning point for the entire country. There were many contributors to the geology of Virginia during these thirty years, and to any one who has made a careful examination of the literature of this time, there is little doubt but that the outstanding student of Virginia geology was William Morris Fontaine. His contributions in the unexplored field of paleobotany entitles his name to be used for this third period. He was the pioneer student of fossil plants in Virginia and the South, and one of the four in this country. His interests went far beyond the bounds of Virginia. Other contributors of the Fontaine period were Major Jed. Hotckiss, John Lyle Campbell, Henry Donald Campbell, Marius R. Campbell, Charles R. Boyd, Arthur Keith, John J. Stevenson, J. P. Lesley, N. S. Shaler, W. J. McGee, N. H. Darton, William B. Clark, and Thomas L. Watson.

The current period began about 1910 soon after the reorganization of the Virginia Geological Survey. Since the late Thomas L. Watson was so intimately connected with the reorganization of the geological survey, and the geological reports and progress of this time, it is fitting that he be remembered in the name of this period. Associated with him were Edward W. Berry, Charles Butts, Albert W. Giles, Roy J. Holden, Heinrich Ries, Earl V. Shannon, George W. Stose, Stephen Taber, Francis B. Laney, and William B. Clark, the last two being deceased. No effort will be made to discuss the contributions later than 1925, though the present may be regarded as being a part of the Watson period. Since 1910 field methods have been advanced, and problems have been approached in a more scientific manner than ever before that time. The achievements of the early Watson period will continue for many years to be the stimulus to geological progress. The advance in ideas will be spoken of again in the biographical notices which follow.

Eight of the deceased Virginians have been selected for brief biographies. These are selected for noteworthy contributions as teachers and investigators. They have helped to pass along the ideas of one age to another, and with their observations they have handed the torch down with brighter light than they received it. Their labors are accepted with gratitude by all understanding Virginians, and any errors they may have made are more than compensated for by their sincere efforts in trying to accomplish something, often in the face of adversity, and by the inspiration they aroused in their contemporaries and posterity. All eight are native born Virginians except Professor Rogers and Major Hotchkiss, but so many years were spent in Virginia by these two pioneers that they are regarded natives of their adopted state.

William Barton Rogers, second of the four sons of Patrick Kerr Rogers and Hannah Blythe Rogers, was born in Philadelphia, Pennsylvania, December 7, 1806. His family moved from Baltimore to Williamsburg in the year 1819 where the father accepted appointment to the chair of Natural Philosophy in William and Mary College. William completed his courses in the Williamsburg institution, and had gone to Baltimore to teach. Shortly after the father's death in 1828, he was recalled to take his father's teaching duties. He remained at William and Mary College until he accepted the chair of Natural Philosophy at the University of Virginia in 1835. In this same year he was appointed state geologist of Virginia. His teaching position he held until 1853, but the geological survey organized in 1835 ended in 1841 as the state legislature did not appropriate funds for further investigation. While state geologist he and

his small but efficient corps of assistants traversed what is now Virginia and West Virginia, and he gathered the information which made his geological map and many reports of the Virginias possible. As teacher, investigator, and administrator he left his scholarly stamp on geological progress of Virginia, and especially upon the Appalachian region. It was largely through his ingenuity that rational geology replaced the catastrophic doctrines, which had been introduced from Europe. His seven annual reports to the Virginia legislature for the years 1835-41 are masterpieces of their kind. Some of his major contributions have been mentioned above, and in addition to these are his studies on the downward increase of temperature in the earth, the Triassic coal fields near Richmond, "Infusorial Earth", and in all some forty papers. These without doubt set the pace for geological investigation not only in the Virginias but throughout the Appalachian states. So well was the foundation for stratigraphy planned by the Rogers brothers that the principle is still secure. After leaving Virginia in 1853, most of his time was taken up with planning for a technological school in which interested students might have the opportunity to work with apparatus in a laboratory and not have to watch abbreviated experiments from the lecture desk. Finally his teaching and administrative genius made possible the establishment of the Massachusetts Institute of Technology in which its founder was Professor of Physics and twice President. He served the Institute faithfully from its beginning to the day of his death which took place while delivering the commencement address on May 30, 1882. For nearly half a century he wrote on problems he investigated in Virginia where he lived for thirty-one years. William Barton Rogers was an unusual person in many ways and his greatest teacher seems to have been himself. Without any special training his work in geology still remains of the highest type, and of the same character were his powers in the class room and in administration.

John Lyle Campbell was born near Lexington, Virginia on December 7, 1818, the second son of Robert Smith Campbell, and Isabella Paxton Campbell. The father with a family of eight children moved to Lexington in order to provide better educational facilities for his children. After graduation at Washington College John L. Campbell taught in Staunton, Virginia, and in Kentucky. In 1851 he was recalled to Washington College as Robinson Professor of Chemistry and Geology, which he held until his death on February 2, 1886. It was his good fortune while in Lexington to be associated with Generals Stonewall Jackson and Robert E. Lee. Professor Campbell was an intimate friend and co-worker with Professor William Barton Rogers of whom he wrote a splendid eulogy. Professor Campbell

published a fine textbook of agriculture in 1859 but this was prevented from merited use by the four years of conflict of 1861-65. He was interested in all phases of geology, and made important contributions in the fields of meteorology, economic geology, mineralogy, and stratigraphy. His principal contribution to Virginia was "The Geology and Mineral Resources of the James River Valley, Virginia". During his life he published thirty papers bearing on geology of Virginia, and others on sections outside of the state. Professor Campbell was an excellent teacher, known for his ability, simplicity in the presentation of his subject matter, kind but firm attitude towards his students, and his remarkable industry. He was familiar with the Valley, Appalachians, Blue Ridge, and the Piedmont. Like his contemporary, Professor Rogers, he had little training in geology, but what he learned in college, he learned well. For the opportunities he had while a student he really accomplished wonders. His busy life and modesty largely kept other naturalists from knowing him. He was interested in the training of young men and during the four years of the war between the states he and three of his colleagues kept Washington College open to students. In all his teaching and administrative activities he managed to find time for investigations. He was succeeded by his son, Dr. Henry D. Campbell.

William Henry Ruffner was born near Lexington, Virginia, on February 11, 1824, son of Rev. Henry Ruffner and Sara Lyle Ruffner. His father came to America from Switzerland. The son was graduated from Washington College with the class of 1842, and received his Master's degree three years later while his father was President of Washington College. William H. Ruffner was a person of many interests, a minister, teacher, geologist, and administrator. During his busy life he always found time to study and write about the natural resources of Virginia and other sections of country. Most of his geological reports were on sections of country outside Virginia. One long report in collaboration with Professor John L. Campbell was written on Georgia Pacific Railroad lines through Georgia, Alabama, and Mississippi. Another he prepared after considerable study on the Seattle and Eastern Railway in the state of Washington. Dr. Ruffner was the pioneer in studying the cement resources of Virginia and was the first to realize the possibilities of water power. He wrote several prospectuses on mineral properties of Virginia. On the basis of his accomplishments he was appointed State Superintendent of Public Instruction of Virginia in 1870, the first appointment to this newly-created office. Like his friend, Professor John L. Campbell, he took no part in petty politics and after twelve years he retired from public office. He

was appointed first president of the State Normal School at Farmville in 1884, and held this position until 1887 when he resigned. Dr. Ruffner laid the educational plans for Virginia along broad and cultural lines. His thorough training gained while a young man is expressed in his philosophy of later years, "learn a few things and learn them well"; this is a slogan we all might well return to at present. In his modest way he added to our sum total knowledge of geology; he was a clear thinker, and interpreted natural processes from what he observed going on in the field, and did not carry worn out ideas of two centuries back of his time merely for tradition's sake. Dr. Ruffner died at the home of his son-in-law, Dr. Robert F. Campbell, in Asheville, North Carolina on November 24, 1908. The writer is grateful to Dr. Robert F. Campbell, Pastor Emeritus of the First Presbyterian Church of Asheville for much of the information on his father, Dr. John Lyle Campbell, his father-in-law, Dr. William Henry Ruffner, and his brother, Dr. Henry Donald Campbell.

Major Jedekiah Hotchkiss was born at Windsor, New York, November 30, 1828, son of Samuel, and Lydia Beecher Hotchkiss. He died in Staunton on January 17, 1899. Major Hotchkiss came to Virginia in 1847, and spent the remainder of his life in his adopted state. He taught school in Augusta County up to 1861, and at the outbreak of hostilities he joined the cause of the Confederacy. In military service he soon became Chief Topographical Engineer on the staff of General Jackson, and after Chancellorsville he was attached to the staff of General Ewell, and later to General Early. His first friend he made in Virginia, Mr. Henry Forrer, owner and operator of an iron smelter near Luray, inspired in him an interest in Virginia's mineral resources. After the close of the war between the states Major Hotchkiss returned to teaching, but in 1868 he opened an office in Staunton as consulting Topographical and Mining Engineer. His travels took him over much of Virginia and West Virginia, and in 1880 he began publishing a monthly magazine devoted to the promotion and development of the mineral resources under the title of *The Virginias*. This ran through six volumes, 1880 to 1885, and due to financial difficulties, it was merged with *The Industrial South* in Richmond in 1886. His first contribution, "Virginia: A Geographical and Political Summary . . ." was published in 1876 by the Board of Immigration in Richmond. Major Hotchkiss was one of the leaders in the opening of the Pocahontas coal field. He published and edited many articles in *The Virginias,* which was a sound and dignified way of advertising the mineral wealth of Virginia. He was the moving spirit in bringing to Staunton the American Institute of Mining Engineers in 1881. He made several county

maps on a large scale, and many small maps of portions of the state showing the extent of mineral properties. He was the first to print the geological map of Virginia by Professor Rogers; this map was ready in 1842, but it never appeared until 1876 in the above mentioned contribution, and in its final form it never came out until 1884. For geological advice Major Hotchkiss depended largely upon Professor Rogers and John L. Campbell, and to them he was always careful in giving credit. No Virginian has ever surpassed Major Hotchkiss in service to the state in encouraging the development of the mineral resources. He did this at a time when Virginia and the South were in the throes of reconstruction, and in some way he managed to avoid enmity of the readjustors. He was sent to England and to many expositions as commissioner to advertise the mineral resources of Virginia. Rogers-Campbell-Hotchkiss formed the great triumvirate of geology in Virginia in the 19th century.

William Morris Fontaine, son of James Fontaine, and Juliet Morris Fontaine, was born in Louisa County, Virginia, on December 1, 1835. He was a lineal descendant of Jean de la Fontaine, a Huguenot martyr at La Mans, France, in 1561. Professor Fontaine was educated at the University of Virginia where he received his Master's degree in 1859. After service in the Confederate Army, he attended Freiberg Mining Academy. Upon his return to America, he accepted a professorship in West Virginia University where he taught from 1873 until called to the University of Virginia in 1879. He was retired on the Carnegie Foundation in September, 1911, and died at Charlottesville, April 30, 1913. Professor Fontaine published extensively on Virginia in the various fields of geology, and several papers on regions outside the state. He was one of the early workers in the field of fossil plants in America, and pioneer paleobotanist in Virginia and the South. In 1883 his first major contribution was published as Monograph VI by the U. S. Geological Survey; this was a description of the older Mesozoic fossil plants (Triassic). This was followed in 1889 by Monograph XV on the plants of the younger Mesozoic or Potomac Group (Lower Cretaceous). In Monograph XV three hundred and sixty plants are described. He also contributed to mineralogy and stratigraphy as well as to economic geology. He was a person of prodigious energy, quiet, and retiring, and mentally honest as he was capable. To his storehouse of knowledge students and colleagues were always welcome, but it was not his desire or custom to advance information. Some of his detailed work on the fossil plants has been modified, but in his major premises he was secure and much in advance of the thought of his time. He is the important link between the Rogers and Watson periods, and at the end of his

service geology was richer by his efforts, for he added to what he had received valuable facts, which removed American geology from the older ideas of the Colonial period.

CHARLES RUFUS BOYD, son of Thomas J., and Margaret A. Boyd, was born in Wytheville, Virginia, on October 31, 1841. Except for the time he spent in the Confederate Army, and at the University of Virginia, Captain Boyd lived in Wytheville all his life where he died in 1903. It was his good fortune to come in contact with Colonel Claudius Crozet from whom he received inspiration to become a civil engineer. He was proficient in his work at Charlottesville as stated in the Catalogue of the University of Virginia of 1873-74. From 1874 to 1900 he was engaged in consulting work at Wytheville, and few areas in southwestern Virginia and western North Carolina were omitted in his travels. His territory was more restricted than that of most of his contemporaries, but no one ever had the development of southwestern Virginia so much their concern as Captain Boyd. After intensive field work for which he hardly received a living wage, he prepared a manuscript, "Resources of South-west Virginia", which was published by John Wiley & Sons, New York in 1881. This was concerned with all of the counties in southwestern Virginia west of New River, with the Great Gossan Lead, and parts of North Carolina as far west as Cranberry. He was called upon often by the state departments to supply material on mineral resources, and to act as commissioner at expositions. He was one of the first to urge the reorganization of a geological survey, but did not live to see this done in 1908. Captain Boyd faithfully followed the stratigraphical scheme of the Rogers brothers to whom he gave due credit. His methods of mining promotion and development were sound, and his interest in southwestern Virginia meant much for this section as it came at a time when the need was urgent. He left many incomplete maps and unpublished reports, and is gratefully remembered as a modest scholar who only sought to learn, and promote the interests of his section of Virginia, and not popularity of his day.

HENRY DONALD CAMPBELL, one of the ten children of Dr. John Lyle Campbell, and Harriet (Peters) Bailey Campbell, was born July 29, 1862 on the campus of Washington College, Lexington, Virginia. Except for the time spent in Germany following his graduation at Washington and Lee University in 1885, his life was spent on the campus of his alma mater, until his death on April 10, 1934. Dr. Campbell grew up under the tutelage of his father, and he stated that he became a geologist both by heredity and environment. Before his father's death in 1886, the two had begun studies in the the Piedmont and Blue Ridge,

which led to the recognition of Cambrian rocks in the basal Paleozoic along the western foothills of the Blue Ridge, and for the first time in the Piedmont. Dr. Henry Campbell identified the Potsdam sandstone-quartzite in James River section from *Scolithus linearis*. With his father he was the first to identify the Cambrian in the Piedmont of Amherst County, which Rogers and Fontaine had regarded as Huronian. He was the first to begin breaking away from the older stratigraphical units in use in the Valley of Virginia, such as the Knox dolomite, Shenandoah limestone, etc. In 1905 he proposed the Liberty Hall and Murat limestones of Ordovician age and Buena Vista shale and Sherwood limestone of Cambrian age. Few people have lived in the Great Valley who knew its resources and geology better. In his late years he was interested in the diabase and related dikes. From the time he succeeded his father in 1886 to the time of his death, forty-seven years, he taught many hundreds of students at Washington and Lee University, which institution he served as teacher in geology and biology from 1886 to 1920; geology, 1920 to 1934; Dean of the College, 1912 to 1932, and Acting President for part of the year 1912. With the termination of his service ended the connections of the Campbell family of seven generations with Washington and Lee University, and the fine service of two generations of this family to the geology of Virginia. John L. and Henry D. Campbell, father and son, geologists, teachers, and administrators occupy unique places in the annals of Virginia Geology. They lie buried beside each other and near the last resting place of General Thomas J. Jackson in Lexington cemetery.

Thomas Leonard Watson, the last character of these brief sketches, eldest son of six children of Fletcher B. Watson and Pattie Booker (Treadway) Watson, was born at Chatham, Virginia, September 5, 1871. Except for the two years at Cornell University, three years on the Georgia Geological Survey, and three years teaching at Dennison University, his life was spent in his native state. He taught at his alma mater, the Virginia Polytechnic Institute, from 1904 to 1907, and came to the University of Virginia in the fall of 1907 as professor of economic geology. In 1908 the Virginia Geological Survey was organized and he became state geologist; these two positions he occupied until his death on November 11, 1924.

Dr. Watson served sixteen years as state geologist, and twenty years as teacher in Virginia's institutions. His final preparation in geology was done at Cornell University (1895-97), where he received his doctorate in June, 1897. He did a considerable amount of work in Georgia, and North Carolina. He began his studies in Virginia about 1900. During his tenure as state

geologist he projected the plans for and edited twenty-four reports and at the time of his death several others had been planned and field work well-near completed on some. Several of these bulletins he prepared himself or collaborated on with others. In 1911 he published the second geological map and at the time of his death was planning to prepare a revised edition. His fields of interests were mineralogy, petrology, and economic geology. One of his best contributions was "Mineral Resources of Virginia" of 1907, distributed at the Jamestown Exposition. This was a masterpiece of compilation with some of his observations and investigations of others. To organize a survey after a lapse of sixty-seven years, and gain the confidence of the legislature was no small adventure. It could not have been accomplished without the loyalty of an understanding commission, sympathetic members in the legislature, and an efficient office force. In his bibliography will be found eighty maps, some of which were adapted from topographic maps of the U. S. Geological Survey, and these were used to illustrate the papers he published. Up to 1910, Professor Watson published papers under thirty-one titles and since that time seventy papers, thus making a total of one hundred and one contributions. His papers cover the entire fields of geology; least, however, was his interest in paleontology. The success of the Virginia Geological Survey was due to his wisdom in securing the services of well-trained geologists, faithful cooperation with the U. S. Geological Survey, and close supervision of field work. He had advantages which were unknown in the days of Rogers. In 1908 some of Virginia had already been mapped on a scale of 1:125,000 and a few geologic folios had been completed. It was possible to get a better base map which was not available prior to 1900. By 1924 much of Virginia had been mapped on scales of 1:125,000 and 1:62,500 and the status of geological progress in this fourth period was left in an excellent condition with much yet to be done, but a better foundation on which to build. Dr. Watson's part in the progress of one hundred years of Virginia geology in the first quarter of the twentieth century merits recognition very close to that of the first state geologist of 1835-1841. Virginia will ever owe a debt of gratitude to the eight geologists mentioned above, and for years to come their labors and results will continue to inspire further and more extended studies upon the ever-expanding earth sciences.

There are many others who have made valuable contributions toward the solution of problems in geology, but the above Virginians have earned the rank of exponents from their achievements. The people of Virginia have been brought to know something of the mineral resources and it remains for the

public to understand the historical events which have transpired during the making of this section of eastern North America. Nowhere in the domain of human endeavor is evolution of thought better illustrated than is reflected in the geological literature of Virginia. Even though a century has passed we have not cleaned house sufficiently to rid it of all the mysticism of the Colonial period when causes were explained by catastrophes and cataclysms of nature and natural processes remained largely unexplored. Yet upon the survey of the past we are due to be grateful for the progress made and at the same time keep the torch of knowledge so oriented that it will illuminate the road ahead and not so much behind us, for half a century from the present holds problems we must prepare to approach even though we may know little or nothing of their nature now.

UNIVERSITY OF VIRGINIA.

Early Winter Food of Ruffed Grouse on the George Washington National Forest*

A. L. NELSON, TALBOTT E. CLARKE AND W. W. BAILEY

This study embraces the findings of the first two years of a five-year study of the food habits of the ruffed grouse *(Bonasa umbellas)* on the George Washington National Forest (Virginia and West Virginia), one of the largest and most important forest game areas in the eastern United States.

Only the early part of the winter is covered in this report, since adequate material was available only for the months of November and December, the period in which the birds were legally hunted in 1935 and 1936. Most of the crops and gizzards studied were taken from birds killed by hunters. The later winter months and other seasons of the year will be covered by subsequent investigations. Stomach material for the out-of-season period will be accumulated, more slowly, of course, as only a few birds will be obtained each month. This report is presented in advance of completion of the project in order that what has now been learned may be made available and utilized in determining current forest game-management practices.

MATERIAL AVAILABLE

Since the food habits of birds and most other animals are best determined by examining their stomach contents, this method was followed in the present study. Complete food analyses were made of 184 crops and 107 gizzards of 185 ruffed grouse taken during November and December 1935 and 1936. Measure-

*Condensation of U. S. Department of Agriculture Circular No. 504.

ments of the volume of each item were then made, and on the basis of these figures comparative percentages were calculated to show what each contributed to the total. The material serving as a basis for the study came from various parts of the Forest, principally from the Shenandoah Mountain range. The collections were obtained by members of the Forest Service, from hunters through the use of Civilian Conservation Corps enrollees stationed during the hunting season near the main entrances of the Forest.

Present Forest Conditions

Approximately 91 per cent of the George Washington National Forest has been cut over during the past 100 years. The present composition may be divided according to age classes as follows: Open land, 0.5 per cent; 0 to 20 years, 26; 21 to 40 years, 49; 41 to 80 years, 12; 81 to 120 years, 3.5; 121 years or older, 9 per cent. The forest type is commonly known as Appalachian hardwood. The stand consists largely of deciduous species with occasional patches of conifers. The elevation of the ridges is from 1,500 to 4,500 feet above sea level.

In many places there is little or no subsoil, the surface soil directly overlying bedrock. In some sections the slopes are covered with boulders or rock slides, and in others with numerous rock outcroppings or ledges. The drier sites on the ridges are covered for the most part with bear oak and associated species, consisting of scarlet, black, red, and chestnut oaks, black locust, pitch, shortleaf and table mountain pines, and chinquapin. The dry slopes and flat ridges support mixed stands of hardwoods, composed chiefly of chestnut oak, black and scarlet oaks, black gum, black locust, and shagbark and mockernut hickories.

The deep fertile soils, as found in coves on north slopes, support mixed stands of northern hardwoods, typical species being sugar maple, red maple, yellow birch, red and white oaks, basswood, black cherry, hemlock, and white pine.

The 20 Most Important Food Plants

Although 98 foods are listed in Table 1 as being utilized by grouse, only about a fifth of these are important from the standpoint of the bulk they contributed. Since availability is a major factor influencing selection, however, and since any number of factors are constantly operating to alter food conditions from year to year, some of the foods listed below the first 20 in Table 1 might become important to the ruffed grouse or even a major source of its food in some areas.

Food	Volume in total food	Stomachs in which found	Parts used
	Per cent	*Number*	
Greenbrier (*Smilax* spp.)	16.29	110	Leaves and fruit.
Oak (*Quercus* spp.)	10.62	56	Acorns and buds.
Grape (*Vitis* spp.)	9.00	29	Fruit.
Mountain-laurel (*Kalmia latifolia*)	7.85	89	Leaves, buds, and flower capsules.
Wintergreen (*Gaultheria procumbens*)	6.11	71	Leaves and fruit.
Sheep sorrel (*Rumex acetosella*)	4.85	54	Leaves.
Blueberry and huckleberry (*Vaccinium* spp. and *Gaylussacia* spp.)	4.17	84	Buds and twigs.
Rose (*Rosa* spp.)	3.85	74	Fruit.
Fern (principally *Polystichum acrostichoides*)	3.54	46	Leaves.
Aster (*Aster* spp.)	3.33	80	Do.
Viburnum (*Viburnum* spp., chiefly V. *prunifolium* and *V. acerifolium*)	2.67	16	Fruit.
Pussytoes (*Antennaria* sp.)	2.32	54	Leaves.
Partridgeberry (*Mitchella repens*)	1.89	36	Fruit and leaves.
Sumac (*Rhus* spp.)	1.39	19	Fruit.
Menziesia (*Menziesia pilosa*	1.31	42	Buds.
Hazelnut (*Corylus* spp.)	1.22	17	Buds and catkins.
Trailing-arbutus (*Epigaea repens*)	1.19	24	Flowers, buds, and leaves.
Serviceberry (*Amelanchier canadensis*)	1.08	24	Buds.
Hawthorn (*Crataegus* sp.)	1.06	20	Fruit.
Selfheal (*Prunella vulgaris*)	.93	37	Leaves.
Rhododendron (*Rhododendron* sp.)	.93	31	Buds.
Birch (*Betula* spp.)	.92	21	Buds and catkins.
Hophornbeam (*Ostrya virginiana*)	.85	7	Buds, catkins, and seeds.
Avens (*Geum* spp.)	.80	23	Leaves and seeds.
Stonecrop (*Sedum* spp.)	.78	26	Leaves.
Hepatica (*Hepatica* spp.)	.67	18	Do.
Grass (Gramineae)	.49	55	Do.
Corn (*Zea mays*)	.49	1	Seeds.
Clover (*Trifolium* spp.)	.47	10	Leaves.
Alumroot (*Heuchera* spp.)	.46	12	Do.
Goldenrod (*Solidago* spp.)	.44	22	Do.
Cinquefoil (*Potentilla* spp.)	.43	55	Do.
Bramble (*Rubus* spp.)	.41	22	Do.
Buttercup (*Ranunculus* spp.)	.41	19	Do.
Apple (*Malus* spp.)	.41	3	Buds.
Barren Strawberry (*Waldsteinia fragarioides*)	.34	4	Leaves.
Witch-hazel (*Hamamelis virginiana*)	.32	41	Seeds, flowers, and buds.
Polygala (*Polygala* spp., chiefly *paucifolia*)	.31	14	Leaves.
St. Johnswort (*Hypericum* spp.)	.30	3	Do.
Dogwood (*Cornus* spp.)	.28	40	Buds and seeds.
Plantain (*Plantago* spp.)	.28	9	Leaves.
Holly (*Ilex*), deciduous species	.28	4	Fruit.
Bushclover (*Lespedeza* spp.)	.27	28	Seeds and leaves.
Bedstraw (*Galium* spp.)	.24	16	Do.
Foamflower (*Tiarella* spp.)	.23	8	Leaves.
Vetch (*Vicia* spp.)	.22	10	Do.
Speedwell (*Veronica* spp.)	.21	21	Do.
Wild carrot (*Daucus carota*)	.21	14	Do.
Maple (*Acer* spp.)	.19	25	Fruit and buds.
Black Gum (*Nyssa sylvatica*)	.19	20	Do.
Virginia creeper (*Parthenocissus quinquefolia*)	.18	2	Fruit.
Elm (*Ulmus* spp.)	.16	2	Buds.
Dandelion (*Taraxacum* spp.)	.12	20	Leaves.
Hawkweed (*Hieracium* spp.)	.11	22	Do.
Saxifrage (*Saxifraga virginiensis*)	.06	3	Do.
Everlasting (*Gnaphalium* sp.)	.05	2	Do.
Chokeberry (*Pyrus* spp.)	.05	2	Fruit.
Wildginger (*Asarum* sp.)	.05	1	Leaves.
Chickweed (*Stellaria media*)	.04	5	Do.
Thistle (*Cirsium* sp.)	.04	4	Do.

TABLE 1.—*Early winter plant foods of ruffed grouse on the George Washington National Forest, based on examination of crops and gizzards of 185 birds, showing volume, frequency with which taken, and part used*

Food	Volume in total food	Stomachs in which found	Parts used
	Per cent	*Number*	
Heartleaf (*Ampelopsis cordata*)	.04	1	Fruit.
Spicebush (*Benzoin aestivale*)	.04	1	Buds and twigs
Alder (*Alnus* sp.)	.04	2	Buds and catkins.
Strawberry (*Fragaria* sp.)	.03	10	Leaves.
Agrimony (*Agrimonia* sp.)	.03	2	Seeds.
Tickclover (*Desmodium* sp.)	.03	2	Do.
Willow (*Salix* sp.)	.03	1	Leaves.
Black snakeroot (*Sanicula* sp.)	.03	1	Seeds.
Rhynchosia (*Rhynchosia* sp.)	.03	1	Do.
Horsenettle (*Solanum carolinense*)	.03	1	Fruit.
Bluet (*Houstonia* spp.)	.02	14	Leaves.
Sedge (principally *Carex* spp.)	.02	7	Do.
Evening-primrose (*Oenothera* sp.)	.02	6	Do.
Zizia (*Zizia cordata*)	.02	3	Do.
Meadowrue (*Thalictrum* sp.)	.02	2	Do.
Violet (*Viola* sp.)	.01	8	Leaves and seed capsules.
Fleabane (*Erigeron* spp.)	.01	8	Leaves.
Hickory (*Carya* spp.)	.01	4	Nuts.
Meadow-parsnip (*Thaspium barbinode*)	.01	3	Leaves.
Pyrola (*Pyrola* sp.)	.01	2	Do.
Cherry (*Prunus* spp.)	.01	2	Buds.
Groundsel (*Senecio* spp.)	.01	2	Leaves.
Chicory (*Cichorium intybus*)	.01	1	Do.
Deadnettle (*Lamium* sp.)	(1)	4	Do.
Hornbeam (*Carpinus caroliniana*)	(1)	3	Buds.
Eupatorium (*Eupatorium* sp.)	(1)	3	Leaves and seeds.
Jersey-tea (*Ceanothus americanus*)	(1)	2	Leaves.
Angelica (*Angelica villosa*)	(1)	2	Do.
Beebalm (*Monarda* sp.)	(1)	2	Do.
Beech (*Fagus grandifolia*)	(1)	1	Buds.
Peppergrass (*Lepidium virginicum*)	(1)	1	Leaves.
Black locust (*Robinia pseudoacacia*)	(1)	1	Seeds.
Mock Pennyroyal (*Hedeoma* sp.)	(1)	1	Do.
Mint (*Mentha* sp.)	(1)	1	Do.
Cowwheat (*Melampyrum* sp.)	(1)	1	Do.
Japanese honeysuckle (*Lonicera japonica*)	(1)	1	Do.
Goldenstar (*Chrysogonum virginianum*)	(1)	1	Leaves.
Undetermined plants	1.06	68	Do.

TABLE 1.—*Early winter plant foods of ruffed grouse on the George Washington National Forest, based on examination of crops and gizzards of 185 birds, showing volume, frequency with which taken, and part used*—Continued

HABITATS PRODUCTIVE OF FOOD PLANTS

Some indication of the types of situations in this forest that are the greatest producers of ruffed grouse foods may be gained by an analysis of the data in Table 1. Compilation of the percentage figures shows that herbaceous plants constitute approximately 33 per cent of the bulk of the early winter food; shrubs, 25; vines, 26; and trees, 15 per cent.

Although some of the herbs, shrubs, and vines utilized are tolerant of moderately dense shade, the majority are restricted by growth habit to the more open type of forest and to cleared spots within the forest proper. This is significant and emphasizes the fact that wooded areas with open canopies and sufficiently productive soils for the growth of good stands of mixed shrubs and vine thickets are the best feeding grounds for grouse.

Food Variety In Individual Meals

It is uncommon for a ruffed grouse to partake entirely of a single food at a meal—frequently, on the contrary, as many as 20 to 30 different items are represented in one feeding. The average number for the 185 meals here reported on was 10. The items are usually selected from a variety of food types, and a single meal may contain green-leaf material, considerable fruit, some buds, twigs, or catkins, a small fraction of mast, and a few dry seeds. No doubt, each of these classes of food contributes to some important dietary requirement of the species. The combination of fruits, leaves, and browse (buds, twigs, and catkins) is certainly an important one, since more than 65 per cent of the meals studied contained all three of these types. Greens apparently are seldom omitted from a meal, as 90 per cent of the stomachs contained one or more representatives of such food; fruit in some form occurred in 77 per cent of the stomachs; and buds, twigs, or catkins were present in 71 per cent.

Quantity of Food Eaten

Like other gallinaceous birds, the ruffed grouse has a relatively high food capacity. The crop is an expanding organ and will hold several times as much food as the gizzard. The maximum volume of crop contents recorded in the present study was 118.5 cc, which is roughly equivalent to half the volume of an ordinary water glass. The maximum food volume recorded for gizzards was 20.5 cc, or approximately one-sixth of the largest crop volume. Extremely full crops and gizzards were infrequent. The average food volume of crops was 24 cc, and of gizzards 10.2 cc. As a rule, in the unusually well-filled crops fruit predominated.

Animal Food

Adult grouse do not utilize insect or other animal food to any appreciable extent in winter. They do, however, take in small quantity a considerable variety of forms, including grasshoppers, crickets, bugs, flies, beetles, moths, small insect galls, spiders, centipedes, and earthworms. The contribution of these to the total food in this study was very slight, only 0.07 per cent.

Gravel Consumption

Gravel plays an important role in the digestive processes of the ruffed grouse just as it does in other gallinaceous birds. As a grinding agent, to supplement the strong muscular movements of the gizzard, it helps reduce food material into finely divided particles preparatory to its passage into the intestine. How much gravel is needed for this function depends on a variety of

conditions, including the nature of the food eaten. In the 107 gizzards analyzed, 76 contained measurable quantities of pebbly rock material. The average per stomach was 0.8 cc, which is equivalent to about one-third of a teaspoon. In almost all cases the gravel was supplemented by hard, digestion-resisting seeds, many kinds of which no doubt are retained in the gizzard for their abrasive action until they are worn to fragments.

The number of gizzards containing no gravel—24 in all—suggests that not infrequently hard seeds serve as the sole grinding agent. These 24 gizzards were well supplied with seeds of rose (in 18), smilax (in 17), sumac, dogwood, witch-hazel, or black gum, all of which were frequently noted to be in different stages of wear. Gizzards with less than the average quantity of gravel content—0.8 cc—showed a higher content of hard seeds than those that were above average in the supply of grit. Gizzards with a gravel content of 0.8 to 4 cc contained, on the average, 3.5 cc of hard seeds. In stomachs with a below-average content of gravel—0.1 to 0.8 cc—the average of such seeds was 5.5 cc.

That gravel once taken into the gizzard may be retained over a lengthy period without having to be replenished daily is brought out quite clearly in the crop material examined. Only 8 of the 184 crops analyzed, contained gravel, and 6 of these had merely a trace. This would indicate that gravel is certainly not picked up regularly with each meal, at least not during the season when the birds normally consume a considerable percentage of hard-seeded fruits.

Winter Feeding

Few game birds are better equipped to endure severe winter conditions than ruffed grouse. Though snow holds no terror for them, it greatly restricts their choice of food. Snow, however, is not likely to cause Virginia or West Virginia birds much hardship under average winter conditions, providing there is an adequate variety and abundance of shrubs and trees from which they can obtain buds and catkins. Among the species that supply such food are blueberries and huckleberries, menziesia, hazelnut, serviceberry, rhododendron, birch, hophornbeam, and apple. Other important foods that enable the birds to survive the ravages of the winter elements are greenbrier, mountain-laurel, rose, and hawthorn.

The weather conditions that the adult ruffed grouse find most difficult are prolonged sleet storms. Not only do such storms often have a directly injurious effect on the birds, but frequently they seriously restrict the availability of food. Heavy coatings of ice over food plants make feeding difficult and at times impossible. Such conditions extended over periods of several days may be disastrous to the birds. The southern and eastern slopes are

the first to thaw after ice storms, and thus are most suitable for the grouse during severe winter weather.

The nature of the food habits of ruffed grouse makes it difficult to supply food to them during emergency periods. They will accept corn, as evidenced by the record obtained from stomach examination, but are slow to become accustomed to it. As a rule, in satisfactory habitat they pull through the winter seiges unaided and without serious consequences. Emergency winter feeding is therefore neither so necessary nor so helpful to ruffed grouse as it is to quail, turkeys, and other upland game birds.

Summary

A preliminary economic study by the Bureau of Biological Survey to provide a scientific basis for forest-game management on the George Washington National Forest, Va. and W. Va., disclosed that the first 20 plants in Table # 1 are outstanding sources of food for ruffed grouse early in winter. These plants furnished about 85 per cent of the contents of 185 stomachs collected, chiefly by hunters, in November and December of 1935 and 1936. Herbaceous plants supplied about a third of the food, shrubs and vines each about a fourth, and trees the remainder. The habitats of these 20 food plants also were studied. The results show that wooded areas with open canopies and with soils sufficiently productive for the growth of mixed stands of shrubs and vine thickets furnish the best feeding grounds.

Bureau of Biological Survey, Washington, D. C.

U. S. Forest Service, Harrisonburg, Va.

Virginia Commission of Game and Inland Fisheries, Richmond, Va.

The Virginia Journal of Science

Vol. 1 APRIL, 1940 No. 4

Virginia Academy of Science

PROGRAM

Eighteenth Annual Meeting

LEXINGTON, VIRGINIA

Thursday, Friday and Saturday
May 2nd, 3rd and 4th, 1940

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Virginia Academy of Science

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Please have all telephone calls made through Lexington 628.

Due to the limited number of available rooms in Lexington it is suggested that all members notify the Committee on Local Arrangements well in advance so that rooms may be assigned. Please indicate if you will have an automobile with you.

Lunch will be served in Crozet Hall Friday the 3rd at 50c per plate. Members of the Research Committee will meet privately in the Steward's Mess.

The Banquet will be held Friday night at 6:30 P. M. in Crozet Hall at $1.00 per plate.

Displays and demonstrations will be located in the Biology Laboratory of Scott Shipp Hall.

There will be a meeting of the Science Club Committee Saturday, May 4th at 12:45 P. M. This will probably be a luncheon meeting, and tickets may be purchased at the Registration Desk. All interested in science club work are invited to meet with the Committee. Dr. Otis W. Caldwell, General Secretary of the A. A. A. S. will be present. He has had considerable experience in this field and will be glad to answer questions and to discuss various aspects of science club work.

General Program of the Eighteenth Annual Meeting

LEXINGTON VIRGINIA

1940

VIRGINIA MILITARY INSTITUTE—HEADQUARTERS

Thursday, May 2

4:30 P. M. Council Meeting. Alumni Hall.
7:30 P. M. Academy Conference. Alumni Hall.

Friday, May 3

8:30 A. M. Registration. Anteroom, Jackson Memorial Hall.
10:00 A. M. Section Meetings.
1:00 P. M. Lunch. Crozet Hall. Tickets at Registration desk. 50c per plate.
2:00 P. M. Section Meetings.
4:00 P. M. Trip to Robert E. Lee Museum in the Lee Chapel at Washington and Lee University.
5:00 P. M. Washington and Lee University invites all members and guests of the Academy to tea at the Student Union.
6:30 P. M. Banquet. Crozet Hall. Tickets at Registration desk. $1.00 per plate.
8:00 P. M. General Session. Jackson Memorial Hall.
Address of Welcome. Major Gen. Charles E. Kilbourne.
Response by President Ruskin S. Freer.
Presentation of Annual Research Prize of the Academy and the Jefferson Prize by Dr. Frank A. Geldard.
Address—"A Winter in Oaxaca: Exploring for Plants in Southern Mexico" by Dr. W. H. Camp, New York Botanical Garden.

Saturday, May 4

9:00 A. M. Section Meetings.
12:00 Noon. General Business Meeting in Jackson Memorial Hall.

Section of Astronomy, Mathematics, and Physics

A. N. Vyssotsky, *Chairman*

F. B. Haynes, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Room 18, Scott Shipp Hall

1. Photographic Determination of the Diameter of Mars.
   Dirk Reuyl; *Leander McCormick Observatory, University of Virginia.* (10 min.)

2. General Perturbations of Planets of the Hecuba Group Determined by Means of the Berkeley Tables.
   Claude M. Anderson, Jr.; *Leander McCormick Observatory, University of Virginia.* (10 min.)

3. Photovisual Sequences from 15° South to 75° North Declination.
   C. A. Wirtanen; *Leander McCormick Observatory, University of Virginia.* (10 min.)

4. A Suggestion for Rational Musical Notation.
   Preston Edwards; *Sweet Briar College.* (10 min.)

5. Electrical Discharge Figures on the Surface of a Conducting Fluid.
   A. J. Hodges and L. B. Snoddy; *Rouss Physical Laboratory, University of Virginia.* (10 min.)

6. Graphical Evaluation of the Statistical Significance of Rate Differences.
   F. T. Holmes; *University of Virginia,* and T. L. Montgomery, *Jefferson Hospital, Philadelphia.* (10 min.)

7. Spectrophotometric Observation of the Minimum of Zeta Aurigae.
   C. A. Wirtanen; *Leander McCormick Observatory, University of Virginia.* (10 min.)

8. The System of Magnitudes of the Second McCormick Proper Motion Catalogue.
   E. R. Dyer, Jr.; *Leander McCormick Observatory, University of Virginia.* (Introduced by A. N. Vyssotsky). (10 min.)

FRIDAY, MAY 3—2:00 P. M.

Room 18, Scott Shipp Hall

9. Business Meeting.

10. Concentration of Chlorine Isotopes by Centrifuging at Dry Ice Temperature.
    F. C. Armistead; *Rouss Physical Laboratory, University of Virginia.* (Introduced by J. W. Beams.) (10 min.)

11. Progressive Electrical Breakdown in a Conducting Liquid.
    Hugh F. Henry; *Rouss Physical Laboratory, University of Virginia.* (Introduced by L. B. Snoddy.) (10 min.)

12. Effective Rotation Temperatures of Two Identical Electrodeless Discharges in Different Gases.
    M. S. McCay; *Virginia Polytechnic Institute.* (10 min.)

13. Temperature Variation in the Specific Heat of Some Gases by a New Method.
    R. A. Weiss; *Rouss Physical Laboratory, University of Virginia.* (Introduced by L. G. Hoxton.) (10 min.)

14. Construction and Performance of a Twenty-One Foot Grating Spectrograph.
    H. D. Ussery and E. S. Bishop; *Virginia Polytechnic Institute.* (10 min.)

15. The Solution of Differential Equations by Operational Calculus. Part I.
    A. Lee Smith, *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (20 min.)

16. Growth Curves as Applied in Predicting School Enrollment.
    Boyd Harshbarger; *Virginia Polytechnic Institute.* (10 min.)

17. A Sequence of Perspective Triangles whose Vertices are Determined by a Difference Equation.
    B. Z. Linfield; *University of Virginia.* (10 min.)

SATURDAY, MAY 4—9:00 A. M.

Room 18, Scott Shipp Hall

18. A Preliminary Survey of the Physical Properties of Microscope Contrast Filters and New Filter Materials.
    Lewis W. Webb, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (15 min.)

19. An Electronic Switch.
    J. R. Cosby; *Virginia Polytechnic Institute* and C. W. Lampson; *University of Richmond.* (15 min.)

20. A Simple Mercury Vapor Lamp, Operating on Direct Current.
    S. M. Heflin; *Virginia Military Institute.* (10 min.)

21. The Radiometer in an Enclosure at Uniform Temperature.
    L. G. Hoxton, *Rouss Physical Laboratory, University of Virginia.* (10 min.)

22. Dynamical Model for Gyroscopic Precession.
    Thomas Davis; *Virginia Polytechnic Institute.* (10 min.)

23. Several Improved Experiments for an Advanced Mechanics Laboratory.
    Herbert Trotter, Jr.; *Washington and Lee University.* (15 min.)

24. Some Lecture Demonstrations.
    Herbert Trotter, Jr.; *Washington and Lee University.* (15 min.)

Section of Biology

BRUCE D. REYNOLDS, *Chairman*

J. G. HARRAR, *Sub-Chairman*

LENA B. HENDERSON, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Auditorium, Nichols Engineering Hall

1. Notes on the Control of Fuller's Rose Weevil, *Pantomorus godmani* (Cotch) on Kale.
   Harry G. Walker and Lauren D. Anderson; *Virginia Truck Experiment Station, Norfolk.* (Lantern, 6 min.)

2. A Perennial Woody Gall on Hickory.
   Raymond L. Taylor and Alphonse F. Chestnut; *College of William and Mary.* (Lantern, 15 min.)

3. Concerning the Structure and Movement of Flagella.
   Bruce D. Reynolds; *University of Virginia.* (Lantern, 15 min.)

4. Making Animated Biological Movie Diagrams.
   Lorus J. Milne; *Randolph-Macon Woman's College.* (Moving pictures, 25 min.)

5. The Effect of Attrahents on Mosquitoes.
   K. B. M. Crooks; *Hampton Institute.* (To be read by title.)

6. Time and Rate of Plant Nutrient Absorption by Bright Tobacco.
   H. R. Davies and A. L. Grizzard; *Virginia Agricultural Experiment Station.* (15 min.)

7. The Relation of Timber Cutting to our Virginia Forest Types.
   W. L. Gooch; *The Chesapeake Corporation, West Point, Va.* (Lantern, 15 min.)

8. Some Foliar Characters for Peach Breeding.
   Fred W. Hofmann; *Virginia Agricultural Experiment Station.* (To be read by title.)

9. Some Fruit Bud Induction Observations.
   Fred W. Hofmann; *Virginia Agricultural Experiment Station.* (To be read by title.)

10. Phosphated Ammonia for Orchard Soil Fibre.
    Fred W. Hofmann; *Virginia Agricultural Experiment Station.* (To be read by title.)

11. A Report on the Prevalence of Helminth Parasites in Sheep in Southwestern Virginia, Together with Observations on Certain Anthelmintics Employed.
    W. L. Threlkeld; *Virginia Agricultural Experiment Station.* (Lantern, 15 min.)

12. Relative Efficiency of Several Sources of Phosphate Fertilizer in Improving the Yield, Quality and Chemical Composition of Pasture Herbage.
    R. E. O'Brien and S. S. Obenshain; *Virginia Agricultural Experiment Station.* (20 min.)

13. Green Algae in Salamander Eggs.
    A. M. Showalter and G. W. Chappelear; *Madison College.* (10 min.)

14. The Etiology of Beauveria Disease of *Dendroctonus frontalis.*
    J. G. Harrar and J. G. Martland; *Virginia Polytechnic Institute.* (Lantern, 10 min.)

15. The Biology of a Species of *Beauveria* from the Southern Pine Bark Beetle.
    J. G. Harrar and Ruth P. Ellis; *Virginia Polytechnic Institute.* (Lantern, 10 min.)

FRIDAY, MAY 3—2:00 P. M.

Auditorium, Nichols Engineering Hall

16. A Study of Avian Malaria.
    King A. Jamison; *Virginia Polytechnic Institute.* (10 min.)

17. Cold Resistance, Mutation and Geographical Distribution in Plants.
    Orland E. White; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

18. Miscellaneous Studies of Codling Moth Bands.
    A. M. Woodside; *Staunton Field Laboratory, Virginia Agricultural Experiment Station.* (Lantern, 15 min.)

19. Experimental Studies on the Cultivation of Excised Anthers in Nutrient Solution.
    Walton C. Gregory; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 10 min.)

20. A Cytological and Morphological Study of the European *Mesostoma ehrenbergii* and a Closely Related American Form.
    Ladley Husted and Trenton K. Ruebush; *University of Virginia* and *Yale University.* (Lantern, 15 min.)

21. The Relationship between Boron and Thallium Toxicity of Tobacco.
    G. M. Shear and R. L. Schnell; *Virginia Agricultural Experiment Station* and *Virginia Polytechnic Institute.* (Lantern, 10 min.)

22. A Simple Method of Diagnosing Plant Deficiencies.
    G. M. Shear; *Virginia Agricultural Experiment Station.* (Lantern, 10 min.)

23. The Relative Importance of the Host Plants of the Tobacco Flea Beetle, *Epitrix parvula* F.
    E. H. Glass; *Virginia Agricultural Experiment Station.* (Lantern, 10 min.)

JOINT MEETING OF BIOLOGY AND GEOLOGY

FRIDAY, MAY 3—4:15 P. M.

Continental Displacement and Its Relation to the Origin and Dispersal of the American Floras.

Dr. W. H. Camp; *New York Botanical Garden.*

Botany Division

SATURDAY, MAY 4—9:00 A. M.

Biology Lecture Room, Scott Shipp Hall

1. Studies of the Germination, Growth and Propagation of Seeds, Berries and Root Fragments of *Berberis canadensis* Mill.
   G. E. Matheny and R. S. Mullin; *Bureau of Entomology and plant Quarantine, U. S. Department of Agriculture.* (Lantern, 15 min.)
2. Diploidy, Polyploidy and the Degree of Winter Hardiness in the Flowering Plants.
   Wray M. Bowden; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)
3. Cytology and Phylogeny in the *Ranunculaceae.*
   Walton C. Gregory; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 10 min.)
4. The Nomenclature and Characteristics of Species of Rosa in Virginia.
   A. B. Massey; *Virginia Polytechnic Institute.* (Lantern, 10 min.)
5. The Identity of the Evergreen Rhododendrons of Virginia in the Dormant Condition.
   A. B. Massey; *Virginia Polytechnic Institute.* (Lantern, 10 min.)
6. Plants at the Edge of Their Ranges.
   Lena Artz, *Arlington, Va.* (10 min.)
7. Corticolous Bryophyte Societies at Mountain Lake, Va.
   Paul M. Patterson; *Hollins College...* (Lantern, 15 min.)
8. Physiological Studies on Mosses. II. The Viability of Old Spores.
   Samuel L. Meyer; *Miller School of Biology, University of Virginia.* (Lantern, 15 min.)
9. Physiological Studies on Mosses. III. The Influence of the Moisture Factor on the Development of Leafy Moss Plants in Liquid Media.
   Samuel L. Meyer; *Miller School of Biology, University of Virginia.* (Lantern, 15 min.)
10. Coprophilous Ascomycetes from Charlottesville and Vicinity.
    Edwin M. Betts and Samuel L. Meyer; *Miller School of Biology, University of Virginia.* (Lantern, 10 min.)
11. "Three Unpublished Letters of Raffinesque to Jefferson."
    Edwin M. Betts; *Miller School of Biology, University of Virginia.* (10 min.)

Zoology Division

SATURDAY, MAY 4—9:00 A. M.

Auditorium, Nichols Engineering Hall

1. Elk in Virginia.
   Roy Wood, Virginia Cooperative Wildlife Research Unit, *Virginia Polytechnic Institute.* (Introduced by C. O. Handley.) (Lantern, 10 min.)

2. The Correlation of Bird Migration and Wind Direction.
   Ruskin S. Freer and John Mahan; *Lynchburg College.* (Lantern, 15 min.)

3. Some Observations on the Spadefoot Toad, *Scaphiopus holbrookii.*
   Hazel Poff and Paul R. Burch; *State Teachers College, Radford, Va.* (15 min.)

4. The Heart of *Cryptobranchus allegheniensis* Daubin.
   William B. Atkinson; *University of Virginia.* (Introduced by Chauncey McL. Gilbert.) (Lantern, 10 min.)

5. A Description of the Venous System of *Cryptobranchus allegheniensis* Daubin.
   William Sangster, Jr.; *University of Virginia.* (Introduced by Chauncey McL. Gilbert.) (Lantern, 15 min.)

6. Banding Chimney Swifts.
   C. O. Handley; *U. S. Biological Survey and Virginia Polytechnic Institute.* (Lantern, 10 min.)

7. A Synopsis of the Genus *Mesostoma ehrenbergii* 1837.
   Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division,* and W. J. Hayes, Jr.; *University of Wisconsin.* (Te be read by title.)

8. Studies on the Turbellarian Fauna of the Norfolk Area. I. *Macrostomum ruebushi* var. *kepneri* new variety.
   Frederick F. Ferguson and E. Ruffin Jones, Jr.; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Lantern, 10 min.)

9. Studies on the Turbellarian Fauna of the Norfolk Area. II. Jensenia leivisi n.sp.
   E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Lantern, 10 min.)

10. Studies on the Turbellarian Fauna of the Norfolk Area. III. Ecology and Distribution.
    Frederick F. Ferguson and E. Ruffin Jones, Jr.; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (To be read by title.)

11. Studies on the Turbellarian Fauna of the Norfolk Area. IV. *Macrostomum norfolkensis* n.sp.
    E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Lantern, 10 min.)

12. A Synopsis of the American Turbellaria.
    Part I. American Acoela Rhabdocoela and Alloeocoela with Notes on Distribution and Ecology and a Diagnostic Key to Families and Genera.
    M. A. Stirewalt, F. F. Ferguson and W. J. Hayes, Jr.; *Miller School of Biology, University of Virginia.* (Demonstration. To be read by title.)

13. The Effect of High Frequency Radio Waves Upon *Microstomum lineare* (Mull.) O. Schmidt 1848.
    W. A. Kepner, M. A. Stirewalt and L. I. Malis; *Miller School of Biology, University of Virginia.* (Lantern, 15 min.)

14. The Elaboration and Transportation of Yolk in *Microstomum lineare* (Mull.) O. Schmidt 1848 (rhabdocoele Turbellarian).
    M. A. Stirewalt; *Miller School of Biology, University of Virginia.* (To be read by title.)

15. A New Turbellarian Worm (Alloeocoele) from Beaufort, N. C.
    M. A. Stirewalt, W. A. Kepner and F. F. Ferguson; *Miller School of Biology, University of Virginia and U. S. B. F., Beaufort, N. C.* (To be read by title.)

16. An Outline of the Development of the Ovum of *Chlorohydra viridissima.*
    William A. Kepner, Bruce Perry, W. B. Atkinson and J. R. Meyer; *University of Virginia.* (Lantern, 10 min.)

17. Morphology and Histogenesis of the Blood Meal Worm. (*Tenebrio molitor, L.*)
    Herbert William Jackson; *Virginia Polytechnic Institute.* (20 min.)

18. Origin of the Mid Gut in *Tenebrio molitor L.*
    Herbert William Jackson; *Virginia Polytechnic Institute.* (10 min.)

Section of Chemistry

W. J. FRIERSON, *Chairman*

W. G. GUY, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Room 102, Maury Brooke Hall

1. The Influence of the Crystal Plane in the Electrodeposition of Copper on a Single Crystal of Copper.
   Allan T. Gwathmey; *University of Virginia.* (15 min.)

2. Rate of Xanthation of Soda Cellulose.
   P. C. Scherer, Jr. and L. C. Ikenberry; *Virginia Polytechnic Institute.* (10 min.)

3. Cellulose Containing Amino Nitrogen.
   P. C. Scherer, Jr. and J. M. Feild; *Virginia Polytechnic Institute.* (10 min.)

4. Sulfur Forms in Crude Viscose Rayon.
   P. C. Scherer, Jr. and J. R. Leonards; *Virginia Polytechnic Institute.* (10 min.)

5. Temperature and Time Factors on Deterioration of Cellulose Acetate Crumb.
   G. Rubenstein, P. C. Scherer, Jr., and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

6. A Study of the Procedure for the Determination of Glycogen in Oysters.
   H. N. Calderwood, and Alfred R. Armstrong; *Bureau of Fisheries, U. S. Department of the Interior, Virginia Commission of Fisheries, and the College of William and Mary.* (15 min.)

7. A Micro-Method for the Determination of Tissue Lipids.
   E. L. Outhouse, B. E. Leach and J. C. Forbes; *Medical College of Virginia.* (20 min.)

8. Physico-Chemical Studies of Soils.
   Howard Kincer, Beulah Wood and H. I. Johnson; *Roanoke College.* (10 min.)

9. The Recovery of Gallium from a Nelson County Virginia Feldspar.
   W. S. Peterson and F. H. Fish; *Virginia Polytechnic Institute.* (10 min.)

FRIDAY, MAY 3—2:00 P. M.

Room 102, Maury Brooke Hall

10. The Kolbe Synthesis with Alkyl-o-Phenylphenols.
    Sidney Harris and J. Stanton Pierce; *University of Richmond.* (10 min.)

11. Separation of Fatty Acids and Rosin from Crude Tall Oil by Selective Chlorination.
    J. M. Crockin and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (15 min.)

12. Refining of Crude Tall Oil with Sulfuric Acid.
    P. E. Chapman and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

13. Eka-Catalysis in Alkylation of Pipe Still Vapors.
    Harrison L. Kalbach and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

14. Alkylation of Benzene with Ethylene with Several Phosphoric Acids as Eka-Catalysts.
    A. Rabinkoff and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

Second Symposium on Organic Analytical Reagents

For several years eight institutions in the state have been cooperating in an extensive research program on organic analytical reagents under the direction of Dr. John H. Yoe. In October 1939, Tulane University of Louisiana joined the Virginia Group in this cooperative effort. The work at Tulane is under the direction of Dr. Thomas B. Crumpler.

At the Danville meeting of the Academy last May, a symposium was held in which each cooperating institution participated. So much interest was shown at this meeting that it seemed desirable to hold a second symposium for the purpose of presenting brief progress reports from the cooperating members and to discuss certain phases of the subject. The following papers (15-26) are included in this symposium.

15. Introduction.
    John H. Yoe; *University of Virginia.*

16. A Summary Report on 500 Organic Compounds.
    W. J. Frierson; *Hampden-Sydney College.*

17. Progress Report on Organic Analytical Reagents Research at Virginia Polytechnic Institute.
    J. R. Noell, B. H. Kemp and F. H. Fish; *Virginia Polytechnic Institute.*

18. The Solubility of the Alkali Earth Salts of the Higher Fatty Acids.
    B. H. Kemp and F. H. Fish; *Virginia Polytechnic Institute.*

19. A Summary Report on 100 Organic Compounds.
    W. E. Trout, Jr.; *Mary Baldwin College.*

20. A Summary Report on 100 Organic Compounds.
    A. R. Armstrong; *College of William and Mary.*

21. A Progress Report.
    W. O. Swan; *Virginia Military Institute.*

22. A Progress Report.
    J. T. Ashworth, B. M. Keys and Ira A. Updike; *Randolph-Macon College.*

23. Structure of Some Organo-Metallic Complexes.
    James W. Cole; *University of Virginia.* (20 min.)

24. Chelation in Relation to the Periodic Classification.
J. R. Taylor; *Washington and Lee University.* (20 min.)

25. Structure of Metal Derivatives of Oximes.
Alfred Burger; *University of Virginia.* (20 min.)

26. The Application of a New Class or Organic Reagents for the Detection and Determination of Palladium.
Lyle G. Overholser and John H. Yoe; *University of Virginia.* (20 min.)

SATURDAY, MAY 4—9:00 A. M.

Room 102, Maury Brooke Hall

27. Chemical Industry in Colonial Virginia.
W. S. DeLoach; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (10 min.)

28. Series Reactions in Organic Chemical Laboratory.
J. B. Lucas and W. B. Downey; *Virginia Polytechnic Institute.* (12 min.)

29. The Action of Chloromethyl Ether on 4-Methyluracil.
Margaret M. Endicott; *Hollins College.* (10 min.)

30. Petroleum Bases. Reactions of 2, 3, 8-Trimethyl Quinoline.
Alfred Burger; *University of Virginia.* (10 min.)

31. The Halogenation of Salicylic Acid.
L. H. Farinholt; *Washington and Lee University,* and A. P. Stuart, *University of Delaware.* (15 min.)

32. The Brominating Action of 1,2,-Diaroylbromo-ethanes.
Monroe Couper and Robert E. Lutz; *University of Virginia.* (15 min.)

33. An Improved Experimental Still for the Isolation of Volatile Oils from Logging Wastes.
H. N. Calderwood;* *University of Wisconsin.* (15 min.)

34. A Chemistry Open House.
R. C. Krug, T. S. Tutwiler and A. I. Whitenfish; *University of Richmond.* (15 min.)

35. Business Meeting and Election of Officers.

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*Present address: Box 2, Williamsburg, Va.

Section of Education

J. ALEX. RORER, *Chairman*

PAUL G. HOOK, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Room 16, Scott Shipp Hall

1. Evaluative Criteria of the Cooperative Study.
   W. R. Smithey; *University of Virginia.*
2. Photography as a College Course.
   J. D. Schumacher; *Roanoke College.*
3. Developmental Reading.
   Eva Bond; *College of William and Mary, Richmond Division.*
4. Physical Education Programs in Virginia Colleges.
   Clarence Hale; *University of Virginia.*

FRIDAY, MAY 3—2:00 P. M.

Room 16, Scott Shipp Hall

5. Janitor Service in Rural Schools.
   W. H. Barrett; *University of Virginia.*
6. The Living Conditions of the White Teachers in Bedford County, Virginia.
   Samuel J. Coffey; *University of Virginia.*
7. Negro Education in Bedford County, Virginia.
   O. T. Bonner; *University of Virginia.*
8. Health Conditions and Activities in Negro Schools of Fauquier County, Virginia.
   W. G. Coleman; *University of Virginia.*
9. Techniques of Research in Apprentice Teaching.
   Boyd Graves; *Mary Washington College.*
10. Control of School Accounting Exercised by State Requirements and Recommendations.
    Charles K. Martin, Jr.; *Mary Washington College.*

Section of Engineering

ALBERT H. COOPER, *Chairman*

D. H. PLETTA, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Room 211, Nichols Engineering Hall

1. An Apple-Milk Confection for Partial Utilization of Surplus and Cull Apples.
   Frank C. Vilbrandt and Robert D. Sieg; *Virginia Polytechnic Institute.* (15 min.)

2. Heat Transfer Coefficients for Condensing Organic Vapors.
   Harvey E. Henderson and Albert H. Cooper; *Virginia Polytechnic Institute.* (15 min.)

3. Utilization of Saltville Wastes for Production of Chlorine.
   J. T. Gormally and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

4. Industrial Conversion of Nitrosyl Chloride to Chlorine.
   H. C. Shockey and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

5. The Use of Test Filtration Data in the Prediction of Filter Capacity.
   Ralph A. Troupe and Robert A. Fisher; *Virginia Polytechnic Institute.* (10 min.)

6. Design, Construction and Operation of a Carbon Dioxide Generator from Fuel Oil for Experimental Absorption Tower Studies.
   I. Resnick and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (15 min.)

7. Countercurrent Liquid—Liquid Extraction of Lubricating Oils in a Spray Column.
   Alfred S. King and Albert H. Cooper; *Virgina Polytechnic Institute.* (10 min.)

8. Drying Characteristics of Scherer Insulation.
   M. Singer, P. C. Scherer, Jr., and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

9. Mixing and Forming Characteristics of Scherer Insulation.
   S. C. Syman, P. C. Scherer, Jr., and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

10. Effect of Operation Variables on Individual Plate Efficiencies of a Bubble-Cap Column.
    Stuart B. Row; *Virginia Polytechnic Institute.* (15 minn.)

11. Business Meeting, Appointment of Nominating Committee. (15 min.)

FRIDAY, MAY 3—2:00 P. M.

Room 211, Nichols Engineering Hall

12. Continuation of Business Meeting, Election of Officers, Reports, etc. (30 min.)

13. Gasoline Engine Exhaust Gas Analysis.
    J. L. Dilworth; *Virginia Polytechnic Institute.* (15 min.)

14. Accidents in Virginia Industries.
    W. B. Davis; *Industrial Commission of Virginia.* (20 min.)

15. Work Simplification Engineering. (Illustrated with motion pictures.)
    R. B. Davenport; *Larus & Brother Co., Richmond, Va.* (30 min.)

16. Miniature Camera Color Photobicrography Applied to Ceramic Technology.
    Paul S. Dear; *Virginia Polytechnic Institute.* (15 min.)

17. Development and Possibilities of Zoisitic Aplite as a Ceramic Raw Material.
    John W. Whittemore and Paul S. Dear; *Virginia Polytechnic Institute.* (15 min.)

18. Design Constants for Fixed-Ended Roof Trusses.
    J. E. Spagnuolo and D. H. Pletta; *Virginia Polytechnic Institute.* (15 min.)

19. The Behavior of Helical Springs.
    F. J. Maher and D. H. Pletta; *Virginia Polytechnic Institute.* (15 min.)

Section of Geology

E. Ray Casto, *Chairman*

E. C. H. Lammers, *Vice-Chairman*

W. M. McGill, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Room 37, Scott Shipp Hall

1. Diatomite in the Petersburg Area, Virginia.
   William M. McGill; *Virginia Geological Survey.* (Slides, 10 min.)

2. Problems of Coastal Plain Geology and Hydrology.
   D. J. Cederstrom; *U. S. Geological Survey.* (Introduced by Arthur Bevan.) (Slides, 15 min.)

3. Notes on Varvelike Clay at Buena Vista, Virginia.
   Robert O. Bloomer; *University of North Carolina.* (Introduced by W. M. McGill.) (5 min.)

4. Map Showing Distribution of the Petersburg Granite in Southeastern Piedmont Virginia.
   Arthur A. Pegau; *University of Virginia.* (Map, 12 min.)

5. A Virginia Piedmont Paleozoic Limestone Belt.
   Arthur Bevan; *Virginia Geological Survey.* (Slides, 12 min.)

6. A Granite as a Thrust Fault Carrier East of the Blue Ridge in Virginia.
   Wilbur A. Nelson; *University of Virginia.* (Slides, 12 min.)

7. Application of Some Biogenic Laws to Stratigraphy.
   A. A. L. Mathews; *Virginia Polytechnic Institute.* (12 min.)

8. Some New Features of the Internal Structure of Receptaculites.
   John W. Harrington; *Virginia Polytechnic Institute.* (Introduced by Roy J. Holden.) (5 min.)

9. Magmatic Carbonation.
   Roy J. Holden; *Virginia Polytechnic Institute.* (12 min.)

10. Geology in Soil Survey in Southwest Virginia.
    H. C. Porter; *Virginia Agricultural Experiment Station.* (Maps, 15 min.)

11. Geological Study of Core from Chickamauga Dam.
    Cecil B. McGavock, Jr.; *Tennessee Valley Authority, Chattanooga, Tenn.* (Slides, 10 min.)

FRIDAY, MAY 3—2:00 P. M.

Room 37, Scott Shipp Hall

12. Lane Use Capability Classification for Farm Planning.
    T. C. Green; *U. S. Department of Agriculture, Soil Conservation Service.* (Introduced by W. M. McGill.) (Slides, 20 min.)

13. The Role of the Tuscarora Sandstone in Little North Mountain, Virginia.
    Raymond S. Edmundson; *Virginia Geological Survey.* (Maps, 8 min.)

14. A Barite Vein Near Lexington, Virginia.
    Edward Steidtmann; *Virginia Military Institute.* (Maps, 12 min.)

15. Comments on the Geology of Northern Virginia.
    Charles Butts; *Virginia Geological Survey.* (Introduced by R. S. Edmundson.) (Map, 15 min.)

16. Problem Relating to the Appalachian Geosyncline.
    E. C. H. Lammers; *Washington and Lee University.* (15 min.)

17. Detailed Study of the Valley Peneplain in the Vicinity of Lexington, Virginia.
    Uriah F. Coulbourn; *Washington and Lee University.* (Slides, models, 10 min.)

18. Heavy Minerals of Some Silurian Sandstones in Virginia.
    James Bierer; *Washington and Lee University.* (Slides, 5 min.)

19. Detailed Stratigraphy of Three Silurian Sections in Virginia.
    John S. Hunter; *Washington and Lee University.* (Maps, 5 min.)

20. Insoluble Residues of Some Silurian and Devonian Limestones in Virginia.

    Homer D. Jones, Jr.; *Washington and Lee University.* (Slides, 5 min.)

Business Meeting.

JOINT MEETING OF BIOLOGY AND GEOLOGY

FRIDAY, MAY 3—4:15 P. M.

Continental Displacement and Its Relation to the Origin and Dispersal of the American Floras.

Dr. W. H. Camp; *New York Botanical Garden.*

SATURDAY, MAY 4—8:00 A. M.

Field Trip—Details of trip to be announced at the meeting, Friday.

Section of Medicine

C. C. Speidel, *Chairman*

Guy W. Horsley, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Alumni Hall

1. The Relation Between Birefringence and Contractile Power of Atrophied and of Hypertrophied Muscles.
   Ernst Fischer; *Department of Physiology and Pharmacology, Medical College of Virginia.* (Lantern, 10 min.)

2. Effect of Food on the Serum Esterase of Rats.
   J. C. Forbes, E. L. Outhouse and B. E. Leach; *Department of Biochemistry, Medical College of Virginia.* (15 min.)

3. A Rapid and Accurate Method for the Determination of Total, Free and Ester Cholesterol of Blood and Serum.
   B. E. Leach, E. L. Outhouse and J. C. Forbes; *Department of Biochemistry, Medical College of Virginia.* (10 min.)

4. A Study of the Methods of Sterilization of Glasses and Eating Utensils Used in Public Eating Establishments and a Solution to the Problem.
   A. F. Meyer, Jr.; *Sanitary Laboratory, Virginia Military Institute.* (30 min.)

5. The Effect of Fresh Aloe Vera Jell in the Treatment of Third Degree X-Ray Reactions on White Rats.
   T. D. Rowe; *Medical College of Virginia.* (15 min.)

6. Sunlight, Skin Cancer and Cancer Immunity.
   Frank L. Apperly, *Department of Pathology, Medical College of Virginia.*

Symposium of Jaundice

FRIDAY, MAY 3—2:00 P. M.

Alumni Hall

7. Hepatic Physiology.

   R. J. Main; *Medical College of Virginia.* (20 min.)

8. Pathological Anatomy of the Liver in Jaundice.

   James R. Cash; *Department of Pathology, University of Virginia.* (Lantern, 20 min.)

9. The Clinical Aspect of Jaundice.

   Walter B. Martin; *Norfolk, Va.* (30 min.)

10. Laboratory and Hematological Diagnosis of Jaundice.

    J. H. Scherer; *Medical College of Virginia.* (20 min.)

11. Surgical Treatment of Jaundice.

    Holcombe H. Hurt; *Lynchburg, Va.* (30 min.)

Section of Psychology

RICHARD H. HENNEMAN, *Chairman*
WILLIAM M. HINTON, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

Room 11, Scott Shipp Hall

1. A Further Study of the Factors Determining Discrimination of Size by the White Rat.
   Robert M. Flory; *University of Virginia.* (15 min.)
2. Spontaneous Alternation of the White Rat in Running and Jumping Situations.
   M. M. Jackson; *University of Virginia.* (15 min.)
3. A Simple Apparatus for Pattern Learning Experiments.
   John M. McGinnis; *Hollins College.* (10 min.)
4. The Effects of Distraction Upon Reading Efficiency.
   Jeanette Hughes and Nancy Phillips; *Randolph-Macon Woman's College.* (10 min.)
5. Time Measures of Individual Differences in Vision.
   F. G. Tice; *University of Virginia.* (15 min.)
6. The Effect of Changing Skin Temperature on Vibratory Sensitivity.
   Joseph Weitz; *University of Virginia.* (15 min.)
7. Estimating Behavior and Interests from Photographs.
   Charles M. Harsh; *Randolph-Macon Woman's College.* (15 min.)
8. The Influence of Information on Changes in Racial Attitudes.
   Evelyn Raskin; *Randolph-Macon Woman's College.* (15 min.)
9. Isolated Children and the Fixity of Early Habits.
   Wayne Dennis; *University of Virginia.* (15 min.)

FRIDAY, MAY 3—2:00 P. M.

Room 11, Scott Shipp Hall

1. Looking Ahead in Social Psychology.
   Steuart H. Britt; *George Washington University.*
2. Informal discussion by members of the section of Dr. Britt's address. All interested persons are urged to participate.
3. Business Meeting.

The Virginia Journal of Science

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CONTENTS

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The Virginia Journal of Science

VOL. 1 MAY, 1940 No. 5

Equalization of Educational Opportunity Among Virginia Counties

ALLEN D. EDWARDS AND BOYD HARSHBARGER

Great variation exists between Virginia counties with respect to the ratio of children to adults and in the amount of tax resources available to support public education. The cumulative effect of a high ratio of children and poor economic resources makes it almost impossible for some counties to provide adequate schools. In general, counties with the poorest schools are those with a relatively large proportion of their population of school age and meager resources with which to pay for education. State and Federal aid is essential if such communities are to provide education of the average quality provided in the Nation.

INEQUALITIES IN EDUCATIONAL OPPORTUNITY

Although Virginia has made rapid strides in improving the quality of education during recent years, striking inequalities still exist. This statement will come as no surprise to those closely associated with education in the State. The average salary of white teachers varies from under $500 in 3 counties to $500-$599 in 12 counties, $600-$699 in 29 counties, $700-$799 in 29 counties and over $800 in 27 counties (Fig. 1). Of the 97 counties with Negro teachers, the average salary is above $500 in 24 and below in 73; in 29 counties the average is less than $400 (Fig. 2). The lowest salaries for white teachers are found in lower Southwest Virginia and Blue Ridge Mountain subregions (Table A). Salaries for Negro teachers are low in all parts of the State where Negroes are numerous except near the urban centers of Richmond and Norfolk. They are higher in counties of Southwest Virginia and Valley of Virginia where they are found in only small numbers. The distribution of other indices of quality of education is similar to that for teacher's salary.

CAUSES OF INEQUALITIES

A primary purpose of this analysis has been to study the causes for poor schools in some counties and good schools in others. In order to obtain a more exact statement of the relation-

ships involved, indices of quality of education in the counties of Virginia were correlated with specified social and economic indices. For example, the results show a high negative correlation between white population fertility and such indices of quality of schools as, average teacher's salary, percent of total enrollment in high school, and per capita cost of instruction. The correlation is highest with percent of total white enrollment in high school (correlation coefficient —.74) (Table 1). Counties with the highest population fertility have the most children in school placing a relatively heavy burden upon such areas. Unless relatively greater tax resources are available to support schools in such areas the quality will inevitably suffer.

Counties with relatively ample economic resources tend to maintain higher standard schools. Thus there is a significant positive correlation between assessed value per capita and average salary of white teachers (.69), per capita cost of instruction (.51), and percent of total enrollment in high school (.30). Similarly, gross farm income per capita of the rural-farm population is positively correlated with average salary of white teach-

TABLE 1.—CORRELATION OF SPECIFIED INDICES OF QUALITY OF INSTRUCTION IN WHITE SCHOOLS, 1936-37, WITH SELECTED ECONOMIC AND SOCIAL INDICES FOR VIRGINIA COUNTIES.

ITEM	Average salary of white teachers	Per capita cost of instruction (white)	Percent of total white school enrollment in high school
Replacement index (white)[1]	—.52	—.67	—.74
Per capita wealth (total)	.69	.51	.30
Gross farm income per capita (total)	.41	.25	—.03[2]
Percent of white farm workers with marginal incomes	—.35	—.59	—.61
Percent Negro	.44	.68	.70

[1]Based on ratio of children under 5 per 1000 women 20-44 years of age in 1930 census.
[2]Not significant.

TABLE 2.—CORRELATION OF SPECIFIED INDICES OF QUALITY OF INSTRUCTION IN NEGRO SCHOOLS, 1936-37, WITH SELECTED ECONOMIC AND SOCIAL INDICES FOR VIRGINIA COUNTIES.

ITEM	Average salary of Negro teachers, 1936-1937	Percent of total Negro school enrollment in high school
Replacement index (Negro)[1]	—.54	—.46
Per capita wealth (total)	.48	.13[2]
Gross farm income per capita (total)	.24	.06[3]
Percent of Negro farm workers with marginal incomes	.32	.34
Percent Negro	—.42	—.37

[1]Based on ratio of children under 5 per 1000 women 20-44 years of age in 1930 census.
[2]Doubtful significance.
[3]Not significant.

ers and white per capita cost of instruction (Table 1). On the other hand, counties with meager economic resources are unable to maintain as adequate schools even though they spend a larger proportion of their total taxes on education.

Studies carried on by the Division of Rural Sociology of the Virginia Agricultural Experiment Station[1] have demonstrated that low income and marginal status are frequently associated with low educational achievements. There is a significant negative correlation between the percentage of white farm workers with marginal incomes and each of the indices of quality of instruction in white schools. The highest negative correlation is with the percentage of total white school enrollment in high school (correlation coefficient of —.61). These data indicate that the poorest opportunity for education is provided in the counties where the largest proportion of rural families have marginal incomes. This explains, to some extent, why it is so difficult for many of the marginal group to improve their economic and social status.

Contrary to what might be expected, the best schools for white children and poorest schools for the Negroes tend to be found in counties with the largest Negro population. The percent Negro is positively correlated with the indices of quality of instruction in white schools (Tables 1 and 2). This is in part a reflection of the higher social status of whites in counties where there is a large Negro population. Fewer whites are found to be engaged in common labor as compared with areas which are predominantly white. Similarly, relatively few Negroes obtain positions in skilled, business and professional occupations in such areas. Since all groups expect most Negroes to engage in relatively unskilled work, high school training is not considered necessary. Similarly, in sections of the State where Negroes are relatively few in numbers a low social status is accepted for the poorer whites both by themselves and by social-economic groups higher in the scale.

The quality of instruction for Negroes is influenced by social and economic factors somewhat differently than is the case for whites. However, counties with the highest fertility rate for Negroes and the lowest per capita wealth tend to have the poorest schools. The fact that the counties with the highest proportion of Negro farm workers with marginal incomes do not have the poorest schools, indicates that other than economic factors are involved in determining the quality of education for that race. Leadership of both of the races and the social attitudes

[1]A more adequate discussion of education as related to the problem of marginal people will appear in a forthcoming bulletin, "Virginia's Marginal Population, A Study of Factors Associated with Rural Poverty and Related Population Trends," by the Division of Rural Sociology, Virginia Agricultural Experiment Station.

toward Negro education are involved as well as the financial ability to support schools. A growing realization of the interdependence of the two races and a more favorable attitude toward adequate education for Negroes is equally as important as economic resources in improving educational opportunities for that race.

The yearly expenditure for education per child aged 5 to 17 years in Virginia is $28, or less than one-half the national average of $58.[2] This low expenditure for education is partly a result of low tax resources. For example, Virginia has tax resources of only $73 per child as compared to $155 for all states according to Newcomer.[3] But limited resources is not the only reason for the low expenditures in Virginia since it is estimated that at least 36 states expend a larger proportion of their tax resources on education than does Virginia.[4] These facts would indicate that Virginia might well spend a greater amount on education but that Federal aid would be necessary if the educational system is to be brought up to the average for the entire country.

Significance of Educational Opportunity

The fact that counties with the highest fertility rates and the largest proportion of white farm workers with marginal incomes tend to have the poorest white schools, constitutes a challenge to the people of the State. These counties also have relatively small economic resources, entirely inadequate to provide schools of as good quality as already exist in more favored areas. Thus, the existing inequalities in education cannot be eradicated through efforts of local units of government alone. Aid from State and Federal governments is necessary to establish adequate schools in those counties of the State with the largest number of children of school age and the smallest resources with which to provide schools.

Efforts to improve Negro schools appear to be most needed in areas where they are most concentrated. For Negroes, as for whites, education is needed to develop useful workers in our economic system. Increasing opportunities for employment along with proper vocational training is an urgent problem if they are to remain self-supporting members of our society.

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[2]*The Problems of a Changing Population*, National Resources Committee, Government Printing Office, Washington, D. C., 1938. Page 218.

[3]*Ibid.*, Page 218. Chism estimates $132 for Virginia as compared to $215 for the Nation as a whole. Thirty-nine states have tax resources greater than Virginia according to Newcomer; while according to Chism thirty-seven states have tax resources per child greater than Virginia.

[4]*Ibid.*, Page 218. This estimate is according to Newcomer. Chism estimates that forty-five states spend a larger proportion of their tax resources on education than does Virginia.

The justification of such aid, from the point of view of self interest, lies in the fact that it is those counties which most need help in educating their children, who will furnish the largest number of migrants to other parts of Virginia as well as to other states. Unless educational inequalities, now existing in the State, are equalized, education will tend to become an instrument for the creation of further inequalities, rather than a means of preserving the democratic ideal of equal opportunity for all. It is apparent from the facts presented above that not all children are given the essentials of training which will enable them to participate effectively in the culture in which they live. Moreover, our high crime rate constitutes additional evidence that many children do not make a socially acceptable adjustment to their environment. The responsibility for remedying this situation must rest in large measure upon our educational system. Large families, poor educational facilities and low standards of living constitute a vicious circle. Perhaps the most effective way to break this circle is to improve the educational facilities.

TABLE A.—Indices of Quality of Instruction, 1936-37, and Specified Social and Economic Indices of Virginia Counties.

Sub-Region and County	Average teachers' salary (1)		Pct. total enrollment in H. S. (1)		Replacement index (2)		Pct. farm workers with marginal incomes (3)		Assessed value per capita (4)	Pct. Negro (5)
	White	Negro	White	Negro	White	Negro	White	Negro		
State median[6]	717	436	22.9	9.6	166	185	56	91	371	30
I. Cumberland Plateau—										
Median	721	592	13	12	271	120	78	100	275	2
Dickenson	759	—	13	—	271	120	78	—	275	2
Wise	721	592	14	12	205	125	74	100	279	6
Buchanan	589	—	7	—	281	47	78	—	235	1
II. Lower S. W. Virginia—										
Median	593	534	17	20	202	146	67	91	235	3
Giles	685	560	19	21	201	152	61	96	712	5
Tazewell	661	663	14	15	206	138	75	89	274	8
Smythe	641	550	17	20	189	113	71	88	235	3
Russell	615	417	14	—	221	180	65	88	235	3
Washington	571	534	19	23	188	140	65	93	231	4
Lee	567	533	14	—	218	131	73	94	160	2
Bland	494	360	18	11	202	152	57	81	260	2
Scott	482	424	11	—	194	155	68	95	188	1
III. Upper S. W. Virginia—										
Median	681	570	20	9	167	133	64	93	455	10
Alleghany	812	573	22	11	164	128	67	88	677	10
Roanoke	763	595	24	15	153	126	63	93	648	9
Rockbridge	706	570	18	6	167	127	64	94	653	11
Montgomery	699	677	19	34	167	133	66	91	431	10
Botetourt	662	469	23	6	170	175	59	95	478	14
Wythe	662	476	18	7	192	171	64	93	330	7
Pulaski	646	462	17	9	179	140	73	99	383	11
Craig	635	—	21	—	165	—	56	—	390	(7)
IV. Valley of Virginia—										
Median	670	500	19	12	164	156	57	94	569	5
Bath	835	619	18	15	174	97	59	81	685	14
Clarke	765	553	23	20	134	156	57	94	688	21
Warren	720	408	20	—	159	166	65	100	362	10

TABLE A.—INDICES OF QUALITY OF INSTRUCTION, 1936-37, AND SPECIFIED SOCIAL AND ECONOMIC INDICES OF VIRGINIA COUNTIES—*Continued.*

SUB-REGION AND COUNTY	Average teachers' salary (1)		Pct. total enrollment in H. S. (1)		Replacement index (2)		Pct. farm workers with marginal incomes (3)		Assessed value per capita (4)	Pct. Negro (5)
	White	Negro	White	Negro	White	Negro	White	Negro		
Augusta	692	555	13	8	157	138	53	92	629	10
Rockingham	670	442	20	—	164	187	51	93	569	3
Shenandoah	649	450	19	—	145	140	54	100	439	2
Highland	621	360	18	—	169	108	48	94	631	3
Page	566	504	20	8	167	172	70	97	366	5
Frederick	573	500	15	—	165	156	60	80	461	4
V. BLUE RIDGE PLATEAU—										
Median	522	464	12	8	181	199	65	92	153	4
Floyd	568	480	10	8	181	227	55	92	153	4
Grayson	522	320	13	—	170	199	65	85	113	4
Carroll	512	464	12	16	192	173	70	95	155	2
VI. BLUE RIDGE MOUNTAINS—										
Median	682	389	17	6	186	215	61	86	363	26
Albemarle	773	538	19	10	161	185	67	95	467	23
Rappahannock	747	428	12	4	209	232	69	94	353	24
Bedford	733	395	22	5	161	169	59	69	517	24
Henry	719	397	13	9	192	224	64	83	239	31
Amherst	708	380	22	6	148	216	57	84	285	30
Appomattox	689	521	26	14	161	183	52	82	435	27
Madison	675	382	17	7	159	221	54	93	370	27
Nelson	638	360	17	4	192	238	61	89	409	28
Campbell	630	405	21	10	180	206	56	86	425	29
Franklin	570	365	16	6	201	213	67	86	206	16
Patrick	550	320	10	—	221	232	61	86	152	9
Green	474	344	14	2	193	116	66	94	196	17
VII. NORTHERN VIRGINIA—										
Median	856	451	22	9	146	181	55	95	672	22
Arlington	1081	848	27	9	106	110	81	100	994	13
Loudoun	910	451	21	7	146	181	56	96	754	22
Fauquier	899	506	17	9	150	188	54	91	772	30
Fairfax	856	451	23	—	135	158	55	95	672	19
Prince William	794	499	22	13	153	180	51	90	499	18
Culpeper	718	370	21	8	129	191	47	83	581	32
Orange	687	406	23	7	146	186	59	95	580	31
VIII. W. SOUTHSIDE VIRGINIA—										
Median	695	386	25	10	169	215	49	78	334	45
Brunswick	681	387	25	10	161	241	46	73	407	56
Charlotte	770	430	27	10	173	232	55	84	332	42
Halifax	700	382	24	11	176	207	52	79	335	46
Lunenburg	689	385	28	12	138	213	42	74	398	44
Mecklenburg	655	449	24	8	164	200	39	60	303	53
Pittsylvania	653	300	17	3	183	217	52	77	288	34
IX. E. SOUTHSIDE VIRGINIA—										
Median	882	419	28	6	122	188	40	79	379	61
Isle of Wight	1030	432	28	9	121	182	45	79	324	52
Nansemond	920	432	21	7	123	155	39	81	454	68
Southampton	907	410	31	6	122	202	40	64	349	61
Sussex	882	426	37	2	114	188	32	70	502	66
Prince George	863	405	17	6	148	188	48	88	640	41
Greensville	830	419	28	11	149	200	38	65	379	61
Surry	716	308	32	6	103	193	42	83	357	60
X. LOWER MIDDLE VIRGINIA—										
Median	852	428	30	10	134	192	44	82	429	52
Prince Edward	877	428	32	10	135	192	45	82	478	52
Dinwiddie	852	369	30	10	134	133	39	77	383	61
Nottoway	779	433	30	8	132	197	44	89	429	45

TABLE A.—INDICES OF QUALITY OF INSTRUCTION, 1936-37, AND SPECIFIED SOCIAL AND ECONOMIC INDICES OF VIRGINIA COUNTIES—*Continued.*

SUB-REGION AND COUNTY	Average teachers' salary (1)		Pct. total enrollment in H. S. (1)		Replacement index (2)		Pct. farm workers with marginal incomes (3)		Assessed value per capita (4)	Pct. Negro (5)
	White	Negro	White	Negro	White	Negro	White	Negro		
XI. MIDDLE VIRGINIA—										
Median	755	424	25	10	168	223	56	88	362	51
Goochland	991	430	25	8	169	240	60	97	468	52
Caroline	850	454	23	10	165	220	47	81	352	51
Fluvanna	819	458	25	18	143	228	65	95	509	40
Cumberland	816	379	28	7	170	239	45	88	278	58
Spotsylvania	755	493	22	14	168	197	58	88	436	31
Powhatan	742	360	28	12	160	214	44	90	362	51
Louisa	673	395	21	9	168	210	57	91	345	41
Amelia	672	424	25	16	185	226	44	88	380	51
Buckingham	533	342	22	6	192	223	56	85	244	44
XII. RICHMOND AREA—										
Median	892	455	24	17	120	141	52	91	910	27
Hanover	957	413	24	5	120	178	43	78	469	37
Henrico	892	555	29	17	113	129	52	91	1123	22
Chesterfield	837	455	23	20	126	141	53	93	910	27
XIII. TIDEWATER AREA—										
Median	709	402	27	13	137	193	52	89	332	44
New Kent	850	398	31	14	138	221	55	95	567	59
Essex	793	390	28.6	6	139	193	53	85	287	55
James City	780	400	21	—	132	194	47	90	662	53
Middlesex	762	375	25	13	126	199	54	89	327	46
King William	751	427	31	9	133	185	54	90	383	48
Westmoreland	750	450	20	3	165	185	47	80	351	44
King George	721	422	23	6	140	232	50	89	236	36
Gloucester	717	404	21	14	138	147	51	89	363	40
King and Queen	701	364	31	6	141	217	46	82	310	55
Northumberland	700	431	33	15	128	182	39	82	327	42
Lancaster	672	423	29	14	127	171	50	89	325	45
York	660	465	25	14	137	180	49	89	336	39
Richmond	660	440	16	3	137	191	52	95	274	39
Charles City	643	396	34	14	102	214	55	86	372	77
Stafford	617	360	22	—	163	202	58	91	397	19
Mathews	595	328	36	18	98	121	56	95	229	25
XIV. EASTERN SHORE AND NOR. VEG. AREA—										
Median	837	474	29	9	119	157	46	92	541	42
Warwick	1151	507	28	9	135	160	57	93	683	28
Norfolk	951	500	31	13	126	153	48	94	745	44
Northampton	845	434	31	9	105	157	24	80	517	54
Princess Anne	810	338	25	8	128	157	44	90	565	47
Elizabeth City	828	505	18	16	112	102	47	93	406	27
Accomac	788	437	31	9	99	168	29	70	357	39

[1]Special tabulation of data from Virginia State Department of Education, 1936-37.
[2]The replacement index is based on the ratio of children under 5 per 1000 women 20-44. A replacement index of 100 is necessary to maintain a stationary population.
[3]A gross family income of under $600 was considered marginal. Based on a special tabulation of data from 1930 Census of Agriculture.
[4]Report of Auditor of Public Accounts on "Comparative Cost of Local Government", 1937.
[5]U .S. Census of Population, 1930.
[6]The median represents the midpoint of a distribution.
[7]Less than 0.5%.

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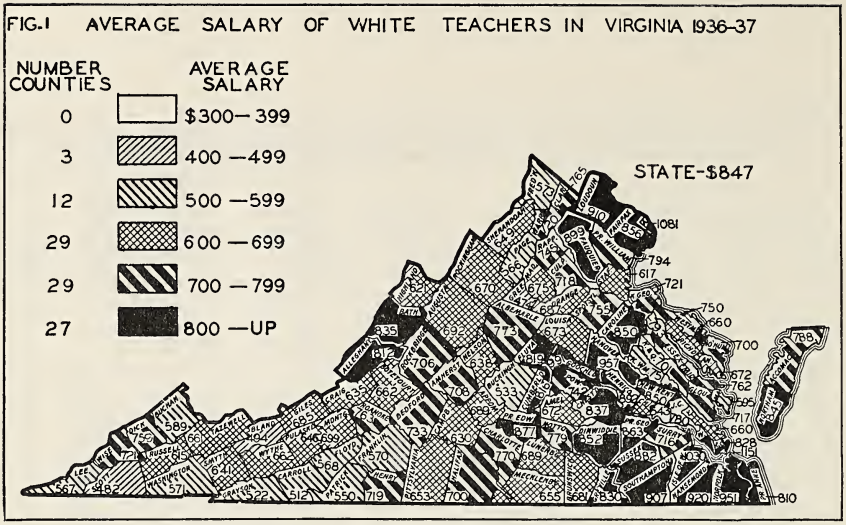
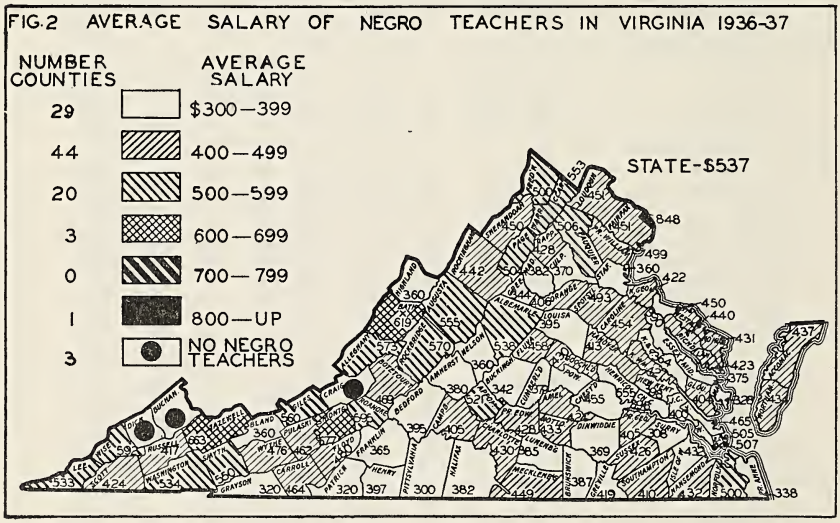
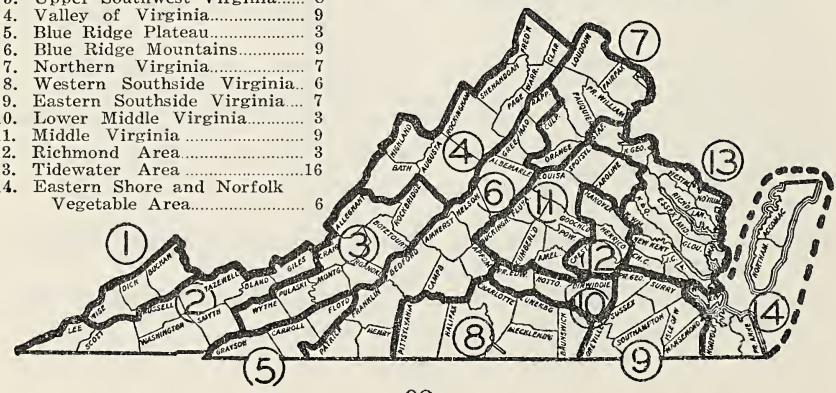




Sub-Regions	*No. Counties*
1. Cumberland Plateau	3
2. Lower Southwest Virginia	11
3. Upper Southwest Virginia	8
4. Valley of Virginia	9
5. Blue Ridge Plateau	3
6. Blue Ridge Mountains	9
7. Northern Virginia	7
8. Western Southside Virginia	6
9. Eastern Southside Virginia	7
10. Lower Middle Virginia	3
11. Middle Virginia	9
12. Richmond Area	3
13. Tidewater Area	16
14. Eastern Shore and Norfolk Vegetable Area	6

FIG. 3 SOCIO-ECONOMIC SUB-REGIONS OF VIRGINIA



A Study of Dielectric Absorption

J. W. Simmons, Jr., and F. B. Haynes

Summary:

A study of anomalous reversible absorption in oiled paper dielectrics has been undertaken as the first in a series of experiments to determine the mechanism of this phenomenon. The effects of times of charge, discharge, and recovery after discharge of the condenser used have been investigated, to be followed by a study of temperature effects.

The relations found thus far, expressed in linear form, are:

$x = \alpha + \beta z$, where x is the reciprocal of the residual charge q, z is the reciprocal of charge time, and α and β are constants when charge time is the only variable.

$x = n + kw$, where x is the same as before, w is the time of discharge, and n and k are constants when discharge time is the only variable.

$x = a + by$, where x is the same as before, y is the reciprocal of recovery time after discharge, and a and b are constants when recovery time is the only variable.

The results of the investigation are not in entire agreement with previous work reported and are interpreted as giving strong support to the theory of ion displacement as the explanation of reversible absorption.

A Study of Dielectric Absorption

Introduction:

The enormous expansion of electrical engineering in recent years has brought to the front one of the earliest recognized phenomena in connection with dielectrics and condensers, the phenomenon of residual charge due to dielectric absorption. Research has shown that dielectric absorption is the chief cause of the alternating current losses in telephone and telegraph cables.[1]

Little is known about this phenomenon because of its complexity. It has been found[2] that the residual charge depends upon the type of dielectric used, the method by which it is prepared, its temperature, the charging potential used, and the previous history of the dielectric.

The amount of residual charge should also depend on the times of charge, of discharge, and of recovery after discharge of the condenser used, and the nature of the dependence should aid in explaining the mechanism of dielectric absorption, with its resultant alternating current losses.

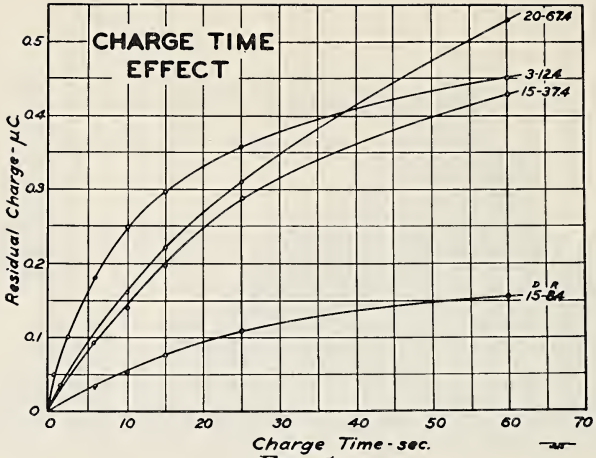


FIG. 1.

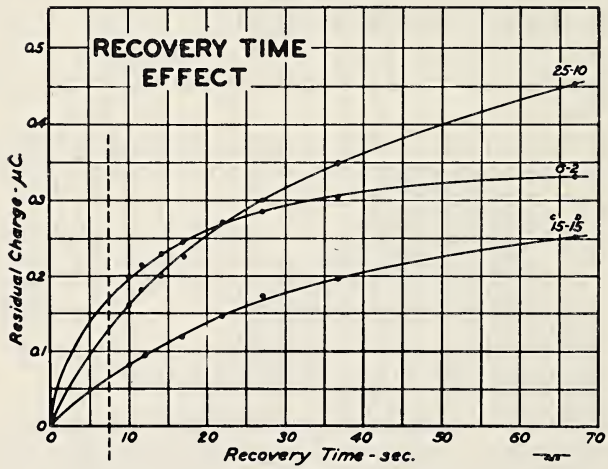


FIG. 2.

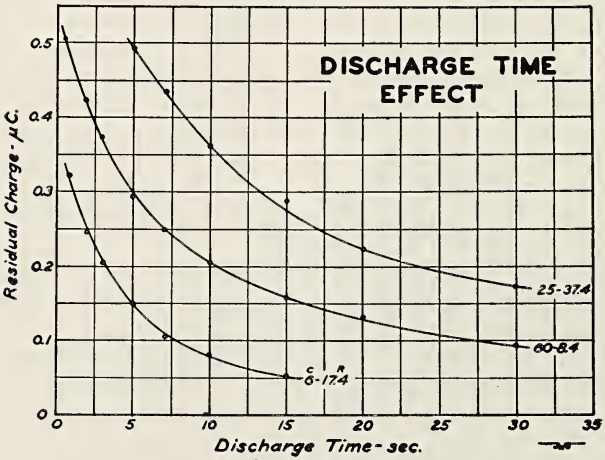


FIG. 3.

INVESTIGATION:

Waxed or oiled paper is one of the dielectrics which exhibits this phenomenon of absorption current to a considerable extent and for this reason was chosen as the material to be used. Ten condensers, Western Electric, Type 1370-A, of capacity 4.32 microfarads, were connected in parallel to give a total capacity of 43.2 microfarads. The charging potential was 1.48 volts obtained from a dry cell. A constant check was kept on the voltage of this cell.

The galvanometer used was a ballistic type of sensitivity 0.002 μcoulombs/mm., and period 28.75 seconds when connected to condensers.

For timing the charge, discharge, and recovery after discharge an entirely automatic combination of relays and selector switch was set up and arranged to be controlled by a seconds pendulum through a photocell.

By adjustment of dials controlling contacts on the selector switch, the times of charge, discharge, and recovery could be varied independently from one to any desired number of seconds in steps of one second. Electrical impulses at one second intervals were received from the photocell to operate the selector switch.

The apparatus could then be set to charge the condensers a given length of time, t_c, stop the charge, and after one second of "soak" begin the discharge. This continues for the desired time, t_d, then the short circuit is removed, the condenser allowed to rest for a set period, t_r, at the end of which it is connected across the ballistic galvanometer and the deflection observed.

Once having set the dials and started the selector switch the operator has merely to wait until the galvanometer deflects, all intervening operations being taken care of by the telegraphic relays and selector switch.

If the effects of times of charge, discharge, and recovery alone are to be measured, it is essential that all other factors which might affect the residual charge shall remain constant. These are such things as temperature, time of soak after charge, charging voltage, and so on.

The automatic apparatus itself took care of any human errors which might have been introduced in timing values, and the time of soak after charge was set to be constant at one second. Constant checking of the charging potential, as before mentioned, was carried out to insure its uniformity. The type of dielectric was the same throughout, the original set of condensers in parallel not being changed during the experiment. The moisture content of the condensers was kept essentially constant by the soldered case, sealed construction of the condensers themselves. Temperature varied only slightly in the closed room where the

experiment was carried out, its effects being eliminated by a periodic checking of galvanometer readings against those previously obtained for the same combination of the three variable times. This continual checking of the readings for self-consistency also eliminated any errors which might have been introduced by an unsuspected change in any circuit constants.

A test of the leakage rate of the charged condensers showed that leakage was small enough to be neglected, the actual value being 0.002 μcoulombs or 0.8% of the average residual charge value for a three-minute period, after charging for 10 seconds, discharging 5 seconds, and allowing recovery for 30, 60 and 90 minutes.

In taking data, charge times of 1, 2, 3, 6, 10, 15, 25, and 60 seconds were used with discharge times of 1, 2, 3, 5, 7, 10, 15, 20, 30, and 60 seconds, and recovery times of the same values. All possible combinations, t_c, t_d, and t_r, of the values were used, the galvanometer reading being recorded for each combination, every point run twice to insure accuracy.

No readings of less than 25 mm. on the curved scale of the galvanometer were counted as accurate enough to be used as data, and no readings of over 250 mm. were taken due to the galvanometer scale limitations. Thus 300 of the 800 available points were eliminated and the remaining 500 double-checked points furnished data for calculations.

A period of three months was occupied with the accumulation of data and the results were consistent as can be seen by the smoothness of the representative curves shown later.

After running a point, the condensers were left on short circuit for a sufficient time to remove essentially all of the remaining residual charge before the apparatus was again set in motion to read the next point. It was found that on the average the two runs for each point checked to within 1% of the mean of the two runs, and the average value of any point could be duplicated later within 3% difference between original and subsequent determinations, even during marked weather changes.

From the data in hand the dependence of the residual charge, q, on t_c, t_d, and t_r was determined for each separately.

By plotting q as a function of t_c when t_d and t_r are held constant we obtain curves of the form shown in Fig. 1. In this case and those following approximately fifteen different curves of each type of variation of q were plotted on large size coordinate paper and the equations mentioned later were checked on these curves. The four representative curves in Fig. 1 were selected as being typical of the q, t_c group. The constant values of t_d and t_r for each curve are indicated as D and R respectively, R being the corrected recovery time as explained later.

Several equations of q as a function of t_c were tried, keeping

in mind the requirements that at $t_c = 0$, q also $= 0$; and as t_c approaches infinity, q approaches constant value. One of the equations suggesting itself is of the form: $q = \frac{1}{\alpha + \beta t_c^{-1}}$, where α and β are constant for any one particular curve. This equation fulfills the requirements just stated.

By determining the constants α and β from points on a curve and testing the fit of the resulting equation to the curve we find an average maximum deviation of predicted from experimental values of q of 2.8% over a range of several curves selected at random from the group plotted.

It was found that for each different curve the values of α and β changed, although remaining constant for any one curve. This indicates that they must be functions of t_d and t_r as these are the only quantities which change from one curve to another. The value of the constants α and β remained of the order of $\alpha = 2.82$, $\beta = 67.5$ as determined for the curve for $t_d = 10$ seconds, $t_r = 5$ seconds.

This small average error for an empirical equation is within experimental error so the equation, $q = \frac{1}{\alpha + \beta t_c^{-1}}$, when t_d and t_r are held constant, may be considered valid.

If q is now plotted as a function of t_r when t_c and t_d are held constant, curves of the form of the representative ones in Fig. 2 are obtained. Here the values of C and D represent the times of charge and discharge, respectively, for each curve. The vertical broken line at the left represents the original $t_r = 0$ axis. It was found, however, that during the time it took the galvanometer to swing from its zero position to the reading recorded, the condenser had a chance to accumulate an additional residual charge to that contributing the original "kick" to the ballistic galvanometer. This further residual charge superimposed upon the deflection produced by the first residual charge an additional deflection and shifted all the curves over to the left.

As a first approximation to the necessary zero correction, the $t_r = 0$ axis was shifted to the left a distance representing 7.2 seconds, which is the value of one-fourth the period of the galvanometer when coupled to the condensers.

The curves may now be extended to pass through this corrected origin and their shape seems to be similar to the general shape of the q, t_c curves, suggesting that an equation of the form used before might also also fit these curves; i.e., an equation, $q = \frac{1}{a + bt_r^{-1}}$, where t_c and t_d are constant for any one curve as are a and b.

Testing the equation as before gives an average difference of only 0.9% between observed and calculated values of q over a range of several curves picked at random. The values of the constants are the order of $a = 2.54$ and $b = 27.5$, as determined for the q, t_r curve for $t_c = 6$ seconds and $t_d = 2$ seconds. They vary from curve to curve with the choice of t_c and t_d, indicating that these quantities a and b are actually functions of t_c and t_d.

When q is plotted as a function of t_d, holding t_c and t_r constant for each curve, the results are as shown in Fig. 3 by three representative curves, t_c and t_r (corrected) for each curve being given by C and R, respectively.

Here it is evident that there is a different type of variation than was discovered before, the curves seemingly being hyperbolic in shape. This suggests an equation of the form, $q = \frac{1}{n + kt_d}$, for t_c and t_r held constant and n and k being constant over any one curve.

Using this form, determining the constants for particular curves, and testing under the same conditions as before, gives an average difference of 2.9% between the calculated and the observed values of q. This error is still within experimental error so this empirical equation may be taken as correct.

The values of n and k vary with choice of t_c and t_r, being of the order of $n = 1.37$, $k = 0.316$, as determined for the curve for $t_c = 25$ seconds, $t_r = 10$ seconds, again indicating that these constants must be functions of t_c and t_r.

It is interesting to note that this form of equation is similar to that obtained by J. Curie, von Schweidler, and H. A. Wilson for the time variation of the reversible absorption current.[3] The significance of this will be discussed later.

Converting these equations to linear form and combining them by the method of partial derivatives gives the general equation:

$$x = a_0 + a_1w + a_2z + a_3y + a_4wz + a_5wy + a_6yz + a_7wyz,$$

where $x = q^{-1}$, $y = t_r^{-1}$, $z = t_c^{-1}$, $w = t_d$, and a_i = constant.

This equation seems to be longer than necessary in view of the fact that it was derived from simple empirical expressions and it is very probable that some of the constants are close enough to zero to be neglected within experimental error.

The above equations lead to a significant point. If t_c and t_d are held constant, then the total amount of residual charge recovered in a given time from a given condenser is a function of the reversible absorption current. Thus $q = \int_{t_1}^{t^2} i(t_r)\,dt$. It has been reported[4] that the anomalous discharge as a function of time has

been found to be: $i(t) = \frac{1}{A + Bt}$, where A and B are constants.

Integrating this expression between the limits gives $q = \frac{1}{B}\left[\log(A + Bt)\right]_{t_1}^{t_2}$, or, $q = \frac{1}{B}\left[\log(A + Bt_2) - \log(A + Bt_1)\right]$ from which, $q = \frac{1}{B}\left[\log(1 - Ft_r)\right]$, where B and F are constants, $t_d = t_1 =$ constant, and $(t_2 - t_1) = t_r$.

This expression is evidently unlike the one which has been derived in the investigation for q as a function of t_r when t_c and t_d are held constant.

There is a similar discrepancy between the results found here and those which follow from equations reported[5] in the case of q plotted as a function of t_c or t_d when the other two time values are held constant, respectively. Some of the reported equations of the charge or discharge current as a function of time in dielectrics exhibiting absorption do not, admittedly, fit the curve. The one selected above for discussion is the one which in the opinion of the writers most nearly fits the absorption curve over its entire length.

The original of the work leading to the reported equations was undertaken prior to 1898 and the article was not seen, so the question as to whether or not sufficient data were used in deriving the empirical equation to give it any accuracy cannot be settled here. It is believed, however, that the equations found in this work are based on enough observations to be accepted as approximately correct. Since reversible absorption occurs the same way in almost all dielectrics which show this phenomenon, then we may say that the equations given in this report will, in general, give the relation existing between residual charge and the times of charge, discharge, and recovery for dielectrics showing reversible anomalous absorption, of which waxed paper is an excellent example.

This work suggests as the most plausible explanation of this reversible absorption the "viscous" displacement of ions in the dielectric. There would be a maximum displacement attainable for large charge times, which would explain the flattening of the q, t_c curves of Fig. 1, the rate of displacement at any time being shown by the slope of the curve at that point.

The rate of return of the ions to normal position would logically follow the same law as the displacement rate, which would account for the same form of equation for q as a function of t_c alone and as a function of t_r alone, respectively. The form of the

q, t_d equation would naturally follow, it being the same as the other two equations with the effect of t inverted.

Since it is the ultimate purpose of the investigation of which this experiment is a part to find the explanation of reversible absorption, it is significant that another "prop" has been added to the many facts supporting this ion theory, of which a few are:

1. Impregnation of paper increases its dielectric loss, probably due to the addition of free ions of the oil used in impregnation. This increase in absorption is a function of the product of the viscosity and conductivity of the oil used, which is a measure of the free ion content of the oil.[6]

2. Puncture strength of a dielectric decreases decidedly with increased moisture in the dielectric.[7]

3. Conductivity and irreversible absorption increase with increase of moisture in the dielectric.[8]

4. Puncture strength decreases with an increase of temperature.[9]

5. Dielectric fatigue[10] may be explained by the displacement of ions.

6. There is no saturation of photoelectric current in sulphur, a factor which requires the absence of ion displacement or flow in the material.[11] There is also no absorption in sulphur when it is used as a dielectric,[12] both of these characteristics being, then, explainable on the basis of the ion theory.

The writers are indebted to Dr. Thomas Davis for his aid in deriving the final form of the combined equations.

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8. Ibid.
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12. See 1, p. 116.

Invisible Stars

DIRK REUYL

"Seeing is believing."

With the unaided eye on a transparent night we may see approximately two thousand stars. Given a pair of binoculars or a telescope, at once we find this number greatly increased.

The criterion of visibility depends in the first place on the equipment used, and this, of course, is directly connected with its location, that is to say, its conditions of transparency and definition, and finally with the observer's eye in visual, and the photographic plate in photographic observations.[1]

We shall not discuss however the invisible stars beyond telescopic reach which are at enormous distances but rather the intrinsically faint stars which are difficult to detect in spite of the fact that they are comparatively near in outside space. Their presence may be revealed to us through their effects as dark or invisible companions to single stars or star systems, hitherto unsuspected of such companionship.

These revelations may come in different ways. With a telescope equipped with photometer we could examine a star periodically changing its brightness with great regularity. Such a star may be a so-called Cepheid, varying in brightness through rhythmic pulsations, or of the type known as eclipsing variable. The latter is a system of two stars of unequal brightness, the faint component in its orbital motion passing in front of and eclipsing the light from the brighter one. Obviously the chances are small for a double star to present itself as an eclipsing variable. Their study is essentially a photometric problem, but two eclipsing variables presumably suited for positional measurement will be discussed in some detail.

Our second instrument, attached to the telescope, will be the spectrograph. If turned to a star known to be single, its spectral lines may be shifted, showing through the Doppler effect a motion in the line of sight, measured in miles or kilometers per second. What happens if the star is not a single star but a binary is easily seen. If the spectra of both components are shown, the lines may periodically become narrow and wide, or perhaps may even appear double. If, on the other hand one

[1]The obviousness of the dependence upon the clearness of the sky, or the transparency, was not evident to the keenly disappointed person who found only a closed dome on a visitors' night at the observatory when there was pouring rain. Another visitor, on another but beautiful night, proved our contention as to its dependence upon the observer's eyesight. Complaining bitterly about "not seeing a thing", this person was found to have had both eyes tightly shut.

component is too faint and the spectrum of the brighter star only is observed, the lines of the spectrum will periodically shift back and forth.

Having outlined two methods of detecting invisible stars, either as components of eclipsing variables through the study of stellar brightness, or as members of spectroscopic binaries through measurements of radial velocities, we proceed to the third method, namely the study of proper motions.

The discovery of the first invisible companion through variability of a star's motion occurred nearly a century ago. It is remarkable indeed that the brightest star in the sky, Sirius, has the distinction of inaugurating this interesting problem. The honor of the discovery belongs to the great Bessel, who made the sensational announcement in 1844, after a study of positions of Sirius determined by the meridian circle over a period of many years. The epoch-making discovery was followed by a startling observation when in 1861, Alvan Clark, while testing the object glass now at the Dearborn Observatory, actually saw the feeble companion, close to its predicted position. Some 50 years later, in 1915, the star again made the headlines when Adams with the great Mount Wilson reflectors succeeded in photographing the spectrum of the faint companion. It showed the star to be white and of a high surface temperature of some 8000° absolute. This implied a high value for the star's radiation per unit area. Yet the star's intrinsic brightness is low, as we know from the apparent brightness and its distance, obtained indirectly through measures of Sirius proper. The obvious result is therefore that we find a small value for the star's area, hence for its radius. As a matter of fact the latter is only 3 times that of the *earth*. Since the mass of the star is actually about equal to that of the sun, it follows that the star presents us with the first case of a "white dwarf", a gas of high temperature with a density roughly 70,000 times the density of water. The first variable proper motion discovered proved to belong to the first white dwarf star brought to our knowledge. Subsequently more stars were found to have non-uniform, non-rectilinear motion, or to deviate from Keplerian motion in the case of double star systems. Procyon and the ζ Ursae Majoris system are interesting examples.

The reader may have noted that up to this point we have only mentioned results which were derived from visual observations. It is hardly necessary to elaborate on their value or importance. However with modern photographic methods now available the visual observations for this type of work have become almost obsolete. There are several reasons for preferring the photographic observations. First of all, the error of a single photographic position is only one-tenth as large as that of a

visual observation, in other words, the ratio of the weights is 100 to 1 in favor of the photographic observation.

Let us begin by studying the behaviour of a single star of large proper motion, which gives us an indication of a presumably small distance. By allowing for the parallactic displacement we note that the star's motion is uniform and along a straight line. It is easily seen what we must expect if a dark companion is sufficiently close to the visible star. We would note that the center of gravity of the system faithfully obeys the law of inertia, or in other words moves uniformly along a straight line. However, our measures are not made on this center of gravity but on the center of the light impression, made only by the visible star. Its motion therefore would be found to be perturbed to an extent which depends upon the masses and separation involved, and as our measures are in angular units the effect will be more pronounced the nearer the system is to the earth. The problem then consists in the systematic observing of nearby stars over a considerable period of time, in an effort to find deviations from uniform rectilinear motion, caused by invisible companions. The project in progress at the McCormick Observatory involves all the stars within a distance of 10 parsecs or 33 light years, a total of some hundred stars or more.[2]

Each star is photographed on about 25 plates covering a period of three years in the average. After an interval of some five years a similar set, the second series, is planned, and after another lapse of time the third series. As an important by-product each new series of plates will materially strengthen the value of the parallax. Regarding our main purpose we may with this arrangement expect to catch the disturbances of shorter as well as those of longer periods. A period, small enough to cause suspicion on a 2 or 3 year series would be checked on the second and again on the third series. A longer period, unnoticeable in any period of three years or less, may yield to the set of three series, when we present each one of these as a single observation with the combined weight of 25 plates. As has been said before, results from this research are not expected to be forthcoming until several years hence. We have, however, available one case for illustration, if only the result of a chance discovery.

To the onlooker the astronomer must as a rule appear as a dissatisfied individual, forever clamoring for larger telescopes, better skies and definition, and faster plates. Quoting the head of the research division of a large photographic factory, "Astronomers always want faster plates and plates with still finer grain, and ——— very few of them."

This may be true in general, but an exception must be made

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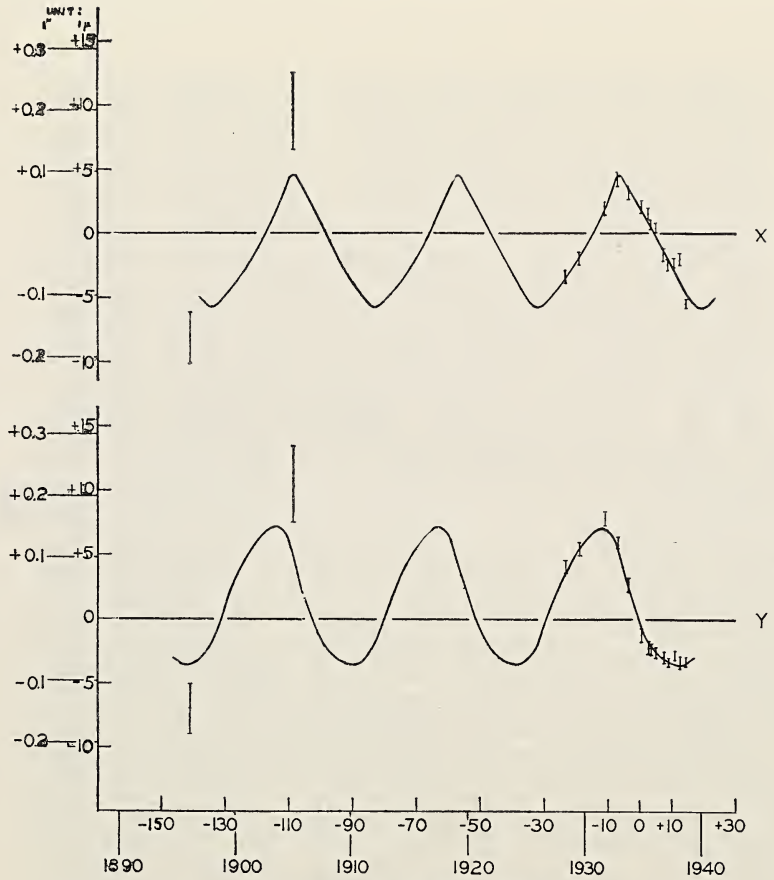
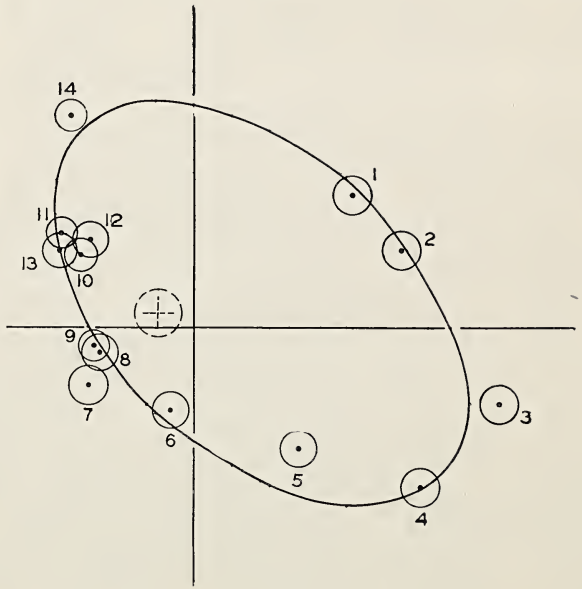
[2]The McCormick parallax program, begun 25 years ago, has so far yielded a grand total of 1400 stellar distances.



RESIDUAL DISPLACEMENTS
IN RIGHT ASCENSION (X) AND DECLINATION (Y)

ROSS 614



APPARENT ORBIT
ABOUT CENTER OF GRAVITY

ROSS 614

in the case of the star Ross 614, with its accidentally detected variability of motion. This rather feeble star with a proper motion of nearly one second of arc per annum, entered the McCormick parallax mill simultaneously with the author on October 24, 1927, without implying however any connection, astrologically or extra-sensory. On account of its faintness, requiring long exposure times, it took no less than eight years for the parallax series to reach completion, in contrast to the minimum interval of two years set by the method in use. Patience and perseverance brought a rich reward however in a large parallax putting the star at a distance of only 4 parsecs, or 13 light-years, but more so in the fact that in the 8-year period covered by the observations the measurements refused to submit to the requirement for uniform rectilinear motion. The effect was detected in the usual right ascension measures, which failed to submit to representation by a linear function of the parallax and time. An additional term involving the square of the time satisfactorily took care of the acceleration. A similar effect was found to be present, to an even larger extent, in the measures in the direction of declination. Had the fast plates of recent times been available, the star's series would have been completed in the normal short stretch of time and as a result the perturbation might have escaped detection on account of the difficulty in distinguishing the corresponding short stretch of curved track from a straight line. At the present time some 70 plates cover the 12-year period during which the star has been observed. From this material it can be concluded that possibly the star has already completed one revolution, implying therefore a lower limit for the period amounting to 12 years. The reason for this uncertainty lies in the fact that the location of the center of gravity and consequently also its motion are unknown so long as the star has not begun its second revolution. We can only measure the deviation from an adopted motion of the center of gravity. Obviously, rather than wait for the star to enter its second round, we may look for information elsewhere. If, for instance, old observations were available, the large time interval involved would give a greatly improved value for the motion of the system and a closer approximation to the true motion of the center of gravity. Such observations were found, one being an astrographic observation at Algiers in 1896, the other a photographic position of 1905, found by a search through the Harvard library of plates. The probable error of these single observations obtained with short focus instruments is estimated to be at least 0″.1. The McCormick positions at each epoch, based upon five or six plates, have an error of approximately 0″.01, or a hundred times greater weight.

However, the inclusion of the old observations is worthwhile in view of their "timely" weight. Adopting the new value of the

motion derived by means of the additional early observations as the motion of the center of gravity of the Ross 614 system, we find that rather than the minimum value of 12 years, a more likely value of 14 years is indicated. We have then obtained the apparent orbit, the projection of the true ellipse upon the plane of the sky, but without the projection of the center of gravity. However, it is possible to calculate the position of the latter through application of the law of areas. Results by this time have become uncomfortably uncertain and we must consider this stage, for the time being, as a good halting place. However if we may attach a reasonable amount of importance to the 14-year period, we may adopt an equally reasonable value of 0.4 solar masses for the mass of the system, and find, through Kepler's harmonic law, that the semi-major axis amounts to 4.3 astronomical units or 1″.1 at the star's distance of 4 parsecs. This very small value may well explain why so far the companion has not been seen, since presumably it may also be considerably fainter than Ross 614 itself. If we, from our halting place, would take another risky step onto the treacherous field of speculations, we could derive the value of 0.3 for the semi-major axis of the visible star about the center of gravity of the system. The mass of the dark companion would be ⅜ times that of Ross 614, giving out of the adopted total mass of the system, 0.3 solar masses to the visible star and 0.1 solar masses to its dark companion.

Let us discuss next the case of dark companions of double star systems. Obviously the same methods could be applied as to the single visible stars. There are however certain advantages in a somewhat different observational technique. In the case of the single stars, exposure times have to be of such length as to register the reference stars satisfactorily, the nearby star incidentally being artificially dimmed to match in brightness the reference stars on the plate.

If however we have a double star with well known orbital motion, we may conveniently forget the reference stars, and define a new method of attack, through the study of the system's orbital motion. If the pair is fairly bright, exposure times are measured in seconds only and large numbers of exposures may be secured in a relatively short time. If we then for instance should take a total of 4 plates of some 50 exposures on each plate at any given epoch, we would obtain an extremely high positional accuracy. Indeed we would have pushed the probable error back into the third decimal place, obtaining a value of about 0″.005. This method as originated by Hertzsprung in 1914 requires additional precautions in order to preserve its accuracy. When dealing with pairs of unequal brightness coarse diffraction gratings are placed over the objective. Such a grating produces a string of spectral images of very small dispersion, the first order spectra of the bright component being used for measurement instead of

its central image. By choosing the proper grating, the brightness of these first order spectra, quite star-like in appearance, may be made equal to the brightness of the fainter star's central image. Positional measurement therefore involves images of equal brightness only, eliminating a possible "magnitude" error, the position of the bright component being determined as the mean of the positions of its first order spectral images.

Observations of this type are now being carried out in various corners of the world, notably at Johannesburg, South Africa and at the Lick and Sproul Observatories. At the McCormick Observatory a large number of stars has been under observation for the past ten years. Included are such well-known binaries as Castor, γ Virginis, ζ Cancri, 70 Ophiuchi, etc. In view of the relatively short interval of time however, none of these is ripe for discussion as yet, with the possible exception of 70 Ophiuchi. At any rate a discussion is under way of the latter interesting system by Dr. Holmberg of the Lund Observatory and the writer. This binary, of magnitudes 4.3 and 6.0 and of annual proper motion 1″.1 has a large parallax, equivalent to a distance of 5 parsecs. The period of revolution amounts to 88 years, and since observations date back to about 1830 the pair is well advanced on its second round. In 1921, Pavel in calculating the orbital elements concluded that it was impossible to "close" the orbit, that is to say the observations differing by the length of the period in time, could not be made to overlap. In addition, there was the wavy string of observed points along the computed ellipse, pointing to perturbations by a third body. Many investigations concerning this dark companion have been carried out leading to a variety of conclusions concerning its mass and the period of the disturbance. Most prominent are periods of 18 and 6 years. It is easy to see that the relatively inaccurate visual observations with the micrometer would never give a satisfactory answer. It is therefore of great interest to have the recent discussion by Strand, who uses all visual observations, covering more than a century, but in addition photographic observations of the past two decades. His conclusion is that no perturbations exist, that in fact all previous discrepancies must be ascribed to the visual observations. At a first glance this result seems conclusive, and continuance of observations on a large scale would form a debatable issue. However a careful investigation reveals that the photographic observations were given very high weights relative to the visual measures, so that of necessity the orbital ellipse passes through the photographic points. Any disturbance slightly larger than the interval covered photographically would thus escape detection. Therefore a discussion of the McCormick material seemed worthwhile and at the present stage of the work a real disturbance is indicated. This however will be only of small size compared with the originally proposed perturbations,

whose reality had been definitely disproved by Strand's work. We may get a rough idea of the masses involved when we apply Kepler's harmonic law. In this case the mass of the bright component is nearly equal to the mass of the sun and the small mass of the dark companion may be added without affecting this calculation. Then, a period of 18 years would, with the parallax of 0″.2 result in a semi-major axis of 1″.5. Realizing now that the accuracy of our photographic normal points is given by a probable error of 0″.005, perturbations as small as 0″.015 can be discovered. It follows immediately that the required minimum value of the mass of the dark companion would be 0.01 times the sun or 10 times as massive as Jupiter. A longer or a shorter period would correspondingly lower or raise this limit.

In leaving the problem of Keplerian motion disturbed by unseen companions we must still pause to mention the use of the objective grating method in the case of a single star.

The star is none other than Polaris, the north star. As is well known Polaris is a variable star, pulsating in a period of 4 days. In addition to this disturbance, Gerasimovic and Oort from meridian observations suspect an invisible companion causing a disturbance with a period of about 30 years. The two investigators agree as to the order of magnitude of the period, but are in profound disagreement regarding the phase. The star is now under observation at the McCormick Observatory. A background star, forming with Polaris an "optical" pair, at a distance of about 18″ serves as a reference star. As Polaris is some 7 magnitudes, or 600 times brighter than this star an objective grating is used which produces first order spectral images of Polaris just 7 magnitudes fainter. Results of this investigation are expected to be forthcoming around 1970 and it is hoped that they will meet the requirements of the VIRGINIA JOURNAL OF SCIENCE.

In concluson we shall return to the two cases of eclipsing variables which appear to offer a reasonable chance of yielding to astrometric methods.

The stars are ϵ Aurigae and VV Cephei, and the problems which they present are rather analogous. The recent VV Cephei discussion was made by Gaposchkin, the ϵ Aurigae study carried out by Kuiper, Struve and Strömgren. We shall choose the case of ϵ Aurigae to illustrate the problem which originates in difficulties encountered in the interpretation of the spectral features and light curve. The interpretation presents some highly interesting problems.

The system is found to consist of a super-luminous white star, and an infra-red star of a temperature of aboue 1300°. The latter emits no appreciable light in the observed spectral region, the spectrum being almost entirely due to the white star. Spectroscopic observations and measures of the light intensity during

the time when the white star is eclipsed by the infra-red, "invisible", star show that the latter is to some extent transparent and that its opacity confined to an outer layer, is caused by the radiation of the white star. The feature which is of immediate concern to us is the derived value of the amplitude of the white star's orbital motion, which amount to 0″.030. From the orbit, of a period of 27 years, the times of maximum displacement are known and by a sufficiently large number of observations the amplitude may thus be checked. A verification of this value would confirm the unusually high luminosity of the white star. Finding no evidence of displacement would imply an underestimated distance and consequently raise the star's luminosity to an even greater value. If however the displacement is determined to be larger than the above mentioned value, it will indicate that the star's luminosity is more nearly normal.

It is evident from this review that the search for invisible stars will yield valuable information regarding various problems, and principally those dealing with stellar masses. Our knowledge about the latter is still rather limited. The smallest stellar mass known is 0.2 of the sun's mass, and belongs to a red dwarf star of relatively low effective surface temperature. The next smaller in size is the largest planetary mass, that of Jupiter, amounting to only 0.001 of the sun's mass. We like to think that masses intermediate between these limits are only awaiting discovery.

Through the systematic application of the methods outlined above, aided by time as a powerful ally, we may well advance toward the ultimate defeat of ignorance.

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University of Virginia.

Notes on the Mid-Appalachian Species of Paronychia[1]

EARL L. CORE

Two genera of native plants, according to Gray's *Manual,* 7th edition, represent the Illecebraceae in the mountains of the mid-Appalachian region. Recent studies by Fernald and others, however, indicate that the treatment of the family in that work requires considerable modification and the interesting center of distribution in this area prompts the publication of the present note, preliminary to the issuance of my more extended paper on the North American species of *Paronychia.*

In Gray's *Manual* the mid-Appalachian species are separated into the two genera *Anychia* and *Paronychia.* The species in *Anychia,* the name itself a contracted derivative of *Paronychia,* are separated from the latter by having the "stamens on the base of the 5-parted awnless calyx" and the "styles hardly any", whereas in *Paronychia* the stamens are "on the base of the 5-parted calyx, the sepals hooded at the summit and bristle-pointed", the "style 1, 2-cleft at the top." The genus *Anychia* is a strictly American group erected by Michaux[2] in 1803. Numerous writers, however, have expressed doubt relative to its maintenance as a separate genus. Fernald[3] summarized the literature on the subject and followed Pax & Hoffman[4] in treating *Anychia* as a section of *Paronychia.* Other botanists in this country seem generally disposed to follow Fernald's lead and the species of *Anychia* have all been transferred to *Paronychia.* Numerous nomenclatorial difficulties have been encountered, which will be discussed in this paper, along with the mid-Appalachian distribution of the species.

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[1]Contribution No. 11 from the Herbarium of West Virginia University.

In the preparation of this paper I am deeply indebted to my friend, Dr. Harold N. Moldenke, of the New York Botanical Garden, who rendered invaluable service in copying out literature not available to me at Morgantown.

I am also indebted to heads of the institutions listed below for loan of the herbarium material cited:

B—Brooklyn Botanic Garden
C—Carnegie Museum
D—Duke University
F—Field Museum
G—Gray Herbarium
M—Missouri Botanic Garden
NY—New York Botanical Garden
P—Philadelphia Academy of Natural Sciences
S—California Academy of Science, San Francisco
US—United States National Herbarium
W—West Virginia University.

[2]Fl. Bor. Am. 1. 112.

[3]Rhodora 38: 416-421. 1936.

[4]Engler & Prantl Nat. Pflanzenfam. ed. 2. 16c: 300. 1934.

PARONYCHIA CANADENSIS Wood, Class Book, 262. 1861.

Queria canadensis L. Sp. Pl. 90. 1753; *Anychia dichotoma* Michx. Fl. Bor. Am. 1. 113. 1803; *Queria capillacea* Nutt. Gen. 1: 159. 1818; *Anychia canadensis* Ell. Sketch. 1. 307. 1824; *Anychia capillacea* DC. Prod. 3: 369. 1828; *Anychia filiformis* Raf. ex Britton in Bull. Torr. Bot. Club 13: 187. 1886.

This is a strongly-marked species easily recognized by its glabrous stems and slender branches. It occurs in dry woodlands from New England to Florida and extends west to Nebraska. The following mid-Appalachian stations may be noted:

VIRGINIA: Stony Man Mt., near Luray, Page Co., *Mr & Mrs Steele* (G,M,US); Lexington, Rockbridge Co., *Churchill* (G,M); New River at the mouth of Brush Creek, Carroll Co., *Small* (G,NY,F); Iron Mt., Smyth Co., *Britton, Britton & Vail* (NY,C); Bull Pasture Mt., Highland Co., *Rydberg* 9220 (NY); Lee Co., *Chance* (M); Pulaski Co., *Meredith* (P); Bluemont, Loudoun Co., *Standley* 10610 (US); Bedford Co., *Curtiss* (US).

WEST VIRGINIA: Tygarts Valley River, Taylor Co., *Smith* (US); Rowlesburg, Preston Co., *Steele* 61 (US); The Pinnacle, Abbs Valley, Mercer Co., *Morris* 1096 (US); Baileysville, Wyoming Co., *Morris* 1268 (US); Fairmont, Marion Co., *MacElwee* (P); Middle Wheeling Creek, Ohio Co., *Bartholomew* 81 (W); Ft. Gay, Wayne Co., *Lycan* 66 (W); Littleton, Wetzel Co., *Haught* 651 (W); Easton, Monongalia Co., *Anderson & Smith* 278 (W); Pink, Calhoun Co., *Harris* (W); Jarrell Branch, near Uneeda, Boone Co., *W.V. U. Bot. Exped.* (W); Nuttallburg, Fayette Co., *Nuttall* (W); Snowy Mt., Pendleton Co., *Rydberg* (NY); Brooke Co., *Oglebay Plant Club* 130 (W); Huntington, Cabell Co., *Gilbert* 601 (G,M, F, W); Hinton, Summers Co., *Boone* (D); Ambrosia, Mason Co., *Core* 6535 (W); Nitro, Putnam Co., *Core* 6425 (W); Huttonsville, Randolph Co., *Hutton* (W).

PARONYCHIA FASTIGIATA (Raf.) Fernald, Rhodora 38: 421. 1936.

Anychia fastigiata Raf. Atl. Journ. 16. 1832; *A. polygonoides* Raf. 1. c., not *Paronychia polygonoides* Muschler, Engl. Bot. Jahrb. 45: 459. 1911; *A. conferta* Raf. 1. c.; *A. lateralis* Raf. 1. c.

Fernald has discussed in detail[5] the tangled nomenclatorial problems involved in selecting the proper name for this species in the genus *Paronychia*. It was not listed by Wood and the name *A. polygonoides*, by which it had long been known, could not be transferred to *Paronychia* because of the previous use of that name by Muschler for a different plant. Fernald, therefore, selected the name *A. fastigiata* Raf. as being conspecific with Rafinesque's *A. polygonoides*, and published in the same article.

This species, unlike *P. canadensis*, is not clearly marked and

[5]Rhodora 38: 416-421. 1936.

consists of several geographic races, some of which have a tendency to grade into the next species. The typical form has a stem differing from *P. canadensis* in being minutely pilose or somewhat puberulent and somewhat coarser and stiffer than in that species. It is likewise widely distributed, occurring from Massachusetts to Florida and west to Wisconsin and Texas, although not usually so abundant. A form with stipular bracts equalling or overtopping the flowers was recognized by Fernald as the variety *paleacea*[6] and is found with the species from Delaware and Pennsylvania to Illinois and Tennessee. Another form with with subulate awns, named by Small *Anychia Nuttallii*[7], was reduced by Fernald to varietal status under *P. fastigiata,* as variety *Nuttallii.*[6]. It is known only from Huntington, Adams, and Franklin Counties, Pennsylvania.

The following stations well represent the mid-Appalachian distribution of this variable species:

VIRGINIA: Potts Mt., *Mr & Mrs Steele* (M); Orkney Springs Shenandoah Co., *Steele* 2, 106, 157, 3854 (US,B); Peaks of Otter, *Beyrich* (M); Natural Bridge, Rockbridge Co., *Bartram* (P); Millboro, Bath Co., *Steele* (US,F); Craigsville, Augusta Co., *Steele* 115 (US); Bull Run Mts., Fauquier Co., *Allard* 2291 (US); Stony Man Mt., near Luray, Page Co., *Mr & Mrs Steele* 72 (G,NY,M); Bedford Co., *Curtiss* (G); between Marion and White Top Mt., Smyth Co., *Rydberg* 8063 (NY).

WEST VIRGINIA: Duck Creek, Harrison Co., *Martin* 353 (W); Burlington, Mineral Co., *Berkley* 1669 (M); Baileysville, Wyoming Co., *Morris* 1254a (US, B); Berkeley Springs, Morgan Co., *House* 1570 (US,M); Huntersville, Pocahontas Co., *Mr & Mrs Davis* 1423 (W); Hanging Rock, Hampshire Co., *Frye* 1481 (W); Wendell, Taylor Co., *Mr & Mrs Davis* 853 (W); Contrary Creek, Fayette Co., *Nuttall* (W); Middle Wheeling Creek, Ohio Co., *Bartholomew* (W).

A fourth variety of *Paronychia fastigiata,* Fernald admits[8], is considerably more remote from the others, although he concludes it to be only one of the extremes of a variable species. Nevertheless, numerous botanists have felt the form to be distinct enough to deserve specific rank and from its usually characteristic diffuse habit, long style, and striking distribution on the Appalachian shale barrens, I am inclined to agree with this disposition. Once more, however, we are confronted with unusual nomenclatorial problems in selecting the proper new combination. Rafinesque in 1838[9] described a species which he called *Anychia divaricata,* found in the Alleghany Mountains. Unfor-

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[6]l. c. 421.
[7]Torreya 25: 60. 1925.
[8]Rhodora 38: 419. 1936.
[9]Raf. New Fl. 4: 42. 1838.

tunately, he was not sufficiently clear in his description and it is not known precisely to what plant his name should belong. In 1911 Steele[10] took up Rafinesque's name for the present form, and cited characteristic specimens of it, from the Appalachian shale barrens. One year earlier, however, Small[11] had described the plant as a new species which he called *Anychiastrum montanum,* regarding it as even generically distinct from *Anychia polygonoides.* Even if it could be determined exactly to what plant Rafinesque's *Anychia divaricata* refers, this name could not be taken over into *Paronychia* because of Jussieu's earlier use of the name for a different plant.[12] Fernald calls attention to a plant which Wood described as *Paronychia canadensis β pumila,*[13] which, having a "style as long as the ovary", is certainly the same as *A. divaricata* Raf., at least as interpreted by Steele. If this plant is to have specific rank, therefore, it would seem that Wood's name is the oldest usable one and hence I propose the following new combination:

PARONYCHIA **pumila** (Wood), comb. nov.

Paronychia canadensis, β pumila Wood, Class Bk. 263. 1861; *A. divaricata* Raf. New Fl. 4. 42. 1838, as interpreted by Steele, Contrib. U. S. Nat'l. Herb. 13: 363, 1911, not *Paronychia divaricata* Juss. Mém. Mus. Par. 2: 390. 1815; *Anychiastrum montanum* Small, Torreya 10: 230. 1910; *Plagidia montana* Pax & K. Hoffm., Eng. & Prantl, Nat. Pflanzenfam. ed. 2. 16c. 300. 1934; *Paronychia fastigiata* var. *pumila* (Wood) Fernald, Rhodora 38: 421. 1936.

This plant is one of the characteristic and abundant members of the shale-barren flora in the mid-Appalachian region and extends sparingly into other dry situations along the mountains to Alabama and Georgia. The following records represent its mid-Appalachian occurrences:

PENNSYLVANIA: Chambersburg, Franklin Co., *Porter* (NY, P); Hyndman, Bedford Co., *Small* (NY), type of *Anychiastrum montanum;* Reading, Berks Co., *Bischoff* (P); Doubling Gap, Perry Co., *Abbott* (P).

MARYLAND: High pine wood hill, *Shriver* in 1859 (M), type of *P. canadensis* var. *pumila;* Savage River, Alleghany Co., *Smith* (US); Sideling Hill, Washington Co., *Shreve & Jones* 796 (US).

VIRGINIA: Stony Man Mt., near Luray, Page Co., *Mr & Mrs Steele* 242 (G,M,NY,US); Three-Top Mt., Shenandoah Co., *Hunnewell & Griscom* 15169 (G); Massanutten Mt., Rockingham Co., *Heller & Halbach* (P,G,US,NY,M,F); Bull Pasture Mt.,

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[10]Contrib. U. S. Nat'l. Herb. 13: 363. 1911.
[11]Torreya 10: 230. 1910.
[12]Mém. Mus. Par. 2: 390. 1815.
[13]Class Book, 263. 1861.

Highland Co., *Rydberg* 9220a (NY); Johns Creek Mt., *Mr & Mrs Steele* (NY,M); Augusta Springs, Augusta Co., *Steele* (M); Hot Springs, Bath Co., *Piper* (US); Grandview, near Bluemont, Loudoun Co., *Williams* (US); Peaks of Otter, Bedford Co., *Palmer* 76 (US); Cedarville, Warren Co., *Miller* (US); Goshen, Rockbridge Co., *Steele* (US); Eagle Mt. R. R., Botetourt Co., *Mr & Mrs Steele* (G,M,NY,US).

WEST VIRGINIA: Back Creek, Berkeley Co., *Core* 5834 (W); Hanging Rock, Hampshire Co., *Frye* 1486 (W); Burlington, Mineral Co., *Rumsey* (W); Seneca Rocks, Pendleton Co., *W. V. U. Bot. Exped.* (W); Slanesville, Hampshire Co., *Wherry* (W); Kates Mt., Greenbrier Co., *Franklin* (G); Sweet Springs, Monroe Co., *Roush* 819 (M); Petersburg, Grant Co., *Strausbaugh* (W).

PARONYCHIA ARGYROCOMA Nutt. 1: 160. 1818.

Anychia argyrocoma Michx. Fl. Bor. Am. 1: 114. 1803.

This perennial species forms characteristic carpets on exposed rocky knobs and ridges along the Appalachians from New England to Georgia. The striking silvery stipules have suggested the common name of Silverling.

VIRGINIA: Pinnacles of Dan, Patrick Co., *Shriver* (P); Monterey, Highland Co., *Leeds* 1042 (P); Balcony Falls, *Britton* (B); Summit of Stone Mt., Caldwell Co., *Small & Heller* 146 (B); Peaks of Otter, *Brown, Hagy, Vail, Timmerman, Britton, & Britton* (NY).

WEST VIRGINIA: New Creek Mt., Grant Co., *Wherry* (W); Cabins, Grant Co., *Mr & Mrs Davis* 466 (W); Nelson Rocks, Pendleton Co., *Allard* 2139 (NY,F); Seneca Rocks, Pendleton Co., *Core* (W); North Fork Mt., Pendleton Co., *Strausbaugh* (W); Panther Mt., Pendleton Co., *Rydberg* 9038, 9163 (NY); Beaver Dam Spring, Pendleton Co., *Core* 3686 (NY).

The fifth mid-Appalachian species has its type locality on the rocks at Harper's Ferry, but seems to be quite rare throughout the whole area. Curiously enough, this species reappears, after broad intermittent gaps, on rocky hills in Arkansas, Oklahoma, and Texas. Its nomenclatorial history is fully as tangled as that of any of the others.

Linnaeus first described the plant in 1767, under the name of *Achyranthes dichotoma*,[14] giving as the type locality, "Habitat in Virginia". Willdenow in 1797,[15] definitely refers to Linnaeus' plant, as he cites "Mant. 51" and gives the same locality "Habitat in Virginia", although he does not make the combination "Illecebrum dichotomum", attributed to him by Nuttall.[16] De

[14]Mant. 51. 1767.
[15]Sp. Pl. 1: 1196. 1797.
[16]Gen. N. Am. 1: 159. 1818.

Candolle in 1804,[17] however, described an entirely new plant under the name of *Paronychia dichotoma*. He cites no type locality and mentions neither Willdenow nor Linnaeus, stating only, with his brief Latin diagnosis, that the type specimen is in Jussieu's herbarium, now in Paris. De Candolle, himself, in 1828,[18] reduces his *Paronychia dichotoma* "DC. in Lam. dict. enc. 5. p. 25" and "Illecebrum dichotomum Pers. ench. 1. p. 261", to synonymy under *Herniaria dichotoma*, which name is, thus, a new combination for his earlier *P. dichotoma*, although he was not certain of its position, for he lists it under "*species non satis notae*" and says "*Patr. ign.*"

On a later page in the same work,[19] De Candolle recognizes a *Paronychia dichotoma* Nutt. which is Linnaeus' plant, for he says, "In rupibus Virginiae ad ripas flum. Shenandoah. *Achyranthes dichotoma* Linn. Mant. 51". Nuttall, in publishing the binomial *P. dichotoma*,[20] clearly intended it to represent Linnaeus' plant, since he gives in synonymy the names "*Achyranthes dichotoma* LINN. *Illecebrum dichotomum* WILLD.", and gives as the habitat of the plant, "On slate rocks, by the margin of the river Shenandoah, Virginia, in the vicinity of Harper's Ferry". Nuttall's name, thus, was taken up by De Candolle because, since he regarded his own *Paronychia dichotoma* as a synonym for *Herniaria dichotoma*, he felt free to adopt Nuttall's binomial, a later homonym, for the Virginia plant. Under the present rules, however, we cannot follow this practice of De Candolle's and the name, *Paronychia dichotoma*, widely used for more than a century, must be regarded as invalid. Sprengel apparently so regarded it as early as 1825,[21] and proposed the new name *Paronychia virginica* to replace the homonym, but later botanists overlooked or ignored his action. Since, under the present International Code, this constitutes the oldest usable name, it would appear to be the correct binominal for the Harper's Ferry plant.

The species was separated from *Paronychia* by Arnott,[22] but only the generic name *Plottzia* is given. A good description of the genus appears and the name is accredited to Arnott in a letter to Lindley. The type species is said to be *Paronychia dichotoma* Nutt., but the actual new combination is made for the first time by Torrey and Gray in 1838.[23]

PARONYCHIA VIRGINICA SPRENG. Syst. 1. 822. 1825.

Achyranthes dichotoma L. Mant. 51. 1767; *Illecebrum dicho-*

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[17]Poir. Encyc. 5: 25. 1804.
[18]Prodr. 3: 368. 1828.
[19]Prodr. 3: 372. 1828.
[20]Gen. N. Am. 1 :159. 1818.
[21]Syst. 1: 822. 1825.
[22]Lindl. Nat. Syst., ed. 2. 441. 1836.
[23]Fl. N. Am. 171. 1838.

tomum Willd., ex Nutt. Gen. N. Am. 1: 159, 1818, in synon.; *Paronychia dichotoma* Nutt. Gen. N. Am. 1. 159. 1818, not De Candolle in Poir. Encyc. 5: 25. 1804; *Plottzia dichotoma* Arnott apud Torr. & Gray Fl. N. Am. 171. 1838.

MARYLAND: Great Falls of the Potomac, *Steele* (D,NY); along Potomac River, Montgomery Co., *Muenscher* 3715 (M); Great Falls of the Potomac, *Vasey* (G,P); prope Washington, *Holm* (S).

WEST VIRGINIA: Harper's Ferry, *Thos. Nuttall* (M); *Blake* 8046 (G); *Schweinitz* (P); *Stotler & Wherry* (NY); Springfield, Hampshire Co., *Frye* (W).

VIRGINIA: "Virginia", *Hall* in 1828-1834 (F); Lead Mines, *Cope* (F); Wythe Co., *Aikin* (G).

WEST VIRGINIA UNIVERSITY,
MORGANTOWN, W. VA.

Members of the Genus Phacus Dujardin at Mountain Lake[1]

SAMUEL LEWIS MEYER

The genus *Phacus*. of the family Euglenidae (Euglenaceae), was established by Dujardin in 1841. Bütschli (1883-1887) credited Nitzsch with the founding of the genus in 1817. Walton (1915) and Skvortzow (1928) both cited Dujardin as the founder of the genus *Phacus* though other writers, such as Doflein (1928) and Kudo (1939), followed Bütschli in citing Nitzsch. Smith (1933) called attention to the fact that Nitzsch's 1817 publication, "Beitrag zur Infusorienkunde oder Naturbeschreibung der Zerkarien und Bazillarien," contained no mention of *Phacus* in which case the citation of Dujardin is undoubtedly correct.

The characteristics of the solitary, free-swimming, conspicuously flattened cells of the members of the genus *Phacus* are too well known to require detailed consideration here. Of the 40 recognized species of the genus, as given by Skvortzow (1928), twelve have been found in this country (Smith, 1933). Of the latter, five species have been found in the vicinity of the Mountain Lake Biological Station, Giles County, Virginia.

Walton (1915) divided the members of the genus *Phacus* into two major groups: those in which the posterior part of the body is more or less uncinate (hooked, curved back at the tip) and those in which the posterior spike-like process is either straight or absent, not uncinate.

Of the former group, two species have been found at Mountain Lake, *Phacus pleuronectes* (O.F.M.) Duj. and *Phacus triqueter* (Ehr.) Duj. Stein (1878) stated that the *Phacus pleuronectes* of Dujardin (1841) was identical with the *Euglena pleuronectes* of Ehrenberg (1838). Bütschli (1883-1887) followed this same usage. Lemmermann (1913) and Walton (1915), among the more recent writers, credited O. F. Müller (1773) with first naming the species while Kudo (1931) cited Ehrenberg (1838). A more recent publication by the same author (Kudo, 1939) changed the citation to Müller (1773). Reference to Kent (1880-1881) clears this nomenclatural difficulty for he stated that *P. pleuronectes* was originally described by Müller as *Cercaria pleuronectes,* was transferred to the genus *Euglena* by Ehrenberg, and was finally placed in that of *Phacus* by Dujardin. *Phacus triqueter* was placed in the genus *Euglena* by Ehrenberg and was transferred to the genus *Phacus* by Dujardin. The two species, *P. triqueter* and *P. pleuronectes,* are evidently closely related. In fact, the similarity is so marked that some investigators list the former as a variety of the latter. The cells of *P. triqueter* are oval and strongly twisted while those of *P. pleuronectes* are more broadly oval and slightly twisted. *P. triqueter* may be easily distinguished by the presence of a dorsal,

[1]Paper presented before the Section of Biology, Virginia Academy of Science, at the Seventeenth Annual Meeting, Danville, Virginia, May 5, 1939.

longitudinal carina or fold which extends from the anterior to the posterior end of the cell, a structure which is absent in *P. pleuronectes.*

Three of the observed species are placed in Walton's second major group, *Phacus longicauda* (Ehr.) Duj., *P. caudata* Hübner, and *P. pyrum* (Ehr.) Stein. The first two species are placed near each other in tables of classification. *P. longicauda* is the larger and, as the name implies, has a long, posteriorly directed spine as long as, or longer than, the body. This species was originally placed in the genus *Euglena* by Ehrenberg. *P. caudata* also bears a straight, posterior spike-like process but one which is much shorter, approximately one-third the length of the cell. The other species found at Mountain Lake, *Phacus pyrum,* was first figured and described by Ehrenberg as *Euglena pyrum.* The cells are oval, gradually narrowed posteriorly to form a somewhat elongated, straight spine. The periplast is marked by spiral striations, a characteristic which distinguishes this species from all others yet observed in the region.

Further study will probably reveal other members of this interesting euglenoid genus in the vicinity of Mountain Lake.

The observations reported here were made at the Mountain Lake Biological Station during the summers of 1936 and 1938 in connection with the courses in Protozoology taught by Dr. L. L. Woodruff, of Yale University, to whom the writer is grateful for many valuable suggestions.

MOUNTAIN LAKE BIOLOGICAL STATION AND
MILLER SCHOOL OF BIOLOGY.

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GENERAL NOTES

Request for Allium alleghaniense Material.—Rev. S. V. Fraser, St. Peter's Church, Aurora, Kansas, would like to have "about a dozen good live bulbs or growing plants of *Allium alleghaniense* Small," from Virginia. Any readers who might supply this material will please write to Rev. Fraser.

Isatis Tinctoria abundant near Luray, Virginia.—The interesting note concerning the occurrence of "*Isatis tinctoria* along Skyline Drive" as observed by Dr. M. A. Chrysler of Rutgers University (Virginia Journal of Science, Vol. 1, No. 1, page 33) caused me to refer to my notes on the occurrence of this species immediately north of Luray, Virginia. I quote from my notes dated May 22, 1939, "*Isatis tinctoria* in full bloom and very abundant in the fields and along the roadside on Route 12 immediately north of Luray, Virginia. The bloom is so profuse in the fields west of the road that bright yellow patches can be seen from a distance. The unusual abundance of the plants caused me to investigate the identity of the species."—W. S. Hough, Winchester Research Laboratory, Winchester, Virginia.

Virginia Academy of Science

PRESIDENTS

Name	*Field*	*Year*	*Institution*	*Place of Meeting*	*Year*
				William and Mary	1923
Ivey F. Lewis	Biology	1923-24	Univ. of Va.	Wash. & Lee	1924
James L. Howe	Chemistry	1924-25	Wash. & Lee	Richmond	1925
R. E. Loving	Physics	1925-26	Univ. of Rich.	Univ. of Va.	1926
J. S. Horsley, Sr.	Medicine	1926-27	Richmond	V. P. I. & E. R. S. C.	1927
D. W. Davis	Biology	1927-28	William & Mary	William & Mary	1928
Wm. M. Brown	Psychology	1928-29	Wash. & Lee	Staunton M. A.	1929
Garnett Ryland	Chemistry	1929-30	Univ. of Rich.	R. M. W. College	1930
L. G. Hoxton	Physics	1930-31	Univ. of Va.	Norfolk	1931
I. D. Wilson	Medicine	1931-32	V. P. I.	Hollins College	1932
T. McN. Simpson, Jr.	Mathematics	1932-33	R. M. College	Fredericksburg	1933
W. A. Kepner	Biology	1933-34	Univ. of Va.	Harrisonburg	1934
Wm. T. Sanger	Psychology	1934-35	Med. Coll. of Va.	Univ. of Richmond	1935
Ida Sitler	Biology	1935-36	Hollins College	V. M. I.	1936
H. E. Jordan	Medicine	1936-37	Univ. of Va.	Univ. of Va.	1937
D. M. Allan	Psychology	1937-38	H. S. College	V. P. I.	1938
E. B. Norris	Engineering	1938-39	V. P. I.	Danville	1939
R. S. Freer	Biology	1939-40	Lynchburg College	V. M. I.	1940
W. F. Rudd	Pharmacy	1940-41	Med. Coll. of Va.	Med. Coll. of Va.	1941
Geo. W. Jeffers	Biology	1941-42	Farmville S. T. C.		1942

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Virginia Academy of Science
Lexington, Virginia
May 2-4, 1940
Second Symposium on Organic Analytical Reagents

Introduction

JOHN H. YOE

According to the periodic classification there are ninety-two chemical elements; the existence of about ninety of these is now well established. The chief object of the research worker in analytical chemistry is the discovery and development of new and more highly sensitive methods for the detection and determination of the chemical elements and their compounds. Such studies have important applications in chemistry and chemical industry, as well as in the various medical, biological, and geological sciences. By far the most promising field for new and better analytical reagents is among the vast number and variety of organic compounds. Much experimental work is needed to establish the relationship between the molecular structure of organic compounds and their analytical reactions. When a new reaction is discovered it is then necessary to make an extensive investigation to determine its nature, limits of accuracy, its sensitivity, optimum conditions for its use, the interference of various ions, etc.

The chemical laboratory at the University of Virginia is especially well equipped with material suitable for research in analytical chemistry. Over a period of years, we have collected compounds of practically all the chemical elements, many of which are extremely rare and difficult to obtain in the high degree of purity required for research work. There are also available in the University laboratory several thousand organic compounds, including many rare ones. Most of these have been supplied gratis by several chemical firms. Each organic compound selected as a possible new analytical reagent is studied by spot-plate reactions with standard solutions of ions of the various

elements under a variety of experimental conditions. About 160 separate tests are made with each organic compound, and to-date over 3000 have been studied, a number of which give promise of being useful as highly sensitive reagents for certain chemical elements.

About two years ago several colleges in the state signified their interest in co-operating with the University in these analytical chemistry investigations. A little later, other state institutions joined in the work. Those now co-operating are: Prof. W. J. Frierson, Hampden-Sydney College; Prof. L. J. Desha and Mr. J. R. Taylor, Washington and Lee University; Profs. J. W. Watson and F. H. Fish, Virginia Polytechnic Institute; Prof. I. A. Updike, Randolph-Macon College (Ashland); Prof. W. E. Trout, Mary Baldwin College; Prof. A. R. Armstrong, College of William and Mary; and Col. W. O. Swan, Virginia Military Institute. Last fall Tulane University joined our group and this spring the University of North Carolina was added. Investigations at Tulane are under the direction of Professor Thomas B. Crumpler; those at North Carolina are under Professor Edwin C. Markham. The work of the various investigators is co-ordinated at the University of Virginia under the direction of Professor Yoe. During the past two years he has been assisted with the experimental analytical work by Dr. Lyle G. Overholser, who received the Ph.D. degree in analytical chemistry at the University of Minnesota in 1938. Dr. Alfred Burger, assistant professor of chemistry at the University, is assisting in the preparation and study of certain organic compounds to be used in this work. Dr. James W. Cole, assistant professor of chemistry at the University, is interested in the reactions of these compounds from the standpoint of valence.

Each co-operating institution is supplied by the University of Virginia with the organic compounds to be investigated. Since a micro-technic is employed, only small quantities are required.

This opens up still another promising field of work, namely, the use of organic compounds as concentrating reagents for "trace elements" in spectrographic analysis and studies. Thus, by means of organic compounds that react selectively with certain elements to form slightly soluble precipitates, it should be possible to extend greatly the range of the spectrograph. In this way it will be possible to detect and measure quantitatively elements at concentrations far below the spectrographic limit, when analyses are made without previously concentrating selectively the constituent in question. This phase of the work has been taken up by Dr. Oskar Baudisch, Research Director at the New York State Research Institute, Saratoga Springs, N. Y.

During the past year a new colorimetric method for palladium has been completed, which makes it possible to measure minute

amounts of this element down to 1 part in 300 million parts of solution. There are satisfactory methods available for determining relatively large amounts of palladium, but the accurate measurement of traces of this element presents a difficult problem to the analyst, and no satisfactory colorimetric method has been reported previously. Our new method will find application in analyses and studies of the platinum group metals and their alloys, and in other investigations requiring a highly sensitive and accurate method for traces of palladium.

This afternoon Dr. Overholser will report upon the discovery of several additional new colorimetric reagents for palladium. Structurally, these organic compounds are similar to the one employed in the new method, and in some respects they are better. Thus, these compounds form a new class of organic reagents that is specific for palladium under the experimental conditions of the procedure.

At the Academy meeting in Danville last May our first symposium on organic analytical reagents was held. So successful was this that it seemed desirable to bring the co-operating group together for a second symposium during the Academy of Science meeting at Lexington. The purpose of these symposia are threefold: (1) To offer an opportunity for the presentation and discussion of progress reports from the co-operating institutions, (2) to present in some detail certain topics of special interest to workers in the field of organic analytical reagent research, and (3) to acquaint members of the chemistry section with recent trends and developments in the use of organic compounds in inorganic analysis. It is hoped that this co-operative effort will lead to a better knowledge of the relationship between the structure of organic molecules and their reactivity as analytical reagents, and that new specific and more highly sensitive reagents will be discovered.

University of Virginia.

A Summary Report on 500 Organic Compounds

W. J. Frierson

At Hampden-Sydney we have completed tests on five hundred organic compounds, three hundred of which were run this year and two hundred last year. A total of about eight hundred reactions were recorded with sixty-five of the seventy-seven ions tested. A majority of the reactions, however, were found to occur with a small number of the metallic ions. Among those reacting most frequently were: gold, 103 reactions; osmium, 90; ferric

iron, 77; copper, 67; vanadium, 50; silver, 46; and nickel, 34. Many of these reactions are oxidation-reductions.

No attempt was made to select any particular type of organic compound for study, but those investigated included a number in each of several different types. The reactions obtained with these compounds are as follows:

Type	*Number Tested*	*Number Reacting*
Napthalenes	26	14
Toluenes	14	3
Glycollic acids	25	16
Benzanthrones	15	1
Anthraquinones	40	10
Benzoic acids	18	3

Among the compounds reacting, the groups most frequently present were the amino, hydroxyl, and sulfonic acid.

A number of sensitivity tests were made, but with the exception of gold, only a few gave a sensitivity better than one part in a million. The following reactions seem promising and worth further investigation:

(1) Dimethyl aniline bromide with gold gives a sky blue color, changing after a few minutes through a light green to tan. The reaction is sensitive to one part in fifteen million.

(2) 2-Hydroxy-5-mercapto benzoic acid gives a purple color with iron (ic); sensitive to one part in a million; and a yellow color with palladium sensitive to one part in two millions.

(3) 3,3′-Di-isopropyl benzidine gives a pink color with gold, sensitive to one part in fifteen millions.

(4) 4-Amino-3-methyl phenyl morpholine gives a purple color with osmium, sensitive to one part in a million; and a pink color with gold, sensitive to one part in thirty millions. This reagent also reacts with chromium, copper, iron, platinum, and silver; all except osmium giving about the same shade of pink which seemed to be due to an oxidation product of the compound. Only one other morpholine was tested, and it gave the same shade of pink with gold as that obtained with 4-amino-3-methyl phenyl morpholine, but the former was much less sensitive.

HAMPDEN-SYDNEY COLLEGE.

Progress Report on Organic Analytical Research at Virginia Polytechnic Institute

F. H. Fish, J. R. Noell, and B. H. Kemp

Of the two hundred organic compounds tested at the Virginia Polytechnic Institute, sixty-six gave colored solutions or precipitates. The majority of these reactions, however, are of little importance from the standpoint of Analytical Chemistry. Ferric iron was the most reactive of the seventy-six ions included in the test, but only one reaction with ferric ions warranted a more detailed investigation.

The organic compounds investigated to-date, or will be investigated later, are:

1. Oleic acid as a precipitant for calcium, barium, and strontium. A report of this work is given in the Symposium under title: "The Solubility of the Alkaline Earth Salts of the Higher Fatty Acids".

2. 2-Acetamino-6-aminobenzothiazole as a reagent for iridium. The report on this compound is given under the title: "A Study of the Reaction Between 2-Acetamino-6-aminobenzothiazole and Iridium".

3. 2-Hydroxy-3-nitro-5-sulphobenzoic acid as a colorimetric reagent for ferric iron. This reaction was found to be less sensitive than several others already employed for ferric iron.

4. Mercapto benzothiazole as a reagent for palladium. This is sensitive to 1 part of palladium in 1 million parts of solution. Overholser and Yoe, however, have discovered several tests for palladium that are much more sensitive than this one. These tests are reported in this Symposium.

5. 4-4′-Diguanidino-3-3′-dimethoxy biphenyl di-hydrochloride as a qualitative reagent for iridium. This compound gives a pink color with iridium which fades almost immediately with the formation of a brown precipitate. No other element was found to react with this substance. A further study is being made.

Virginia Polytechnic Institute.

A Study of the Reaction Between 2-Acetamino-6-amino-benzo-thiazole and Iridium

J. R. Noell and F. H. Fish

During the investigation of organic compounds as possible new reagents in inorganic analysis, B. H. Kemp of the Virginia Polytechnic Institute found that 2-acetamino-6-aminobenzothiazole gave a purplish brown colored precipitate with a solution of chloroiridic acid. Due to the fact that iridium is very difficult to separate from the other members of the platinum group, and that methods of testing for iridium are usually long tedious procedures, it was thought that this reaction was worthy of further study.

After studying the reaction and the color produced by it, it was found that the iridium ion, so highly colored itself, interferes very seriously with the detection of a color change in dilute solutions of chloroiridic acid and reagent. There is a slight difference in the color of a solution containing 0.15 mg. of Ir^{+4} reagent per 100 ml. of solution and that of distilled water. This solution of iridium and reagent has the same color intensity as a 100 ml. solution containing 0.15 mg. of Ir^{+4}. When the concentration of the iridium ion is increased by 0.1 mg. per 100 ml. of solution, no difference in color can be detected.

There are three ions that react with the reagent other than iridium, namely, ferric iron, ruthenium, and palladium. Palladium does not interfere with the color produced by iridium as the color of the former is a very pale yellow. Ferric iron and ruthenium give dark brown precipitates very similar to the precipitate produced by iridium. Hence these ions must be removed before the test for iridium can be made. A method which proved successful in the separation of ruthenium consists in treating the solution of ruthenium and iridium chlorides with potassium carbonate and potassium nitrite. The solution is taken to dryness and the residue is covered with alcohol. The alcohol dissolves the ruthenium but not the iridium. The residue is treated with HCl until acid and the organic reagent then added to test for iridium. Iridium must be present in as much as 0.02 mg. per ml. for a definite test.

No method of separating ferric iron was successful. It could not be separated as the hydroxide, due to the fact that if a solution of chloroiridic acid is made alkaline with NH_4OH and then made acid with HCl no test for iridium could be obtained. Reducing agents could not be used since all that reduce ferric iron also reduce iridium, and trivalent iridium does not give a colored solution or precipitate with the organic reagent.

Virginia Polytechnic Institute.

Solubility of the Alkaline Earth Salts of Some of the Higher Fatty Acids

B. H. Kemp and F. H. Fish

This investigation was made in connection with the search for new organic analytical reagents. During the course of our work, it was observed that the elements of the alkaline earth group gave precipitates with oleic acid, but only a very slight turbid suspension with stearic acid, when aqueous solutions of the chloride of the metals were treated with 48 per cent alcoholic solutions of these acids. This suggested that there was a difference in the solubilities of the alkaline earth salts of the higher fatty acids, as well as a difference in the solubility of the salts of the same acid. The utility of such a difference should serve a very useful purpose in the quantitative separation and estimation of the fatty acids. Lewkowitsch states: "A systematic study of the metallic soaps and their solubilities in the usual solvents is greatly desired; and an investigation should well repay the time required for it, as new methods of separating fatty acids could be elaborated".[1]

In spite of the many uses, both singly and in mixtures, there is a great lack of information on the pure compounds. The literature contains discrepancies in some cases, while in others, no information whatever is available. The work herein reported was inaugurated to prepare the pure normal salts or soaps of the alkaline earth metals and to determine their solubilities.

The only suitable method for the preparation of these salts was double decomposition from aqueous-alcoholic solution, using the chloride of the metal and an alkali salt of the fatty acid. The pure acids were obtained from A. Diagger & Co., and Eimer & Amend. The salts of the alkaline earth metals were Merck's C. P. quality. The solvents were absolute alcohol, absolute ether, commercial benzene, and distilled water.

To determine the solubility, an excess of the metallic salt was added to the solvent in a 50 ml. wide mouth bottle, stoppered, and placed in a constant temperature bath, 25° C. ± 0.2°, for 24 hours. A measured volume of the saturated solution was withdrawn with a pipet, evaporated, dried, and weighed. The results are shown in the table.

Table of Solubilities

Solubilities of the calcium, strontium, and barium salts of stearic, oleic, linoleic, and linolenic acids expressed in grams per 100 ml. of solution at 25° C.

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[1]Lewkowitsch, J. I., "Chemical Technology and Analysis of Oils, Fats, and Waxes", Vol. 1, p. 140. Macmillan & Co., London, 1912.

Metal	Acid	Water	Ethyl Alcohol	Ether	Benzene
Calcium	Stearic	0.0014	0.0112	0.0030	0.0180
	Oleic	0.0657	0.0166	0.0444	0.0414
	Linoleic	0.0348	0.0610	0.0122	0.0352
	Linolenic	0.0386	0.0784	0.0244	0.0334
Strontium	Stearic	0.0018	0.0116	0.0130	0.0170
	Oleic	0.0268	0.0478	0.0268	0.0170
	Linoleic	0.0164	0.0416	0.0112	0.0192
	Linolenic	0.0268	0.0562	0.0544	0.0838
Barium	Stearic	0.0014	0.0084	0.0014	0.0078
	Oleic	0.0196	0.0688	0.0112	0.0274
	Linoleic	0.0276	0.0494	0.0386	0.0296
	Linolenic	0.0234	0.0230	0.0126	0.0182

Physical Properties of the Alkaline Earth Salts of Certain Higher Fatty Acids

Calcium

Stearate—Fine, fluffy, talc-like powder, easily ground, and has no odor.

Oleate—Grayish-white to a yellowish powder, slightly greasy to touch, and has odor of oleic acid. On standing, over calcium chloride, it changes to a semi-opaque, glassy, wax-like mass.

Linolate—Yellowish-white powder, slightly waxy. It will not grind to a loose powder, but tends to lump. Odor of fatty acid.

Linolenate—Fine, creamy-white powder, easily ground, and has a very slight odor.

Strontium

Stearate—Chalky-white, fluffy powder, smooth and talc-like to touch. No odor.

Oleate—Fine, creamy-white powder, slippery to touch. On standing changes to a semi-plastic yellowish, waxy mass. Rancid odor.

Linolate—Creamy-white, granular, and slippery to touch. Very slight fatty acid odor.

Linolenate—Yellowish, granular powder. Tacky to the touch, and on grinding tends to lump slightly.

Barium

Stearate—White, fluffy, amorphous powder. Talc-like to the touch. Grinds easily and has no odor.

Oleate—White, granular powder. Tends to lump slightly on grinding. Slight fatty acid odor.

Linolate—Creamy-white, talc-like powder. Grinds easily and has very slight odor.

Linolenate—White, granular powder. Slightly tacky. Tends to clump slightly on grinding. Very little odor.

Discussion

The solubility determinations were run in duplicate of 25 ml. The variation in the duplicate runs was of the order of 0.4 mg. to 2 mg. Only freshly prepared salts were used.

The instability of the salts of oleic acid is probably due either to its ease of hydrolysis or to some intermolecular change taking place. The latter seems to be the most logical, since these salts undergo a similar change even when moisture and atmospheric oxygen are excluded.

The tacky and plastic nature of many of the salts seems to be associated with their water content. When the water content is completely removed, the salts lose, to a great degree, their plastic and waxy nature, especially the linolates. These properties, however, do not seem to be associated with the degree of unsaturation of the fatty acid from which the salts were prepared.

There is a gradual decrease in the solubility of the corresponding calcium, strontium, and barium salts of stearic, oleic, linoleic, and linolenic acids in the solvents, water, and absolute ethyl alcohol. A decrease in the solubility of the corresponding salts of these acds with an increase in molecular weight, from calcium to barium, is not as consistent in the case of absolute ether and benzene as solvents.

The oleates of calcium, strontium, and barium are more soluble in water, ethyl alcohol, ether, and benzene than are the corresponding stearates, linolates, and linolenates. The stearates of calcium, barium, and strontium are the least soluble in water, ethyl alcohol, ether, and benzene. The alkaline earth salts of stearic, oleic, linoleic, and linolenic acids are more soluble in absolute ethyl alcohol than in absolute ether, benzene, or water.

Summary

It has been shown that there is very little difference in the solubilities of the alkaline earth salts of stearic, oleic, linoleic, and linolenic acids in the solvents, water, benzene, absolute ethyl alcohol, and absolute ether. The solubility of the alkaline earth salts of these acids increases slightly with unsaturation, but this increase is not entirely a function of the degree of unsaturation.

Virginia Polytechnic Institute

A Summary Report on 100 Organic Compounds

MARGARET B. KELLER, EUGENIA S. VANCE, MARY B. POLLOCK, BETTY BAILEY, MARY F. CLINE, ANN ATWELL, AND WILLIAM E. TROUT, JR.

The compounds investigated were selected by Dr. John H. Yoe from the stock of E. I. du Pont de Nemours and Company. No reactions of apparent significance in analysis are to be reported at this time. Acetoacetyl-p-anisidine produced a specific teal-blue precipitate with Fe^{+3}. 2-(4-Aminobenzoyl-amino)-4-aminotoluene gave a pink precipitate with Ce^{+4}. 2-(4-Aminobenzoyl)-m-phenylenediamine reacted with Ce^{+4} and Pt^{+4}. Of eight substituted thioureas investigated, seven reacted with Ag^{+}, six with Pd^{+2} and Hg_2^{+2}, and five with Pt^{+4} and Cu^{+2}. None of these reactions was very sensitive.

The investigation of 2,4-dihydroxybenzoic acid (β-resorcylic acid) as a colorimetric reagent for ferric iron is being continued.

MARY BALDWIN COLLEGE.

A Progress Report

A. R. ARMSTRONG

The one hundred compounds run here appear to have no value as organic analytical reagents. Two show some promise as acid-base indicators.

As the number of compounds studied is small, no attempt has been made to correlate the structure with the colors or precipitates observed.

It is expected that student participation in the project during the coming year will greatly increase the number of compounds studied.

COLLEGE OF WILLIAM AND MARY.

A Progress Report

WILLIAM O. SWAN

Most of the time devoted to Organic Analytical Reagent research during the past year at the Virginia Military Institute has been spent in the preparation of a set of standard test solutions of the various inorganic ions—about eighty in number. These solutions are now prepared and work has been started on the testing of organic compounds, one hundred of which are on hand.

VIRGINIA MILITARY INSTITUTE.

A Progress Report

IRA A. UPDIKE, J. T. ASHWORTH, JR., AND B. M. KEYS

Considerable time was consumed this year in preparing the standard ion-solutions and, in consequence, relatively few organic compounds were investigated. Two compounds, however, proved to be sufficiently reactive as to excite our interest and a further study of them is being made. The compounds are:

(1) Para-anisidine sulfate which gave a deep purple color with auric ions that does not fade in several hours.

(2) Dibromo-2-anilino benzanthrone sodium sulfonate which gave yellow colors or precipitates with the rare earths, iron, nickel, magnesium, and barium. Calcium and strontium do not give color reactions or precipitates and hence this compound may be useful as a qualitative test for barium.

RANDOLPH-MACON COLLEGE.

Summary Report of Progress

J. ROBERT TAYLOR

About 160 organic compounds have been tested by the regular procedure at Washington and Lee University. The results are tabulated below; compounds are grouped according to the active function; the number of compounds giving colors or precipitates with each ion is given:

Compounds	Au^{+3}	Fe^{+3}	OsO_5^{-1}	Cu^{++}	Ce^{+4}	Pd^{++}	$PtCl_6^{-1}$	Ag^{+}	VO^{+}	NO_2^{-}
19 Phenols	4	12	2	5	1	1	..	..	..	..
4 Amino phenols	4	4	4	3	1	..	..	..	..	1
37 Amines	33	14	13	4	9	..	2	1	3	3
52 Acids, esters, and quinones	2	4	2	2	..	..	1	1	..	..
17 Thiazoles	2	..	..	5	..	2	..	..	..	..
15 Amides	2	6	..	2	2	..	..	..	..	..
6 Thioureas	..	..	..	1	..	2	1	1	..	..
4 Mercaptans	..	..	..	2	..	3	..	1	..	..
3 Pyrazoles	..	1	..	1	..	..	..	..	..	..

Specific reactions of considerable sensitivity were given by 1-hydroxy-2-naphthoic acid, 3-methyl salicylate, diiodo-dihydroxy benzophenone sulfonic acid, and nitro-salicylic acid with ferric ion; by 4,4′-diacetylamino *sym*-diphenyl thiourea with palladium; by p-amino-p′-ethoxy-diphenylamine-o-sulfonic acid with platinum; and by 4,4′-dimethyl 3,3′-dinitro *sym*-diphenyl thiourea with copper and with ammoniacal silver.

WASHINGTON AND LEE UNIVERSITY.

Valence Theories Applied to Some Organic-Metallic Complex Compounds

JAMES W. COLE

The purpose of this paper is to review briefly some valence theories and to show applications of recent theories to several organo-metallic compounds containing chelated rings. Aside from the value of compounds formed from metals and organic radicals as analytical and concentrating assistants, such compounds have been of increasing importance to the theoretical chemist. Knowledge of the nature of binding forces in these compounds will contribute much toward an ultimate understanding of the illusive subject of valence.

In the middle of the nineteenth century, we find the belief that molecules were formed from atoms held together by hooks. Each atom was thought to have a definite number of hooks, which number Frankland called the valence of the atom. The rise of organic chemistry gave tremendous support to the hook concept which, in effect, graduated to the bond theory. Every atom was imagined to have a definite number of valence bonds and compounds were thought to result when all bonds were satisfied. Variable valences did not worry the organic investigators whose main desires were to make new compounds and to establish structural formulae which showed probable relationships among the atoms on the basis of the bond theory.

During the latter part of the nineteenth century, a strong line of demarcation arose between the organic chemist and the inorganic chemist. The inorganic chemists found many compounds such as peroxides, alums, and complex amines which did not readily lend themselves to explanation on the basis of the valence bond theory. The term "ordinary, or classical, valence" appears to be connected with the concept of a valence bond in a definite direction without any explanation of what the bond might be composed.

With the publication in 1893 by Alfred Werner (1) of the work on the complex amines of cobalt and platinum, we find some new terms applied to chemical binding. In speaking of the compound, hexammine cobaltic chloride $[Co(NH_3)_6]Cl_3$, Werner stated that in addition to the "primary valence" of cobalt, i. e., the valence between cobalt and chlorine (ordinary valence), there is a "secondary valence" of cobalt which causes six molecules of ammonia to combine to form the complex compound. Similarly, the terms "principal" and "auxiliary valence" have been applied to the two forms of combination. Werner also gave us the term "coordination number" to represent the number of groups attached by secondary valence. The term "coordinated valence

bond" was also applied to secondary valence and much use has been made of Werner's coordination theory when dealing with complex compounds.

With the establishment of the nuclear atomic theory by Lord Rutherford and others, it was natural for investigators to seek new explanations for valence in terms of nuclei and extra nuclei electrons. In 1916, G. N. Lewis (2) in America and W. Kossel (3) in Germany announced, almost simultaneously, valence theories which were remarkably similar. The essential idea in these theories (4) lies in the assumption that the extra nuclear electrons are responsible for chemical properties of the atoms. These investigators further postulated that the arrangement of electrons in the rare gases was peculiarly stable and that the atoms would gain, lose, or share electrons in order to have the same number and arrangement of extra nuclear electrons as the nearest rare gas.

Following the original work of Lewis and Kossel, Abegg, Langmuir, Sidgwick (5), and others took up the study of valence from the electronic standpoint. It became apparent that there were at least two different kinds of chemical combination based on electron arrangements. The terms *polar* and *non-polar* were loosely applied to cover two limiting types of binding. A polar bond (sometimes called hetereopolar) was said to result from electrostatic attraction between two charged ions. Such a condition is attained when one atom has one or more electrons which are relatively easily removed, while the other atom has a considerable tendency to add one or more electrons. The usual textbook example of this type of valence is sodium chloride. Many writers have called this type an "ordinary valence bond". This is not correct when one considers that x-ray studies (6), (7), (8) show that in the sodium chloride crystal no molecules exist, but only sodium ions, Na^+, and chloride ions, Cl^-. The natural electrostatic attraction between these ions apparently causes the formation of the well-known cubic crystal structure in which each ion is surrounded by six ions of opposite charge at unit distance.

More recently, and more properly, compounds in which the units are ions and the forces purely electrostatic have been termed ionic compounds and the valence called *ionic valence* or *electrovalence*.

The second general type of valence according to Lewis, Langmuir, Sidgwick, and others (5a) arises when two atoms have nearly equal tendencies to lose or gain electrons. When two atoms of the same kind combine the situation is ideal. Lewis (2) in 1916, speaking of this type of valence bond, stated that a pair of electrons formed the valence bond and that the electrons arranged themselves about the atomic nuclei in a stable arrangement, the stable arrangement being an octet similar to the rare gas nearest to the element in the periodic system.

Lewis and Sidgwick (5b) pointed out that an electron pair bond might arise in two ways. An electron might come from either atom as shown by

$$4H. + \cdot\dot{\underset{\cdot}{C}}\cdot \longrightarrow H:\overset{\overset{H}{\cdot\cdot}}{\underset{\underset{H}{\cdot\cdot}}{C}}:H$$

or both electrons might come from the same atom,

$$H:\overset{\overset{H}{\cdot\cdot}}{\underset{\underset{H}{\cdot\cdot}}{N}}: + H^+ \longrightarrow \left[H:\overset{\overset{H}{\cdot\cdot}}{\underset{\underset{H}{\cdot\cdot}}{N}}:H^+ \right].$$

(The dots represent electrons in the valence shell.)

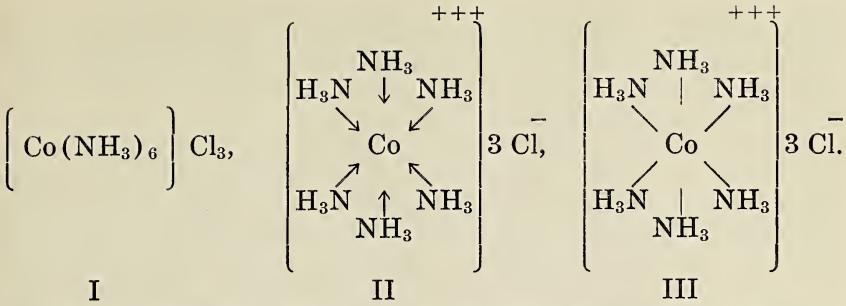
In the latter case, the nitrogen atom is said, by Sidgwick, to be the *donor* and the proton to be the *acceptor*. In the final analysis, it is immaterial from which atom or atoms the electrons come as long as the pair is the bonding means. Sidgwick further pointed out that in cases of certain ions, one of the electrons may have been furnished by an atom that is no longer present. A typical example would be an acid radical, e. g., $:\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}:^-$, combining with a solid such as AgCl to form a complex ion.

$$:\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}:^- + Ag:\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}: \longrightarrow \left[:\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}: Ag:\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}:^- \right].$$

The terms "homopolar", "non-polar", and "covalent" have been applied to the case of bonding between two atoms when *each* atom contributes an electron to the pair. The terms "semi-polar", "coordination", "coordinated covalent", and "dative" have been applied to the bond formed when one atom acts as a donor of the electron pair and the other acts as an acceptor. To eliminate illusive terminology the term "covalent" should be consistently applied to describe any bond resulting from a pair of shared electrons since after the bond is formed, the mechanism of formation need not necessarily be shown in the formula for the compound. If it is desired to *stress* the fact that donation of a shared pair has taken place in the formation of a compound, the term "dative bond" may be used.

Since much usage has been made of the arrow in the chemical literature, it appears desirable to show several methods of writing the structural formula for a Werner complex compound (1). Using hexammine cobaltic chloride, we may write: (see next page)

Formula I is sufficiently descriptive if we recognize that the 6 molecules of ammonia are attached by electron pairs donated to the cobaltic ion by nitrogen. The parentheses simply indicate that this binding is covalent. On the other hand, the part in-



closed by brackets is a trivalent cation and the binding between it and the 3 chloride ions is caused by electrostatic forces, or ionic, or electrovalent forces. No increase in knowledge of the valence forces is gained in Formula II by employing arrows to indicate a donated pair of electrons. In III, where the dash represents a shared pair, the value of such a formula lies in the representation of the octahedral grouping of the ammonia molecules about the central cobaltic ion. In II and III, the brackets inclose the cation and represent an ionic bond between the chloride ions and the cation. The term "coordination number" may be applied in these types of compounds to indicate the number of groups, atoms, or ions joined to the central ion, or atom, by covalent forces.

Some further discussion of the terms "polar and non-polar" (9) appears desirable in view of considerable loose usage of the terms since they were suggested first by Bray and Branch in 1913 (10) and later elaborated by Lewis and others (4). These investigators attempted to classify many compounds according to the following properties:

Polar		*Non-Polar*	
Mobile	High dielective Constant	Immobile	Low dielectric Constant
Reactive	Association	Inert	No association
"Tautomerism"	Abnormal liquids	Isomerism	Normal liquids
Ionized	High boiling point	Not ionized	Low boiling point
Ionizing solvents	High melting point	Not ionizing solvents	Low melting point

In considering these criteria, several points will at once be recognized. Each of these criteria cannot be applied in any given case. Every substance does not belong to one or other of the two

extreme types, and there will be many controversial compounds. Nevertheless, Lewis, Langmuir, Sidgwick, and others (4), (5) were able to roughly classify many inorganic and organic compounds as being either polar in which bonding is ionic, or non-polar in which bonding is covalent.

It is probably in order to mention that recent usage (11), (12) of the terms "polar molecules" and "non-polar molecules" has these terms applying to molecules possessing high and low dipole moments, respectively. Since the dipole moment is a measure of the net separation of positive and negative charges in a molecule, it is obvious that ionic bonding represents the extreme case of charge separation, while covalent bonding in a symmetrical molecule represents a case of no net separation of charges. The existence of compounds with wide ranges in dipole moments indicates that the simple electronic theory of valence is by no means the final answer to valence. It is now necessary to consider briefly a different method of approach to the subject of valence.

With the advent of the Bohr theory of energy levels in atoms and the application of quantum and wave mechanics to the treatment of the energy relationship in atoms and molecules, we find the beginning of an exact approach to the subject of valence. (12), (13), (14).

Analysis of the spectra of many atoms and compounds has given the law of uniform atomic plan, and Pauli's Exclusion Principle (15) which designate each electron in terms of four quantum numbers. The discovery of the wave character of electrons by Davisson and Germer (16) gave experimental verification of the modern wave mechanics (17), which, from a broad point of view, treats the electrons as the most probable location of negative charge. The energy associated with electrons may be handled by a *wave function.* Each electron in an atom has its own wave function and when the wave functions of two electrons are properly handled mathematically, probable locations of valence bonds may be determined. Such a treatment of the hydrogen molecule as a four body system (2 electrons and 2 nuclei) shows that the electron pair is a reasonably correct picture of a covalent bond.

The term *bond-eigenfunction* has been applied to the combination of individual electron wave function and the attainment of the so-called "proper eigenfunction" as a prediction of bond direction and stability may be considered to be a major triumph for the theoretical chemists.

Following the original application of the quantum and wave mechanics to valency problems, we find several theories (18) appearing with the idea of again giving a mechanical picture to a chemical bond. The essential thought among the recent theories is to relate the covalent bond with the energy relations among the electrons in the valence shell of an atom.

Following the system in which four quantum numbers are necessary to completely specify the energy of an electron, Heitler and London in 1928 (18) proposed a theory which bears their name. The theory is based on the assumption that only electrons differing in the quantum number which designates the direction of electron spin can be paired to form a valence bond. In such a bond the electron spins are imagined to cancel each in order to act as a bond. The valence of an atom might, as a first approximation, be considered to be equal to the number of unpaired electrons in the valence shell, or to the number of electrons which might be unpaired without expenditure of too much energy. The so-called "dative bond" may be accounted for by assuming that electrons are promoted to high energy levels so that net pairing is the result. This point of view, however, is speculative.

Another recent theory of valence which has been useful in treatment of simple substances and promises to be more useful with complex compounds was proposed by Hund in 1928 and elaborated by Mulliken in 1931 and by Pauling (13), van Vleck, Sherman, Herzberg, Lenard-Jones, and others (19) over the period, 1930 to date. The general point of view is to consider the electronic orbits in the field of force produced by several centers of force and to lay stress upon the general electron configuration rather than the bonds between particular atoms. The terms *bonding electrons* and *anti-bonding electrons* are used extensively by these investigators to describe valence electrons. As would be expected, the "field of force" theory requires considerable mathematical support.

When we consider the problems involved in the study of chemical bonding, even in the most simple substances, we ask ourselves what is valence anyway and what valence theory must I use? In attempting to answer these questions we must be reasonably certain with what we are dealing. This situation is, of course, complicated when we deal with solutions (20), (21), (22) because there is much evidence for solvation effects, especially in the case of aqueous solutions. The polar character of the water molecule qualitatively accounts for many of the so-called abnormalities in aqueous solutions. This character apparently causes water to associate with most ions and in many cases definitely hydrated ions are formed. The charge or ionic valence number of a cation may not necessarily be the same in aqueous solution as it is in a crystal. The existence of elementary ions with large positive charges (3 or more) is extremely doubtful when one considers the ionization potential necessary to remove 3 electrons. Other energy effects, however, such as lattice energies of ionic crystals, solvation energies, etc. must be considered. Just where the balance in energies lies is difficult to calculate in a simple manner. Nevertheless, the facts that hydration of cations

and polarization of anions increases with charge on the cation leads us to doubt qualitatively the existence of *purely elementary* ions in aqueous solutions with a charge greater than 1. It appears then that before any sort of complete classification of specific organic reagents for metallic ions can be devised, a study and tabulation of ionic states is necessary. This is to be the subject of a future publication.

Recent work by Pauling (13), Brockway (23a), and others (23b) may help in the predictions of valence behavior of the atoms. These investigators have derived from a large amount of data obtained from x-ray, electron diffraction and dielectric experiments, values for the radii of atoms depending on whether they involve ionic bonding or covalent bonding. They also have derived values for bond angles. The usefulness of such data is somewhat limited at present but the data promise to be of increasing value when additional properties such as "degree of hydrolysis" and size of hydrated ions become established. For the present, however, the formation of *covalent* complex compounds from the interaction of "simple cations" with organic radicals or complex anions may be reasonably predicted by means of the electronic valence theories of Lewis and Sidgwick (9). It might be added that many apparent exceptions appearing in the studies of organic reagents in inorganic analysis may be clarified when the valence bond relations are more clearly understood. It appears to the writer that some very useful organic compounds may be neglected in these studies because of a lack of clear knowledge of the solvent effect upon the ions or dissolved substances. It is obvious that careful control of conditions is necessary. It is also desirable that the elements being tested should be in the form of simple ions (small charge) to minimize solvent action.

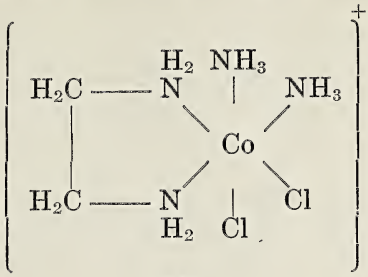
In order to have consistent nomenclature in dealing with complex compounds some suggestions on valence will be offered. Justification for the suggested terminology should be obvious from the foregoing discussion.

Bailar and coworkers (24) at the University of Illinois have recently re-investigated a number of the Werner complex compounds from the standpoint of proof of structure and stereo relationships. A study of a typical example such as diammino dichloro ethylenediamine cobaltic salts,

$$[Co(NH_3)_2(Cl)_2(NH_2.CH_2.CH_2.NH_2)]X,$$

lends strong support to the picture that nitrogen may donate a lone pair of electrons to a cation in the formation of a stable covalent linkage. An octahedral arrangement of covalent bond directions about the cobaltic ion as well as the existence of optical isomerism in some complex cations is clearly shown by the work of Bailar. In indicating structural formulae for these complex substances, the use of arrows to indicate donated electron pairs

is entirely superfluous. The formulae for cis dichloro cis diammino, ethylene diamine cobaltic ion may be represented by

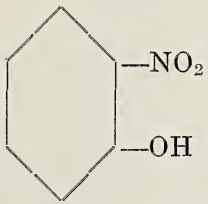


IV

The dash indicates a covalent bond formed from a pair of shared electrons.

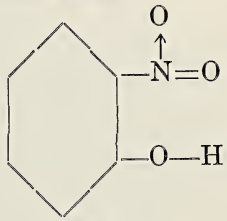
Many ortho disubstituted benzene derivatives have shown interesting properties both from theoretical and practical viewpoints (33). For example, o-nitro phenol is considerably less polar (10), (11) than the para and meta derivatives. This behavior may, in part, be ascribed to a tendency to attain a symmetrical molecular system as a result of intramolecular association and resonance.

The classical formulae for o-nitrophenol are



V

or

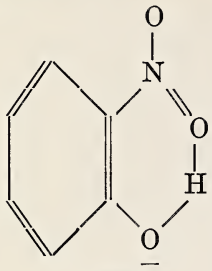


VI

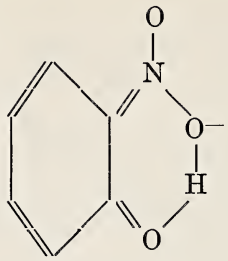
(The arrow indicates the donation of an electron pair.)

Use of the term *resonance* has been increasing during the last few years and its understanding promises to be of much importance in proposing reaction mechanisms. We may define resonance phenomena from a partial mechanical viewpoint. If two or more possible states, or arrangements of atomic nuclei and electrons, exist with nearly equal potential energies, then it might be imagined that the system "resonates" among the possible states (25). Quantum and wave mechanical treatment thoroughly justify resonance and even predicts that the most probable arrangement of a system with the lowest energy may be in between the resonance forms or, as we might call them, "electronic isomers".

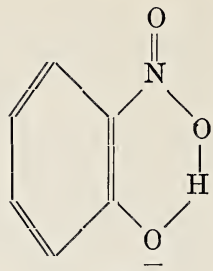
Considering some resonance possibilities in o-nitrophenol we may write,



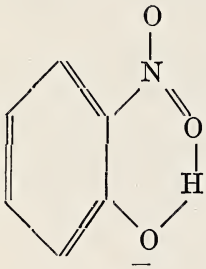
VII



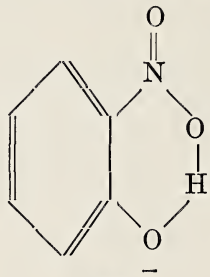
VIII



IX



X



XI

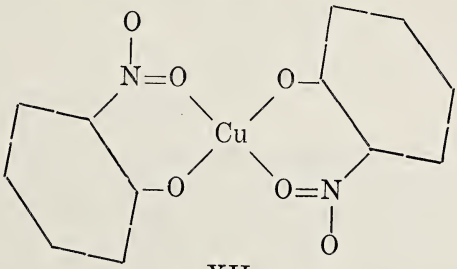
The lines between atoms indicate covalent bonds formed by shared pairs of electrons. The negative charge near an oxygen atom indicates that this atom has in effect gained the valence electron from hydrogen. The existence of hydrogen bonds as indicated seems justified on the basis of the non-polar character of the substance and on the ground that hydrogen bonding ("divalent hydrogen") is well established (26). Showing oxygen as trivalent (in the classical sense) appears justified on the basis of established oxonium compounds (20), (21), (27). It may be objected that oxygen is never univalent and that nitrogen is not quadrivalent as indicated. These conditions may or may not be the case. The use of an arrow, however, to show a "dative bond" or to indicate a deviation from "classical valence" has no value in the above formulae. In justification of the structures given it must be remembered that the actual configuration of o-nitrophenol is most probably an "average" of the indicated structures.

Calculations by Huggins (26b) on hydrogen bond energies and a consideration of atomic radii (23a) support the conclusion of the hydrogen bond between two oxygen atoms. Also, there are no lone electron pairs on the nitrogen to promote such a bond. It is readily seen that compounds with functional groups so located

that a potential hydrogen bond is present, should give rise to an ideal situation for chelated compounds involving metals. Chelation will occur provided that the proton is removable by action of the solvent medium or may be displaced by the metal. Feigl (28a) and Diehl (28b), in reviews of the experimental data on chelated compounds involving metals and organic groups, give a fairly complete list of functional groups that, when adjacent to each other in a molecule, give rise to stable compounds with metals.

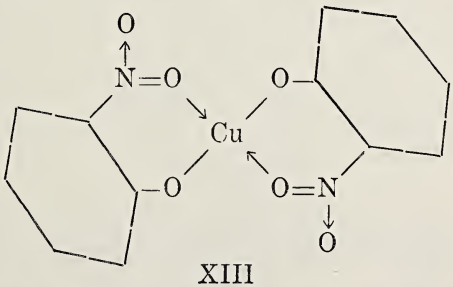
It must be remembered, when making predictions of formations of chelated compounds, that the cation must not be too highly charged or easily hydrated (22). Further consideration in the future will be undertaken as to the effect of additional substituents to compounds with two functional groups. Such a study will include where possible the effect of the substituent on the available distance for a metal between the functional groups.

From a consideration of properties of the cupric derivative of o-nitrophenol, we may write its structural formula as



XII

Each bond indicates a pair of shared electrons and the coordination number of copper is four. In the classical manner the formula would have been written

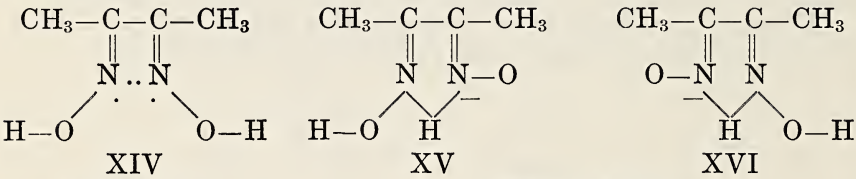


XIII

The arrows in XIII indicate that there is something fundamentally different about four of the bonds which, of course, is not the case. A consideration of the resonance possibilities in

formulae VII, VIII, IX, X, XI do not clearly indicate which atom might be called the "donor". Also, in view of the resonance possibilities in many types of compounds that may form chelated rings, such an arbitrary distinction between "bonds" as shown in XIII is not justified and any such designation in the compound as two "ordinary valences" and two "coordinated valences" (28b) is not warranted.

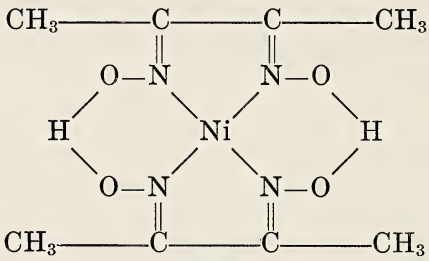
As an interesting and well-known compound we have the nickel derivative of ∝ dimethylglyoxime (diacetydioxime). The chemical and physical properties of this compound and the evidence favoring the belief that the alpha form is also the anti form of dimethyl glyoxime are well covered by Diehl (28), (29) and by Burger (30) so we shall only show the possible formulation of the metallic derivative. Probable resonance forms may be indicated,



XIV anti form

XV, XVI Nitrone forms

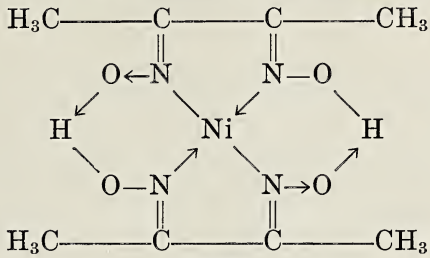
The presence of a hydrogen bond gives rise to an ideal situation for formation of stable metal derivatives when the cation or metal is of the correct size. Apparently, dielectrovalent nickel is the ideal ion and the resulting compound is very stable. Following our proposed system of bond designation, we may write for the nickel derivative,



XVII

The absence of cis-trans isomers led Brady (31) to propose the hydrogen bonds in order to attain further symmetry in the molecule. The absence of hydration in this compound and the perfect agreement of the wave mechanical treatment (32) of nickel with a coordination number of four support this formulation with the nickel atom and the four nitrogen atoms symmetri-

cally arranged in the same plane. From the evidence presented, it is readily seen that the formulation of nickel dimethyl glyoxime in which arrows are employed is distinctly arbitrary,



XVIII

Summary

A brief survey of the trends in thought on the subject of valence has been given with the idea of suggesting a more consistent terminology in dealing with complex organo-metallic compounds, especially those involving chelated rings. It is obvious now that association of a definite valence number to indicate in all cases the combining capacity of an atom is questionable.

It is suggested that the terms *ionic valence* or *electrovalence* be consistently used in speaking of bonding in which ions or unsymmetrically charged groups are involved and the forces are purely electrostatic in nature. It is also suggested that the term *covalent bond* be employed whenever one or more electron pairs appear to be the binding force. The term "coordination number" may also be used when the number of covalent bonds about a given atom does not appear consistent with the "classical valence" of a given element. Nickel, for example, in $[Ni(NH_3)_4]SO_4$ and in nickel dimethylglyoxime may be said to have a coordination number of four.

Use of the few well defined terms suggested will eliminate such illusive terms as "ordinary valence", "auxiliary valence", "secondary valence", "residual valence", "coordination", etc., will make for a better understanding of the nature of the binding forces in complex compounds and will assist in the prediction of organic compounds useful in inorganic analysis.

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The Relation of Some Chelating Reagents to the Periodic Arrangement of Metals

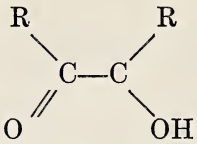
J. Robert Taylor

In discussing the analytical behavior of the metals a periodic arrangement of the Lothar Meyer type is frequently of value, particularly in emphasizing the similar reaction of adjacent elements in a given period. For example, one of the best defined analytical groups is that of the "insoluble sulfides". Metals analogously situated near the troughs of the ionic radius curve in each long period, form water-insoluble sulfides. The effect of dilute acid medium is to narrow the region of insolubility, excluding, for example, Mn, Fe, Co, Ni, In, Tl.

In the field of organic reagents a number of structures have been found, which act preferentially on metals situated in analogous positions on a plot of the Lothar Meyer type. An urgent problem of the analyst is, of course, to find reagents specific for single elements; but at present there is no sound method of predicting specificity. It might be supposed that the sizes of the atoms entering into ring formation in chelated complexes would play a role in determining the strength of the coordinate bonding, and consequently the stability of the complex. Eventually this consideration may lead to accurate predictions; but at present there is great difficulty in assigning sizes to the atoms in chelated rings and in relating the ring-stability to ionic or atomic sizes calculated from independent data. In certain cases such relations can be recognized. Thus the phthalocyanines have been shown to form a macro-cycle with a "hollow" center of a definite size; the metals which yield the stablest complexes with phthalocyanines are just those with radii which correspond to the available space in the cycle. An interesting case of a somewhat different nature was recently described by Jensen (1). The 8-hydroxy quinoline complex with nickel is a greenish, paramagnetic compound in which the two oxygen atoms appear to form a tetrahedral angle with the central Ni-atom. But in the red, diamagnetic 8-mercapto quinoline analog, the larger sulfur atoms lie on opposite sides of the Ni and the two chelated rings are coplanar. Other cases are indicated below.

While it is not possible to predict with certainty which metals will form stable chelated complexes with a particular organic structure, it is now possible to recognize organic groupings which show preferential reactivity in certain well defined regions of the periodic curve. It is instructive to examine some of the more striking regularities that have been discovered in recent years. The sort of regularity referred to here is well illustrated by some familiar reactions of the tetrad of divalent metals at the

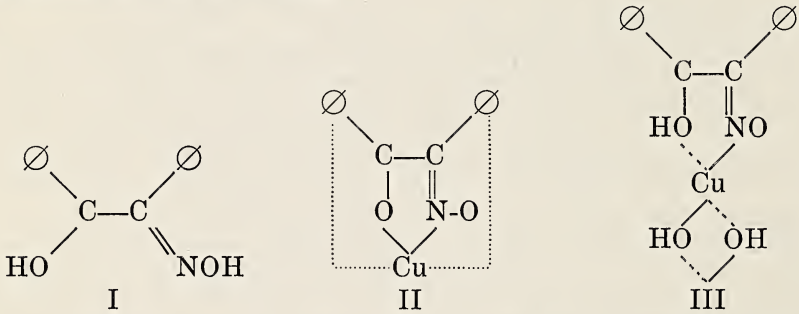
center of the first long period; Fe, Co, Ni and Cu, which form one of the most persistent series of chelating metals. A number of reagents for this series are based on the same basic organic structure:



in which the role of N and O may be interchanged, and sulfur in some compounds may replace oxygen. The dioximes of the 1,2-diketones form the long-familiar Ni-complexes.

The substituent R- may be methyl, phenyl, furyl, etc.; or may be joined together in the form of a saturated cyclohexadione ring (but an unsaturated ring, such as that of o-quinone dioxime, is no longer specific in action for Ni). Since one of the oxime groups appears to act only as an electron donor, it is not surprising that :N-OH may be replaced by :N-.

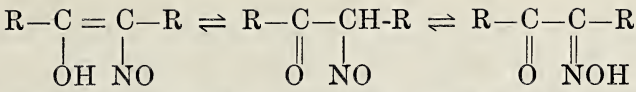
If the state of oxidation of the reagent is lowered by one step, the reagent forms complexes with all four metals but shows specific activity for copper.



The copper complex has been formulated in various ways. Feigl (2) writes the wholly unsatisfactory formula II to account for the apparent coordinate saturation. Researches of Jennings seemed to indicate that the Cu is not coordinately saturated, while more recent work in Dubsky's laboratory points to a "diol" basic salt structure III (3), which brings the complex into a form similar to that of the dioxime complexes.

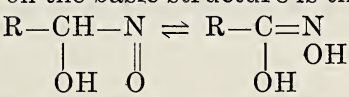
It should be noted that two metals situated at analogous positions in the next two long periods—Pt and Pd—form unusually stable complexes with the foregoing reagent types.

If the hydroxyl group is enolic, the marked activity shifts to iron. The ferrous "iron blue" test of Whiteley is given by alpha-nitroso carbonyl compounds of the type:

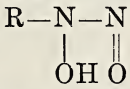


such as the highly sensitive dinitroso acetone of Kuras. There is considerable doubt about the structure of the complex, which may be represented as an oximino, or as an enolic derivative, or perhaps as a resonance hybrid. In either form the relation to the basic structure is obvious. The enol may be either aliphatic, or aromatic, as in the various nitroso phenols which give complexes with Fe, Co and Cu. In these aromatic enols there is less doubt as to structure, since enolization is forced, and oximation is improbable. This brings us to the compounds showing preferential activity toward cobalt: the nitroso naphthols, and nitroso camphor and thiocamphor; the latter may react in the isonitroso (oxime) form.

A final variation on the basic structure is the hydroxamic acid

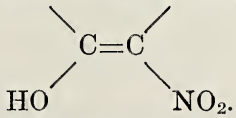


and nitroso-hydroxylamine type, such as "Cupferron",



The reactions of this list of reagents are by no means confined to the tetrad of metals discussed here. Most of the other metals with which they react occur at analogous periodic positions, however. The basic structural group therefore affords a starting point from which to develop specific reagents for these metals. A most valuable procedure in developing specificity is to study systematically the effect of substituents on the basic structure, as Baudisch studied the substituted "Cupferrons" (4). Baudisch's work was carried out over twenty-five years ago; but it is only within very recent years that similar systematic investigations have been made.

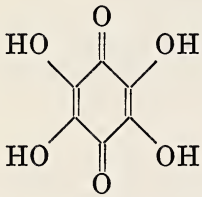
A large number of specific and partly specific reagents have been proposed for metals lying in the middle of the several periods; the metals lying near the crests of the periodic waves show a weaker tendency to form coordination complexes of useful stability. Consequently the recent discovery of a series of compounds showing activity with the alkali metals is important. The essential structure appears to be the alpha-nitro enolic group

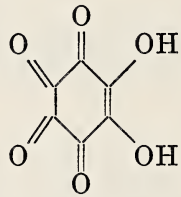


The very low solubility of the K-salt and o-nitro phenol was noted

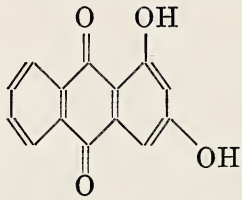
as early as 1887 (5). In 1936 Fredholm (6) showed that dilturic acid (5-nitro barbituric acid) forms slightly soluble complexes with K, Cs, Rb, and NH_4, which where recommended for gravimetric determinations. Styphnic and chloro-picric acids also give insoluble complexes with these metals under some conditions; but it seems that the enolic group in general, and not specifically a phenolic group, can participate in the complex formation, for dilituric and violuric acids—enols of doubtful "aromaticity" yield stable complexes. From the analogy of $-NH_2$ to -OH it might be expected that amines would react similarly, if the amino group could be rendered sufficiently acidic. Sheintsis (7) showed that this was possible. By loading the diphenyl amine molecule (itself practically non-basic) with nitro groups, "dipicramide" is obtained. It forms insoluble complexes of K, Cs, Rb, NH_4, and is suitable for separating these metals from sodium.

Few characteristic reagents have been reported for the alkaline earth metals. Two useful ones have almost identical structures





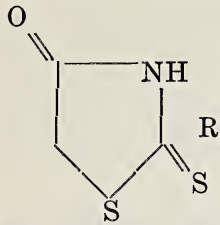
and form colored, insoluble complexes containing 5-atom rings, with Ba and Sr; the Ca compound is unstable in water. But the dihydroxy anthraquinone of structure



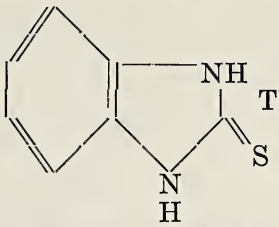
reacts specifically with Ca, forming a 6-atom ring, while the larger Ba and Sr do not give stable complexes. It is quite probable that a systematic study of substituted hydroxy anthraquinones and quinones would yield other more useful reagents for the alkali earths.

The Cu, Ag, Au, series, and certain adjacent metals, give characteristic reactions with a number of compounds containing the structure $-\overset{\|}{C}-NH-\overset{\|}{C}-$. It has been shown (8) that the

structure $-\overset{\|}{C}-NH-\overset{\overset{S}{\|}}{C}-$ which occurs in the rhodanines

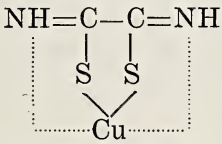


Rhodanine



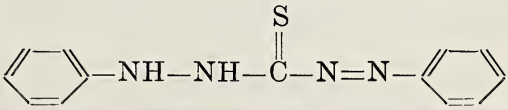
Thiobenzimidazolone

shows special reactivity toward silver, particularly the rhodanines condensed with certain aromatic aldehydes, in which color and insolubility are increased. This structure occurs also in thiobenzimidazolone, which yields complexes of Cu, Ag, Au, and of divalent Hg and Pb, which lie close to gold on the periodic curve. The reaction is actually given by cupric ion, but there is evidence that the final product is a cuprous complex. Indeed the structures of all the complexes of copper with thio-imides need reexamination. They are apparently chelated compounds containing 4-atom rings. Recent work at Prague, on the rubeanic acid-Cu complex, usually written



indicates that the copper is first reduced by the reagent, so that the complex is actually an acid rubeanate of cuprous copper.

Diphenyl thiocarbazide ("dithizone"), introduced by Helmuth Fischer, gives sensitive color and precipitation reactions with two definite series of metals, the Cu, Ag, and the Zn, Hg, Pb (ous) series.

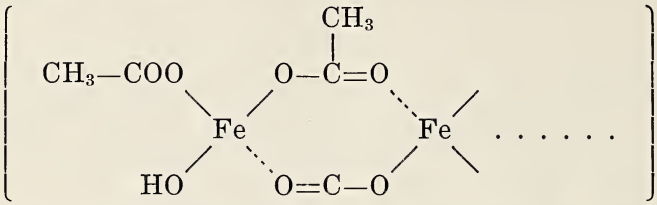


Dithizone

It is not clear what constitutes the essential structure in this class of reagents (which includes also diphenyl-carbazide and -carbazone). Feigl's formulation of the metallic complex is unsatisfactory for steric reasons, while Fischer does not take account of the salt forming property of the S or O atoms. The formulas of the latter suggest a relation to the metallic of the porphyrins and phthalocyanines; but it is possible that the ring structures are not the same for the two series of metals.

The trivalent cations of the ferric class yield the familiar

"basic acetates" and carboxylates with certain other fatty acids. There is evidence that the complex actually formed has a polynuclear cyclic structure:



The tendency to precipitate these high molecular weight complexes is so strong that there is doubt as to the existence of normal carboxylates for these metals. No extended study of the behavior of fatty acids with Fe, Cr and Al has been made, but the available evidence suggests that the formation of the polynuclear complexes is a specific property of the carboxyl group. With thiocarboxyl (–CSSH) the same metals give a very different type of complex ion. It is significant that –CSSH acids form 4-atom chelated rings, which the –COOH acids seem incapable of forming. The analogous sulfinic acids (–SOOH) have not been shown to give polynuclear complexes either, although they do yield insoluble ferric salts.

The reagents described above are those for which the activity of metals is clearly related to the periodic positions of the metals. It is to be expected that the work of members of this symposium will disclose more regularities. Once the organic structure essential for reactivity with a particular series of elements has been found, the procedure for developing specificity within the series is obvious. It is well illustrated by the history of oxine, which can react with a variety of metals. By control of conditions, but more important, by variation of the substituents on the fundamental structure, several specific reactions have been devised.

A classification of reagents, such as the one implied here, should be of some aid in simplifying the search for specific reagents.

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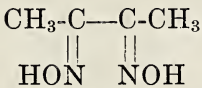
Oximes in Analytical Chemistry

ALFRED BURGER

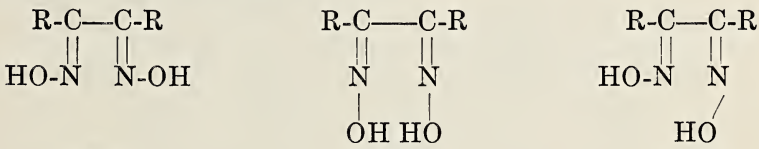
Compounds containing oxime groups in addition to some other groups suitable for the establishment of chelated, or in some cases of heterocyclic rings, have been used extensively as reagents in organic analysis ever since Chugaev pointed out the specificity of diacetyldioxime (dimethyl glyoxime) (I) for Ni^{++} in 1905 (6).



(I)

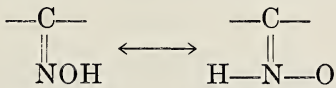
Many oximes containing auxiliary groups capable of salt formation or of formation of covalent links will react rather indiscriminately with a large number of metallic ions, but ions of certain metals, especially those of Ni, Co, Fe, and Cu, will form insoluble and highly colored compounds with such oximes more frequently at a definite pH. Due to this observation, certain types of oximes have been designated as specific for certain metals. The specificity of the dioxime group HON=C—C=NOH for metals of the Ni group is the best-known example for this observation.

1,2-Dioximes may exist in three configurations: the anti-, or α-dioxime form (II), the syn-, or β-dioxime form (III), and the amphi-, or γ-dioxime form (IV).[1]



(II) (III) (IV)

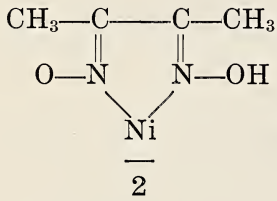
Meisenheimer proved that the Ni-specific α-dioximes had the anti-configuration. It would be difficult to visualize formation of a chelated ring which should include one or both hydroxyl groups if their spatial relation is that expressed in formula III. According to Pfeiffer, the salts of oximes are not derived from the traditional hydroxyimino form (V) but from the resonant nitrone form (VI).



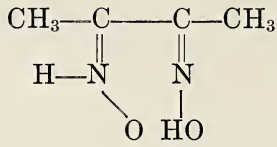
(V) (VI)

[1]In the α- or anti-form the two groups are sterically opposite, while they are close to each other in the β- or syn-dioximes.

In VI, the proton directly attached to the nitrone-nitrogen, is replaceable by cations; therefore, diacetyl dioxime could be expressed by formula VIIa which explains the absence of steric hindrance by the oxygen atom of the second oxime group in a satisfactory manner. It also demonstrates why the stereoisomeric β-dioxime (VIII) cannot yield metal derivatives; the metal atom



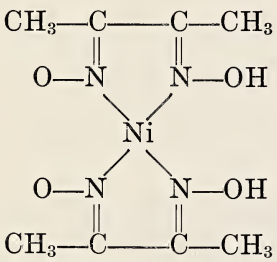
(VIIa)



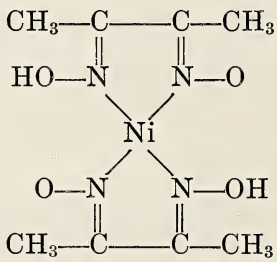
(VIII)

replacing the hydrogen atom which is linked directly to nitrogen could not be bonded in a ring.[2]

According to Sugden (14) (8) the four nitrogen atoms of the two molecules of an α-dioxime linked to nickel lie in one plane. This theory would predict two stereoisomeric formulas for nickel diacetyl dioxime, VII b and VII c. No such geometrical isomerism has ever been observed, and this fact, together with the established inertness of the two hydroxyl groups, has led to the acceptance of formula VIId for the nickel derivative (2).



(VIIb)



(VIIc)

In this formula, the hydrogen atoms of the hydroxyl groups are bonded to the nitrone oxygen atoms.

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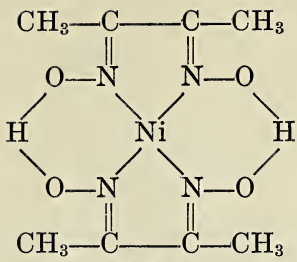
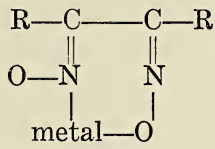
[2]All valences and ring structures in this article conform with modern valence theories as explained by Cole (8). The author is indebted to Prof. James W. Cole for many helpful critical suggestions.



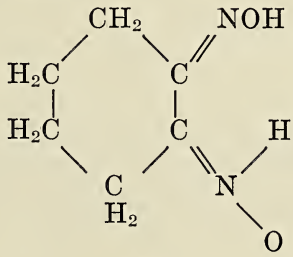
(VIId)

The γ-dioximes (IV) generally furnish amorphous metallic derivatives which differ from those derived from the α-form. They are assumed to contain the metal atom in a six-membered heterocyclic ring (IX), and are converted to the isomeric α-dioxime derivatives by the action of acids.



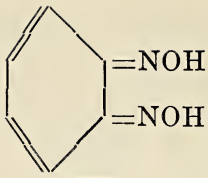
(IX)

Both diacetyl dioxime (I) and its nickel derivative (VII) are insoluble in water. However, the insolubility of the metal compound is not due to the insolubility of the metal-free dioxime. 1,2-cyclohexadione dioxime (X)



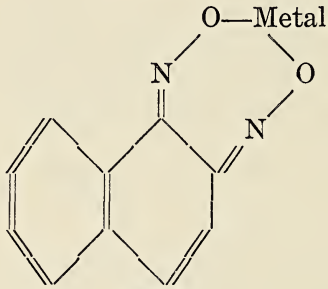
(X)

is readily soluble in water, while its Ni-salt resembles Ni-diacetyl dioxime, and can hardly be distinguished from the latter except by analysis. This behavior demonstrates the influence of the structure of the rest of the molecule on the essential chelating groups. Changes in the structure of apparently unessential portions of the molecule may also abolish the specificity of the α-dioxime group towards Ni. Orthoquinone dioxime (XI) and



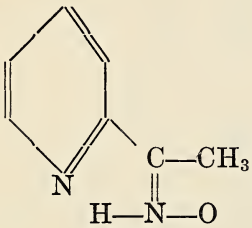
(XI)

analogous compounds in the naphthalene series give brown precipitates with many metals, in which the dioximes function as dibasic acids, e. g.,

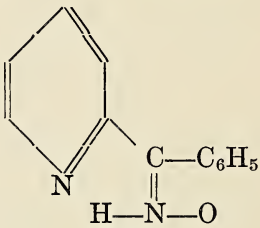


(XII)

On the other hand, one of the two oxime groups may be replaced by certain other nitrogen-containing groups without loss of specificity for Ni^{++}-ions. Thus, the oximes XIII (7) and XIV (9) also furnish chelated nickel salts, similar to nickel diacetyl dioxime:



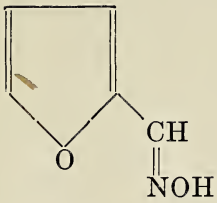
(XIII)



(XIV)

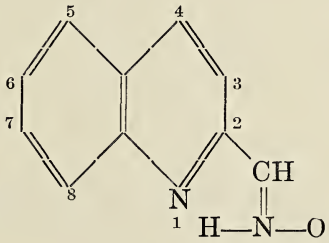
The second oxime group does not seem to be necessary for the specific behavior of such compounds towards nickel, cobalt, and related metals. The essential condition to be fulfilled by Ni-specific reagents seems to be the ability to form a five-membered ring in which the metal atom is linked to two nitrogens. The second N-atom cannot be replaced by other elements, such as oxygen. α-Furfuraldoxime (XV), for example, gives no metal

derivatives comparable to those of diacetyl dioxime or other α-dioximes.



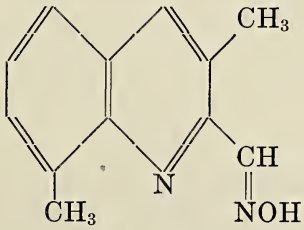
(XV)

The influence of various groups which would not be expected to have any bearing on the ability of the two N-atoms to establish a chelated ring including a metal atom is observed in comparing several aldoximes and ketoximes of the pyridine and quinoline series. Pyridyl-2-methylketoxime (XIII) forms metal salts which resemble those of other α-dioximes in many respects. Similar metal derivatives are obtained from quinoline-2-aldoxime (XVI) (15).



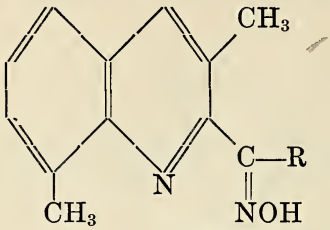
(XVI)

Introduction of nuclear alkyl groups into positions 3 and 8 of the quinoline system changes the picture considerably (5). 3,8-Dimethylquinoline-2-aldoxime (XVII) still gives a green precipitate with Ni^{++} in ammoniacal solution,



(XVII)

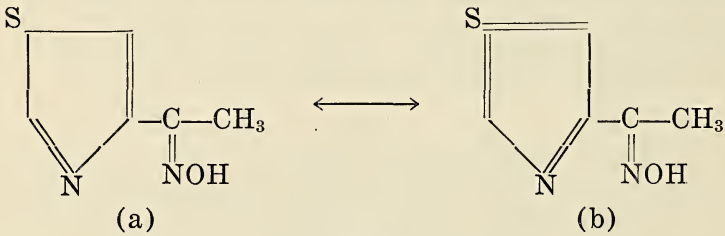
but the corresponding 3,8-dimethylquinolyl-2-alkyl ketoximes (XVIII) do not show complex formation. It may be argued that the 8-methyl group, and perhaps even the methyl group in posi-



(R=CH_3, C_2H_5)

(XVIII)

tion 3, exert a sterical hindrance on the cyclic N-atom, depriving it, at least partly, of its coordinative power. This argument could be supported by the inability of 2,3,8-trimethylquinoline to form quaternary salts (1). On the other hand, the ability of the aldoxime XVII and its 5-nitro derivative to give a large number of deeply colored or insoluble metal complex salts (5), seems to speak against the assumption of sterical hindrance. The configuration of the ketoximes XIX remains to be established; if these oximes should prove to be of the β-type, their inertness towards metallic ions would be readily explained. It may also be well to consider the possibility of a distortion of the pyridine half in the quinoline system by the condensed aromatic nucleus. Such a distortion might alter the $-N = C-$ distance and, thereby, change the shape of chelated rings attached to these atoms. Indeed, this deformation may even prevent formation of a chelated ring. An interesting sidelight has been thrown recently upon this possibility (10), by comparing pyridyl-2-methyl ketoxime (XIII) with thiazolyl-4-methyl ketoxime (XIX). While the pyridine derivative (XIII) gives a red Ni-derivative, the analogous thiazole derivative does not undergo any reactions with nickel ions.



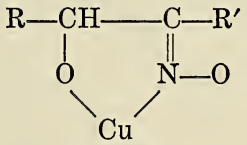
(a) (b)

(XIX)

According to Erlenmeyer's studies (10), pyridine and thiazole should be isosteric, and, therefore, ought to exhibit many very similar properties. The discrepancy in the chelating ability of

the ketoximes in the two series may be traced to a difference in the arrangement of the nuclear double bonds in the two systems. The formation of oxime salts depends on the presence of the system –N=C—C=N–. This arrangement may be found in XIII, but not in XIXa which features the traditional formula for thiazole. In order to establish a conjugated system, the thiazole derivative would have to be written in the resonating form XIXb. In this formula, however, the new linking of the S-atom to the adjacent C-atoms will distort the thiazole nucleus and thereby alter the length of the linkage between the heterocyclic N-atom and the α-carbon atom. This could explain the disappearance of isosterism of the pyridyl and thiazolyl ketoximes, because equality of size and shape of the respective molecules is among the properties postulated for isosteric substances. It would also explain the inability of oxime XIX to furnish metal derivatives.

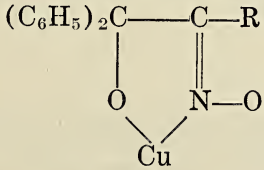
The influence of unspecific portions of the molecule upon the specific chelating groups is observed also in compounds containing the group –CHOH–C=NOH. Such compounds react as dibasic acids in ammoniacal solution, furnishing specific insoluble Cu^{++}-salts (XX):



(XX)

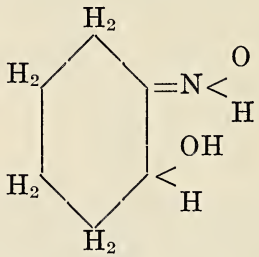
The radicals R and R′ may be varied over a wide range without affecting the formation or the color of the Cu-salts, or their insolubility in water. If these radicals are aliphatic, and not too large, the Cu-salts are soluble in ammonium hydroxide solution. If one, or both, of the radicals are aromatic or represent similar resonating ring systems, the solubility of the Cu-derivatives is lost. This has been explained by assuming that the aromatic system can link metal atoms (11) and thereby suppress the field of force of the metal which would otherwise be extended to the ammonia molecules.

If the carbon atom carrying the alcoholic hydroxyl group is connected with two aromatic groups, as in XXI,



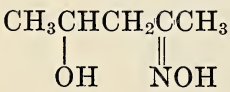
(XXI)

the compound will be soluble in ammonium hydroxide solution. This phenomenon has been explained by an unsupported hypothesis which points out that the "coordinative forces" of the aromatic nuclei saturate one another, and only covalences are left for the linkage of the Cu-atom within the molecule. This explanation is contradicted by the observation that a few compounds containing the group RCHOHC(=NOH)R′, in which R is a straight alkyl chain of four to eleven carbon atoms, may also yield Cu-salts which are very sparingly soluble in ammonium hydroxide solution. It would be rather far-fetched to claim chelating ability for a butyl or amyl group, and therefore it has been postulated that the large size of molecules containing long alkyl chains probably is the cause of the low solubility of the respective metal compounds. However, some derivatives with higher molecular weights are soluble in ammonium hydroxide solution, and this solubility is retained even when the -CHOH-C(=NOH)- group is part of a ring system, as in o-hydroxycyclohexanone oxime (XXII). The Cu-salt of this compound is soluble in ammonium hydroxide solution since the alicyclic nucleus cannot offer an electron pair to the Cu-atom.

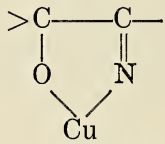


(XXII)

If the salt forming groups are separated by a carbon atom, as in XXIII, no Cu-derivative can be obtained. This indicates that a five-membered covalent ring is necessary for the formation of Cu-salts. It is notable, however, that benzoin oxime can yield

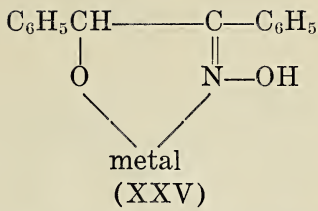


(XXIII)



(XXIV)

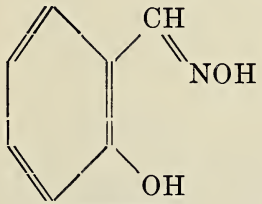
metal compounds also in acidic and in ammoniacal solution. In these derivatives, benzoin oxime functions as a monobasic acid (XXV). If the alcoholic hydroxyl and the oxime groups are *cis*



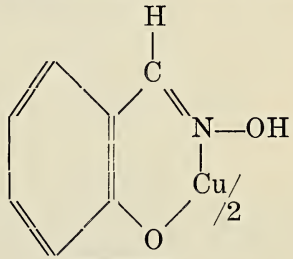
(XXV)

in respect to each other, metal derivatives of different and, as yet, unexplained nature are obtained.

The acidity of the weakly acidic alcoholic hydroxyl group is increased by the immediate vicinity of the oxime group, and this mutual influence makes possible covalent linking of weakly basic metallic atoms to the oxygen atom of the alcoholic hydroxyl group. If this oxygen atom belongs to a phenolic hydroxyl and thereby acquires a much more strongly pronounced ionic character, it may be separated from the oxime group by an aromatic C-atom and yet retain its specificity for Cu, although at a different pH. The typical representative of this series is salicylaldoxime (XXVI) which forms an insoluble Cu-derivative in dilute acetic acid solution (XXVII). The formula of this com-

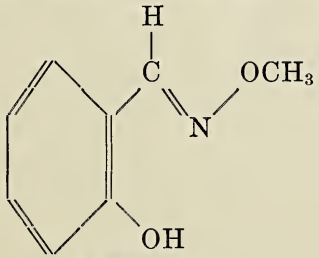


(XXVI)

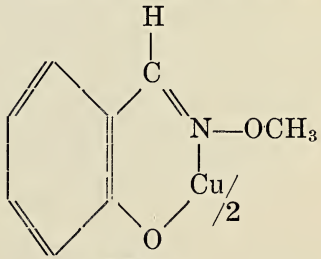


(XXVII)

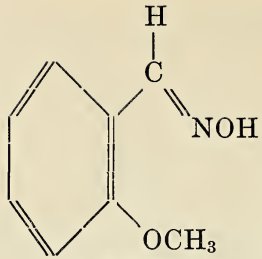
pound was established by converting N-methoxy-salicylaldoxime (XXVIII) into its Cu-salt (XXIX). The isomeric o-methoxybenzaldoxime (XXX) gives no Cu-salt; the phenolic hydroxyl



(XXVIII)

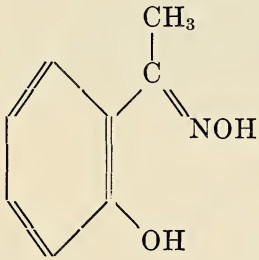


(XXIX)

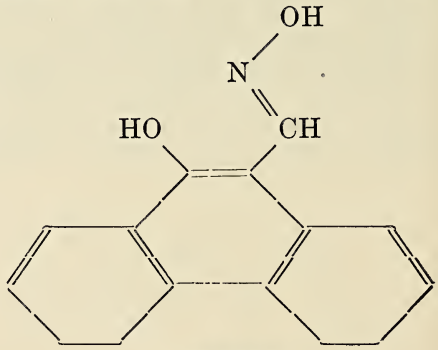


(XXX)

group must be the salt-forming, the oxime group the coordinating group. A long series of analogous compounds behaves in a similar fashion; o-hydroxyacetophenone oxime (XXXI), 9-hydroxyphenanthrene-10-aldoxime (XXXII) (4) and its isomer, 3-hy-



(XXXI)



(XXXII)

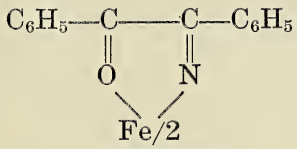
droxyphenanthrene-4-aldoxime (4), may serve as examples. The function of the phenolic hydroxyl as the salt-forming group in XXXII and its 3,4-isomer was proved by Burger (4) by blocking the phenolic group by esterification and etherification. The corresponding methoxy- and acetoxyphenanthrene aldoximes exhibited no reaction with metallic ions.

In some of these phenolic aldoximes and ketoximes both the α- and β-forms have been isolated. Only the phenolic α-oximes give metal salts (XXVII); this explains the formation of six-membered rings in which the metal atom is coordinated to the N-atom. The hydroxyl group of the sterically opposite β-oximes would prevent formation of such a ring.

Compounds containing a carbonyl group α to an oxime group, $>CH\text{-}CO\text{-}\underset{|}{C}{=}NOH$, frequently give a blue color with ferrous salts in a solution buffered by sodium acetate. The blue com-

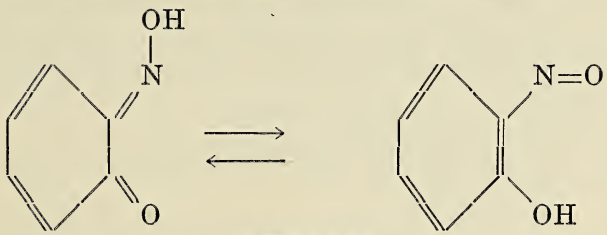
plex compounds are soluble in benzene. α-Benzil monoxime, $C_6H_5COCC_6H_5$, illustrates the behavior of such oximes. The
||
NOH

stereoisomeric β-monoxime is completely inactive. Only the configuration of the oxime group seems to determine the reactivity of the compound towards Fe^{++}-ions. The formula of the iron salt is expressed in XXXIII; the metal atom appears coordinated to the carbonyl oxygen atom.



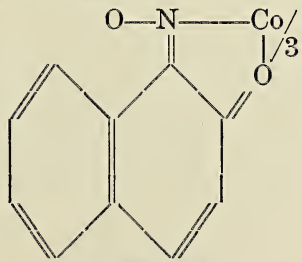
(XXXIII)

Monoximes of cyclic 1,2-diketones are usually written in the tautomeric o-nitrosophenol form (XXXIV.) The o-nitrosophenols



(XXXIV)

give insoluble, deeply colored complex salts with almost all heavy metals and may react selectively with certain metallic ions under controlled conditions. The best-known examples are α-nitroso-β-naphthol (13) and the isomeric β-nitroso-α-naphthol (12) which are specific reagents for Co^{+++}-ions. The formula for one of these cobalt salts may be expressed as in XXXV. o-Nitrosophe-



(XXXV)

nols are easily synthesized now by the Baudisch reaction (3) in which phenols or even aromatic hydrocarbons are oxidized by the oxygen of the air in the presence of hydroxylamine and metallic salts. They are among the most promising newer organic analytical reagents.

References

This article follows in some respects the corresponding chapters (pp. 78-91) in Feigl's "Qualitative Analyse mit Hilfe von Tüpfelreaktionen", Third Edition, Akademische Verlagsgesellschaft m. b. h., Leipzig, 1938. Many additional examples and references may be found there. An excellent discussion of "The Application of the Dioximes to Analytical Chemistry" by H. Diehl was published recently (1940) by the G. Frederick Smith Chemical Company, Columbus, Ohio.

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University of Virginia.

The Application of a New Class of Organic Reagents to the Detection and Determination of Palladium[1]

Lyle G. Overholser and John H. Yoe

The organic reagents studied include, in addition to p-nitrosodiphenylamine [I] which has been previously reported on, p-nitrosodimethylaniline [II] and p-nitrosodiethylaniline [III]. All three of these reagents contain the p-NOC_6H_4N- group which we believe to be responsible for their reactivity with palladous chloride to give the highly colored addition compounds of the type $Pd[NOC_6H_4N\text{-}]_2Cl_2$. Compounds similar to [I], [II], and [III] with other groups as $-NO_3$, $-NH_2$ replacing the -NO group do not give the reactions, indicating the necessity for the pres-

[1]This is an abridgment of the paper that received the Jefferson Award of the Virginia Academy of Science on May 3, 1940. The paper in full is being submitted in competition for the Jefferson Gold Medal. The state academies of science competing for the Jefferson Medal are: Florida, Georgia, North Carolina, South Carolina, and Virginia.

ence of the -NO group. We have not studied a sufficiently wide variety of these organic compounds to make a positive generalization as to the effect of the presence of other substituents, but we believe this group imparts the nearly specific reactivity with the palladous ion.

This coordination or addition type of reaction with palladous chloride is given by many organic compounds, but it often requires some specal method for their isolation. The addition compounds of [I], [II], and [III] with palladous chloride, which will be called the phenyl, methyl, and ethyl compound, respectively, may be prepared by simply adding the reagent to a slightly acid solution of palladous chloride, filtering off, washing, and drying the precipitate at 110° C.

The physical characteristics of these compounds are quite different. The methyl and ethyl compounds are red, slightly soluble in water, and insoluble in ethyl alcohol. The phenyl compound is dark purple, insoluble in water, but moderately soluble in alcohol.

The colorimetric procedure, previously reported, using p-nitrosodiphenylamine is satisfactory if certain precautions are observed. The use of the methyl and ethyl reagents afforded certain advantages which will be presented in this paper in comparison with the phenyl method. The behavior of the methyl and ethyl reactions is so similar that results will be given for only the methyl reaction, but they are applicable to the ethyl reaction as well.

The detailed technique used was essentially the same as in the phenyl method. Briefly, it consisted in adding the palladous chloride to the buffer in a 100 ml. volumetric flask, followed by the addition of the reagent, and diluting to the mark with water. The color matching was done in a roulette comparator using 100 ml. tubes and a suitable color filter.

The color of the phenyl and methyl reagents, as well as that of the addition compounds, is affected by pH changes, requiring the use of buffers. A hydrochloric acid—sodium acetate buffer having a pH of 1.4 was used in the phenyl method. The maximum sensitivity occurs at a higher pH, but the buffer, having a lower pH, had to be used to avoid the formation of turbid solutions. This turbidity was due to the formation of unstable colloidal suspensions. The methyl compound which is slightly soluble in the buffer would be expected to give clear solutions over a wider pH range. Actually, clear solutions were obtained in all cases, making it possible to use the method at a pH of 4.8 which corresponds to the maximum sensitivity.

The phenyl method requires about 30 minutes for the development of maximum color intensity. This compares with less

than 5 minutes for the methyl method. If the two reactions are carried out at the same pH, the rates are more nearly equal.

The suspension of the phenyl compound is stable for only 1 to 1½ hours under the most favorable conditions and stable for less than this time at the higher palladium concentrations. This in combination with the slow reaction rate makes it necessary to add the phenyl reagent to all the solutions at as nearly the same time as possible. In the methyl method the color was found to be perfectly stable for 3 to 4 hours, and after 24 hours, the color intensity decreased by only 5 per cent, the shade of color was unchanged, and there was no evidence of precipitation. The phenyl compound precipitated after a day. The methyl compound is not sufficiently stable to permit the use of permanent standards but they may be used for several hours. In this connection, it should be pointed out that palladous chloride must not stand in contact with the buffer of pH 4.8 for more than 10 minutes before adding the reagent. If allowed to stand, low results are obtained due either to a hydrolytic precipitation of the palladium or to an absorption of palladous ion on the glass surface.

The reaction rate in the phenyl method is sensitive to temperature changes, increasing with a temperature rise; the stability of the color decreases. It is necessary to control the temperature to within 5° C. The methyl reaction is but slightly affected by a temperature difference of 20° C.

The interfering substances in the two methods are practically identical. Oxidizing agents destroy the reagents; reducing agents interfere by reduction of the palladous ion. Of the metallic ions tested only ceric, auric, and silver ions, in addition to palladous ion, react with the reagent. These reactions are not as sensitive as the palladium reaction. Gold when present in amounts exceeding 100 γ interferes, but it can be removed by extracting with either ether or ethyl acetate. Silver ions do not react in acid solution but must be absent since a hydrochloric acid buffer is used. Of the other metals, only those yielding colored ions interfere when present in sufficient amount to impart an interfering color. Those metals that may be encountered include cobalt, copper, iridium, iron, nickel, platinum, and rhodium. In the case of iron and copper, they interfere at lower concentrations in the methyl method than in the phenyl method because of the higher pH of the solution employed. For example, the limiting concentration of iron in the methyl method is 3 p.p.m. as compared to 30 p.p.m. in the phenyl method.

The sensitivity of the two methods is of the same order, although it is to be remembered that the methyl method uses the pH giving the maximum sensitivity, while the phenyl does not. Actually, under the optimum conditions 1 part of Pd in 300,000,000 parts of solution can be detected by the phenyl reagent

in Nessler tubes, as compared to 1:200,000,000 for the methyl reagent. Using the spot plate the concentrations are 1:10,000,000 and 1:8,000,000, respectively. In the colorimetric procedures used, 1:200,000,000 (or 0.5 γ) can be detected by using either reagent. Both methods are applicable to quantities of palladium up to 50 γ, although the best results are obtainable using less than 30 γ. With the roulette comparator equipped with a suitable filter, the results obtainable under the most favorable conditions are accurate to 5 per cent for 5 γ of palladium and 2 to 3 per cent for 10-25 γ.

Spectrophometric studies were made on solutions of the reagents and of the compounds using a photoelectric spectrophotometer. The use of such an instrument is especially advantageous because the reagents themselves are colored. If white light is used, the absorption is the sum of that due to the compound and that of the excess reagent. By using monochromatic light, it is often possible to select some wave length, or wave band, which is not absorbed by the reagent but is by the compound, thus eliminating the effect of the color of the reagent. By plotting the relative absorption, i. e., the absorption referred to the maximum as 100, against the wave length, curves known as relative absorption curves are obtained. By comparing the curves obtained for the reagent and for the compound, the relative absorption of each will indicate at what wave length, if any, the absorption by the reagent is eliminated and yet the absorption by the compound is somewhere near its maximum. The relative absorption curve for the methyl reagent gave a maximum at 450 mμ; for the compound at 485 mμ. At 525 mμ the relative absorption of the reagent was less than 1; that of the compound 80. By using the reagent as a standard, its effect could be entirely eliminated. For the phenyl reagent, the most favorable wave length was 550 mμ but at this wave length, the reagent interfered slightly and only 50 per cent of the maximum sensitivity was obtainable. Furthermore, the slow rate of development and limited stability of the phenyl compound does not make it suitable for spectrophometric studies. The methyl reaction can be satisfactorily used and is adaptable to quantitative determinations, especially since the solutions of the compound conform to Beer's law up to a palladium content of 20γ.

Briefly comparing the reagents, it can be said that the methyl and ethyl reagents have the following advantages over the phenyl reagent:

1. The time required for development of the color is less than 5 minutes as compared to 30 minutes for the phenyl.
2. The stability of the color after formation is greater—4 hours compared to 1-2 hours. Hence, it is not so important that the reagent be added within such a limited time.

3. The reaction is much less sensitive to temperature changes than is the phenyl.
4. And as just mentioned, the reagents are more suitable to spectrophometric studies because of the greater stability and the availability of a suitable wave length of light.

The disadvantages of the methyl and ethyl reagents are:

1. They are more subject to the interference of certain ions, especially cupric and ferric ions.
2. Palladous chloride must not be allowed to remain in contact with the buffer for more than 10 minutes before adding the reagent. This is not a serious objection if one is aware of it.

The sensitivity and accuracy are of the same order of magnitude for all three reagents, and the effect of pH and of the electrolyte concentration is also comparable.

The methyl and ethyl reagents can be used advantageously in determinations in which the interfering ions are known to be absent.

The reactivity of these reagents is not limited to palladous chloride. All three react with palladous nitrate to give highly colored compounds similar to those obtained with palladous chloride. The phenyl compound may be precipitated and isolated without difficulty. The methyl and ethyl compounds are soluble and precipitate only after the solutions are evaporated to a small volume. The solids so obtained are probably contaminated with the reagent as evidenced by their color. The physical properties of the phenyl compound are similar to the corresponding chloride compound. An analysis of the compound failed to give any definite indication of its structure, though it probably is an addition compound analogous to the chloride compound.

The colorimetric determination of palladous chloride failed if silver was present. Turbidity resulted if the determination was carried out in its presence and if the silver was removed by precipitation as the chloride a part of the palladium was lost. The reaction of p-nitrosodiphenylamine was investigated to determine whether or not a direct determination of palladium in the presence of silver was possible. A method was developed which can be used for those special cases in which palladium and silver are present in solution or may be brought into solution by means of nitric acid.

The character of the reaction is very similar to that with palladous chloride and the general procedure is essentially the same. A nitric acid-sodium acetate buffer of pH 1.2 is used, and a standard palladous nitrate solution is employed for the standards. The most important precaution to be observed is that all the reagents are chloride-free. In the presence of silver, tur-

bidity will result and even when silver is not present, the precaution must be taken since very small amounts of chloride markedly decrease the color intensity.

The sensitivity is of the same order as for the palladous chloride determination. The rate of formation is about the same, though the stability is somewhat greater. The effect of temperatures, of pH, and of electrolytes is comparable. The interference of metallic ions is the same with the exception of silver which may be present to the extent of 20 mg. Larger amounts of silver cause a slight decrease in the color intensity, but this effect may be eliminated by adding approximately the same amount of silver to the standards. Thus, by such a procedure, it is possible to estimate 0.005 per cent of palladium in 100 mg. of silver with an accuracy of 10 per cent.

The methyl and ethyl reagents may be used for the determination of palladous nitrate by using a nitric-acid—sodium acetate buffer of pH 4.6. No special advantages over the phenyl method are obtainable. The reaction is slow and only slightly more stable than the phenyl reaction. The temperature effect is less, but ferric and cupric ions interfere at a lower concentration. Silver ions have about the same effect as in the phenyl method.

The reagents may also be used for the qualitative detection of palladous nitrate with the same sensitivity as with palladous chloride.

These reagents because of their high sensitivity and nearly specific reaction with palladium provide valuable methods for the detection and determination of palladium. They are also interesting from a structural standpoint, and we hope to be able to make additional studies with other related compounds to substantiate further our ideas in regard to the essential group required.

University of Virginia.

The Virginia Journal of Science

Vol. I NOVEMBER, 1940 No. 7

Virginia Academy of Science

Proceedings for the Year 1939-40

Minutes of the Eighteenth Annual Meeting
Virginia Military Institute
May 2-4, 1940

The Virginia Journal of Science

Official journal

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Virginia Academy of Science

CONTENTS

General Program of the Eighteenth Annual Meeting

LEXINGTON, VIRGINIA

1940

VIRGINIA MILITARY INSTITUTE—HEADQUARTERS

Thursday, May 2

4:30 P. M. Council Meeting. Alumni Hall.
7:30 P. M. Academy Conference. Alumni Hall.

Friday, May 3

8:30 A. M. Registration. Anteroom, Jackson Memorial Hall.

10:00 A. M. Section Meetings.

1:00 P. M. Lunch. Crozet Hall. Tickets at Registration desk. 50c per plate.

2:00 P. M. Section Meetings.

4:00 P. M. Trip to Robert E. Lee Museum in the Lee Chapel at Washington and Lee University.

5:00 P. M. Washington and Lee University invites all members and guests of the Academy to tea at the Student Union.

6:30 P. M. Banquet. Crozet Hall. Tickets at Registration desk. $1.00 per plate.

8:00 P. M. General Session. Jackson Memorial Hall.
Address of Welcome. Major Gen. Charles E. Kilbourne.
Response by President Ruskin S. Freer.
Presentation of Annual Research Prize of the Academy and the Jefferson Prize by Dr. Frank A. Geldard.
Address—"A Winter in Oaxaca: Exploring for Plants in Southern Mexico" by Dr. W. H. Camp, New York Botanical Garden.

Saturday, May 4

9:00 A. M. Section Meetings.
12:00 Noon. General Business Meeting in Jackson Memorial Hall.

Minutes of the Council Meeting

The Council met in Alumni Hall of the Virginia Military Institute, Thursday, May 2 at 5:00 P. M. with the following present: D. Maurice Allan, Preston Edwards, Ruskin S. Freer, W. C. Jones, C. E. Myers, E. C. L. Miller, W. F. Rudd, R. F. Smart, and M. H. Stow.

After considerable discussion of the future organization of the Virginia Journal of Science, Mr. Rudd moved, and it was carried that the Council recommend to the Academy:

1. That each section be authorized and requested to elect at least one member to represent its field of interest and that all these representatives constitute an editorial board for the VIRGINIA JOURNAL OF SCIENCE. (See page 177).
2. That an executive board of three members be constituted to be made up of the editor and managing editor to be elected by the Council and a chairman to be appointed by the incoming president. The Council at once reelected the present incumbents, Prof. Freer as editor and Col. Carroll as managing editor.

The Council then added to the permanent officers of the Academy by electing Dr. S. S. Negus as Assistant Secretary-Treasurer by a unanimous vote. (See page 194).

After a statement by Lt.-Col. Carroll concerning the financial status and prospects of the JOURNAL, the Council adjourned to meet at 8:00 A. M. Friday.

8:00 A. M., Friday

A number of matters were brought up, discussed and formulated for presentation to the Saturday noon business meeting. For the wording and action see page 194.

E. C. L. MILLER, *Secretary.*

Minutes of the Academy Conference

The Academy Conference met in Alumni Hall of the Virginia Military Institute, Thursday, May 2 at 8 P. M. with the following present: D. M. Allan, F. L. Apperly, A. R. Armstrong, J. T. Ashworth, R. C. Berry, G. R. Boyd, H. N. Calderwood, R. P. Carroll, Hunsdon Cary, A. F. Chestnut, W. E. Clark, R. B. Davenport, A. L. Delisle, P. H. Edwards, I. G. Foster, W. J. Frierson, T. H. Garber, F. A. Geldard, L. German, W. G. Guy, A. T. Gwathmey, J. G. Harrar, F. B. Haynes, S. M. Heflin, L. L. Hill, J. L. Howe, L. G. Hoxton, W. D. Hoyt, J. S. Jamison, Jr., G. W. Jeffers, W. C. Jones, B. M. Keys, E. C. H. Lammers, I. F. Lewis, John Mahan, A. B. Massey, W. M. McGill, L. L. Montague, S. S. Negus, J. B. Newman, J. R. Nicholson, Jr., H. M. Read, B. D. Reynolds, H. E. Ritchey, J. B. Robb, R. G. Robb, F. L. Robeson, T. McN. Simpson, Jr., R. F. Smart, F. F. Smith, M. H. Stow, I. Taliaferro, R. L. Taylor, H. McC. Trout, W. E. Trout, Jr., I. A. Updike, Mrs. I. A. Updike, H. D. Ussery, I. D. Wilson, and W. F. Young.

Report of the President

The work of your President for the past year has consisted chiefly in attempting to keep up with routine duties. The larger projects for the year, adopted by the Council or Academy at the last meeting, have been carried out by two new committees,—the Committee on the Academy Periodical, and the Committee on Science Clubs. The other committees have carried out their usual functions, and they and the Academy Secretary, Doctor Miller, are responsible for the achievements of the year.

I have met with two committees during the year, the Research Committee and the Committee on the Academy Periodical. The latter served as an emergency committee on the place of meeting for this year, when it suddenly became apparent a day or two before the committee met in Lynchburg that that city would not be able to offer hotel accommodations for the Academy meeting, due to May Day programs at Randolph-Macon Woman's College and Sweet Briar College which occur on the same weekend as our program. Because of the late date of this discovery your Secretary and President decided to present the situation to the Committee on Periodical, representing most of the sections of the Academy, to facilitate a hasty solution of the difficulty. Secretary Miller found that the Virginia Military Institute was glad to extend an invitation to our group, and on very short notice, the host institution made preparations for this meeting.

It is very unfortunate that our meetings conflict with May Day celebrations in the women's colleges of the State. Many faculty members and administrative officials who are members of the Academy are prevented from attending our meetings. The Apple Blossom Festival occurring at Winchester often provides an additional conflict. Not only do these conflicts prevent attendance of many at our meetings, but they preclude any meetings of the Academy at Lynchburg or Winchester. The question might be raised as to the advisability of changing the time of meeting. (See page 194). Another question that might be considered is the advisability of an additional meeting of the Academy, to be held in the autumn, as is done in several other state academies. An argument in favor of this suggestion is the fullness of the programs of some of the sections of the Academy, with only one meeting a year.

I wish also to suggest to the Academy the importance of continuing the work of the Committee on the Place of Science in the Schools. At the Danville meeting a year ago, Dr. Donald W. Davis asked that he be relieved of the Chairmanship of this Committee and suggested consideration of overlapping of functions of this and the Committee on Junior Membership and Science Clubs. It would appear that there is enough difference in the work of these committees and enough work for each of them to do, to continue as distinct committees. I did nothing about reconstituting the Committee on the Place of Science in the Schools because of the question raised in the Academy Conference last year as to the future of this Committee. (See page 194).

Attention has been called recently to a tendency toward decreased emphasis upon the sciences in secondary school curricula. Courses in biology, chemistry and physics, as well as other sciences formerly taught in the high schools, are giving way to general science courses and various types of survey courses. The colleges, too, are affected by this move.

On the other hand, there appears to be increasing interest in the inclusion of science material in work of the elementary grades. A number of teachers' colleges in the State, as well as the University of Virginia, are offering a course usually called, "The Teaching of Science in the Elementary Schools", with emphasis upon content rather than methods. There is a rapidly growing literature in this field. An Academy committee should continue the work of keeping abreast of this development, standing ready to give aid of any sort that may be deemed advisable. Individual members of the Academy might interest themselves in this movement in their own localities. A survey of what is going on in the schools of the State might be made, and its results presented to a future general meeting of the Academy. I strongly urge, therefore, the continuation of this Committee. I feel that it should be one of our major concerns. (See page 194).

I wish to express my deep appreciation to the Chairmen of the various Academy committees for their splendid cooperation through the year. Mr. L. C. Bird and Dr. Ivey F. Lewis, in particular, have put much time, thought and labor into launching two new endeavors, the Science Clubs project, and the VIRGINIA JOURNAL OF SCIENCE, respectively.

I cannot close my report without paying tribute to Doctor Miller. Thoroughly aware of all activities and details of Academy work, alert and anticipatory with regard to new needs and opportunities, he seems never to sleep. I also apologize to him for my own short-comings during the year. I do not know whether to call him the spark plug or the dynamo of our organization. Perhaps "dynamo" would have more dignified connotations.

RUSKIN S. FREER, *President.*

Report of the Secretary

1939-40

The two outstanding events this year are the launching of the VIRGINIA JOURNAL OF SCIENCE, and the initiation of science club work in the high schools of the State. Both promise to be highly important for the Academy and for science in Virginia, if they are properly supported.

It has been clearly recognized for several years that a Virginia Journal of Science would be very important and helpful if all fields of science would support it with articles and subscriptions. It would enable Virginia science to present a united front to the world and would be another influence binding Virginia science together. Now that it is started, let's all cooperate in its support.

At the Danville meeting a year ago, the incoming president was authorized to appoint a Committee on Science Club Work. Mr. Bird, as Chairman of that committee will report on the work done so far, but acknowledgment should be made at this time of the very cordial cooperation and support given this work by the State Board of Education, the Virginia Education Association, and the American Institute of the City of New York. Without this support, the new committee would have been greatly handicapped.

Acknowledgment should also be made of the excellent spirit shown by the Virginia Military Institute in offering to act as host to the Academy when it was discovered that we could not be accommodated in Lynchburg, owing to the simultaneous occurrence of May Day exercises in the two large women's colleges there, Randolph-Macon Woman's College and Sweet Briar College and the resultant influx of visitors.

We started the year with 843 members, lost 121 and gained 101 new members, making the present membership 823. This is 20 fewer than were reported last year. This apparent loss is probably due to the constant fluctuation in the number of junior members and is not significant.

The Treasurer's report also shows a somewhat similar condition, as our balance last year was $1576.38 and this year $1410.80. This shows a deficit of $165.58. However $300.00 has been advanced to the VIRGINIA JOURNAL OF SCIENCE, as partial payment for their printing of the Program and Proceedings. This amount normally would have been charged to the coming year, and then we would have shown a gain of $134.42.

President Freer has made the following appointments to committees:

TO NEW COMMITTEES

Committee on Science Clubs: L. C. Bird, Chairman, J. T. Christopher, H. J. Davis, G. W. Jeffers, S. S. Negus, P. M. Patterson, J. A. Reese, J. A. Rorer, W. E. Trout, and I. A. Updike.

Committee on the Journal: I. F. Lewis, Chairman, and R. P. Carroll, Business Manager.

EDITORIAL BOARD FOR THE JOURNAL

Astronomy, Mathematics and Physics: T. McN. Simpson, Jr. and Preston Edwards.

Biology: Botany—Lena Artz, R. P. Carroll, R. S. Freer, I. F. Lewis, G. C. Mason, A. B. Massey, and R. F. Smart;

Zoology: Paul R. Burch and Florence Hague.

Chemistry: W. E. Trout, Jr. and John H. Yoe.

Education: A. M. Jarman and C. E. Myers.

Engineering: A. H. Cooper and D. H. Pletta.

Geology: Ed. Steidtmann and J. K. Roberts.

Medicine: J. E. Kindred and I. D. Wilson.

Psychology: R. H. Henneman and Helen Peak.

TO ROTATING COMMITTEES

Nominating Committee: Dean Earle B. Norris, so that the committee now stands in order of rotation: H. E. Jordan, D. Maurice Allan, and Earle B. Norris.

Place of Meeting: Preston Edwards, R. C. Sommerville, and Florence S. Hague.

Research Committee: Gillie A. Larew, so that the committee now stands in order of rotation: C. C. Speidel, F. L. Apperly, F. A. Geldard, F. C. Vilbrandt, and Gillie A. Larew.

To Standing Committees

Committee on Junior Members: A. H. Cooper, so that the committee now stands: Paul R. Burch, A. H. Cooper, Helen Schultz, G. M. Shear, M. E. Taylor, and W. E. Trout, Jr., Chairman.

Conservation Committee: R. P. Carroll, so that the committee now stands: R. P. Carroll, Chairman, A. W. Drinkard, W. C. Hall, L. B. Henderson, W. D. Hoyt, W. M. McGill, J. E. Shillinger, A. M. Showalter, and T. W. Turner.

Committees that carry over unchanged:

Finance Committee: D. W. Davis, Garnett Ryland, and T. McN. Simpson, Jr., Chairman.

Publicity Committee: William Clift, Douglas Freeman, L. G. Hoxton, W. M. McGill, S. S. Negus, W. F. Rudd, Chairman, Ellen Shenk, I. A. Updike, C. E. Wheeler, III, and I. D. Wilson.

Flora Committee: Lena Artz, R. P. Carroll, R. S. Freer, I. F. Lewis, J. B. Lewis, G. C. Mason, A. B. Massey, Chairman, and R. F. Smart.

Fauna Committee: L. D. Anderson, J. W. Bailey, Paul R. Burch, R. P. Carroll, Geo. W. Chappelear, J. R. Christie, G. Talbot French, Geo. W. Jeffers, E. Ruffin Jones, Jr., Chairman, W. A. Kepner, J. J. Murray, B. D. Reynolds, R. T. Taylor, W. L. Threlkeld, H. G. Walker, I. D. Wilson.

Museum Committee: Arthur Bevan, J. S. Bryan, W. E. Carson, D. S. Freeman, W. C. Hall, G. W. Jeffers, Chairman, G. C. Mason, Helen McCormack, Stuart McGuire, J. M. Miller, Jr., W. T. Sanger, and Ida Sitler.

E. C. L. Miller, *Secretary.*

Report of the Treasurer

Balance on hand, April 15, 1939			$1,576.38
Receipts			
From Dues:			
546 Regular Members	$1,092.00		
1 Regular Member	1.50		
86 Junior Members	86.00		
10 Sustaining Members	100.00	$1,279.50	
From Interest	20.69		
From Gift	3.00		
Total Miscellaneous		23.69	
Total receipts			1,303.19
Total to account for			$2,879.57
Disbursements			
For:			
Printing and supplies		$ 105.85	
Labor		60.00	
Stamps		215.77	
Programs		210.00	
Proceedings		265.00	
Advance Virginia Journal of Science		300.00	
Assistant Secretary		25.00	
Secretary		150.00	
Auditor		5.00	
Corporation Tax		5.00	
A. A. A. S. Meeting		48.50	
Badges		20.07	
Dues Virginia Wildlife Association		10.00	
Deposit returned		25.50	
Transfer to Trust Fund		3.00	
Returned check		4.00	
Petty Cash		11.44	
Express		4.64	
Total Disbursements			1,468.77
Balance on hand April 15, 1940			$1,410.80
In Morris Plan Bank		$ 843,44	
In First and Merchants National Bank		567.36	
Total		$1,410.80	
Balance April 15, 1939	$1,576.38		
Balance April 15, 1940	1,410.80		
Deficit	$ 165.58		

E. C. L. Miller, *Treasurer.*

Richmond, Virginia
April 18, 1940

Dr. E. C. L. Miller
Virginia Academy of Science
Richmond, Virginia
Dear Doctor Miller

This is to certify that I have checked the books of the Virginia Academy of Science for the year ending April 16, 1940, and found the accounting system in good shape.

Yours very truly,
(Mrs.) Ola Darden Hellen.

Report of the President-Elect

I am fully aware that for the President-Elect to set forth his views about Academy affairs before he is inducted into office is a distinct innovation in this organization. I therefore hesitated to ask for this privilege. However, as I studied rather carefully the Academy's history and potentialities on the one hand, and what seems to me to be a few of the major needs of the State for some sort of helpful cooperation by a more or less detached group of scientific workers on the other hand, I felt impelled to make a brief appraisal of our assets in personnel, organization and vision, and over against this of the Academy's obligations and opportunities. I am grateful to those of you who are responsible for giving me a brief period in which to set forth a few conclusions based upon this appraisal.

It is obvious, I think, to all who have followed the Academy through its formative years that it has now come to a measure of maturity rarely found in organizations so young in years, and having a membership so widely diversified. This maturity has come at such a period in the economic and social life of Virginia that it is now not only our privilege but, I believe, our inescapable duty to so relate this work of the Academy to those problems in the years just ahead of us, that our influence in the trends which we see all around us will be a strong determining factor in the direction these trends are going to take.

With a membership of more than 800, drawn from practically every field of science, and with a fair number from industry also, we should be able to bring to the study of and an eventual solution of some of our vital problems, a degree of competency, sincerity of purpose and detachment of judgment, that I believe may be found in no other single organization in the State.

A profound study of many of these problems and their wise solution are of primary concern as they effect the material progress which Virginia has now begun to make on a scale far greater than we have known before. All of us here tonight have lived through an almost meteoric change in both the economic

and social aspects of life among us. The latest figures available show that out of every dollar of income earned by people in Virginia, practically one-fourth of it comes from sources that are dependent wholly upon industry that has its roots in some sort of scientific soil. Further, the indications are at present that the percentage of our income from such sources will show a definite increase in the years immediately ahead of us if we may judge at all by what has happened during the past quarter of a century.

Not forgetting for a moment the importance of an organization like ours in the cultural, educational and social aspects of our community life, I am deeply conscious of the obligations that we must assume for an even more fundamental part in all of these matters than it has been possible for us to assume during the early years of the Academy's existence. I believe we must, with enthusiasm, set ourselves to the task of seeing how we may better relate the Academy to the kind of life we see around us on every hand. How to do this most effectively, and with the fullest cooperation from all groups that must have a part in such an important program, will require a long range study of the problems by the best minds that the Academy has in it.

Further, this study must be a continuous one. It should be so organized and directed that the rank and file of our membership should know the objectives, and feel themselves a definite part of the machinery for bringing about their consummation.

It has been my good fortune to have discussed these matters with many members of the Academy in the past few months. Almost without exception they agree that we are now ready for a second step in Academy activities. There is unanimous agreement that although in the hand of Dr. Miller, and many others who have shared with him his hopes and efforts in bringing the organization to its present potentially strong position, nevertheless, from now on we shall be on trial. It will not be sufficient that we meet once a year and have a wide variety of papers, however strong they may be, on a great variety of subjects. An organization like ours may content itself with that sort of existence for the period of its youth, but will most certainly atrophy if it does not in its maturer years set itself resolutely to definitely constructive tasks that lie naturally within its sphere of influence.

Most of the things I have said are self-evident. I asked for this opportunity to say them to you tonight because I wanted to ask you to give your approval of two or three things which I believe the Academy should do at this time to make itself an even more vital force for good than it has been in the past. The proposals which I shall make have the hearty approval of our long time efficient secretary, and of Dr. Updike who, for several years, has worked with Dr. Miller as his assistant. The time has come, we believe, when our secretary needs an understudy. Such a man

should be selected with great care for upon his shoulders will probably fall, ultimately, the ever-increasing responsibilities of directing the affairs of the Academy in the second phase of its history as Dr. Miller has done in its formative years.

He should possess all of Dr. Miller's unusual qualities of leadership, industry, and vision; he should have time to devote to the work. That he should be so situated as to have available competent stenographic help is imperative. He should be so located that during the next few years he may have the benefit of close personal contact with Dr. Miller, that he may catch something of his devotion that has made the Academy what it is today. And perhaps most important of all, he should possess to a marked degree the ability to properly publicize the activities of the Academy throughout the State, and even across State lines if and when its accomplishments merit such publicity. (See page 173).

It has long been my considered judgment that the future of the Academy should be so important to the welfare of the State that its policies should be mapped out years in advance. Such planning and its direction should be controlled, it seems to me, by a very carefully selected committee that might well be called "The Committee on Long Range Policy". The Council has always functioned as more or less an administrative committee rather than as a policy making body. Further, its personnel changes too frequently for it to do the things that such a committee as I am recommending would be able to do. (See page 194).

In the beginning we feel that the committee should be reasonably large—probably ten members; two of them to be appointed for two years, two for three years, three for four years, and three for five years, their terms to be determined by lot.

Feeling as I do about this, I am asking the Academy to give me the authority to appoint such a committee as soon after I am inducted into office as I find it possible to select the personnel for, perhaps, the most important work of the Academy has as yet undertaken. I can assure you that I shall consult freely with Dr. Miller and other leaders in the Academy in the selection of such a group.

Realizing fully that it is not my duty to lay out for this new committee, should the Academy in its wisdom decide to provide for its appointment, any sort of program, I do, nevertheless, feel that it is not out of place for me to mention here tonight, very briefly, a few State-wide problems that it seems to me are just now pressing for some sort of non-partisan, intelligent solution.

Despite the fact that although more rapidly than any one of us dreamed of a short time ago we are becoming a highly industrialized Commonwealth, almost no provision is being made on the secondary school level for training our boys and girls to fit into these new demands. We have our agricultural high schools for those who expect to go back to make our farm life better, but

no counterpart of them for the large group that must go into our factories, and mills, and power plants, etc.

Only a few weeks ago you saw in the public press a statement from some of our big industrialists. Said a spokesman for the duPont organization:

> "Although the Ampthill plant has approximately 16,000 applications on the files in its employment office, it has been necessary to start an apprentice course because of lack of trained craftsmen.
>
> "There is no need to fear that vocational schools will train more people than can be absorbed by the vocation in the vicinity, he said. He cited the New England States where efficient vocational schools are being operated.
>
> "They actually create jobs in these vicinities, he said, since industries are anxious to locate where skilled workmen are available. This tends to absorb not only the product of training schools, but surplus as well, he added."

In a recent address by Dr. George F. Zook, president of the American Council on Education, occurred this most significant observation about this same problem:

> "The traditional curricula in high schools and junior colleges have proved entirely unsuited to a large proportion of the new mass of young people who have been driven, through force of circumstances, into our classrooms. The diverse character of modern industrial employment with its large proportion of repetitive jobs requires a reorganization of our program of vocational education. Economic circumstances and a natural desire to be of use in the world point clearly to the necessity of a combined program of work and study for a large proportion of youth, but so far only the Civilian Conservation Corps and the National Youth Administration see the vision."

A dangerous subject in Virginia, but nevertheless a most important one, is the pollution of our streams. This subject has been for years, and still is a more or less political football. Indeed, we venture to assert that it always will be a political matter unless and until some properly qualified and non-partisan group puts it on the proper scientific basis, and working in cooperation with the industrialists, the communities, and the lawmakers, sees it through to a satisfactory solution. In these, and many other just as important issues, the Academy might, it seems to me, exert a fine influence—a sort of intelligent, and scientific, and moral suasion—for a better way of doing things.

It all adds up to make it a distinct challenge for higher endeavor on the part of the Academy as it begins what I believe that all agree is its first years of real maturity.

As is well known, the appointing of a Committee on Science Clubs a year ago was very definitely a step in the right direction. If you think the program I have outlined, or one similar to it, deserves a trial, won't you see to it that it gets under way and then won't you give it your full and enthusiastic support? Certainly the office holders, however enthusiastic they may be, will not be able to solve any of these difficult problems without all the backing that the membership can possibly give them.

W. F. Rudd.

Report of the Committee on Science Clubs

Part I

Last year the Virginia Academy of Science authorized the appointment of a committee on Science Clubs. The members of this Committee—as appointed by your President, Dr. Ruskin S. Freer—are Dr. George W. Jeffers, Dr. I. A. Updike, Dr. Sidney S. Negus, J. T. Christopher, Hubert J. Davis, Dr. J. A. Reese, and Dr. John A. Rorer.

Some of the most valuable work was done by your Secretary, Dr. Miller. In preparing for this report, I found it most interesting to review the correspondence (voluminous in amount) pertaining to the activities of this committee. I am not going to give you much detail, but here are the highlights.

The committee felt that it was most essential to ascertain the number of Science Clubs in existence in the State of Virginia. Therefore, a letter, accompanied by a questionnaire, was sent to all school principals in Virginia—about 700—over the signature of Dr. Fred M. Alexander, State Department of Education, (this department, headed by Dr. Sidney B. Hall, has been most cooperative), Mr. Francis S. Chase, Executive Secretary of the Virginia Education Association, (Mr. Chase has also assisted to the fullest extent), and L. C. Bird, Chairman of your committee. A copy of the letter and questionnaire which were sent are attached and become a part of the record. The number of responses was unusual. We found that there were more than fifty science clubs already in existence in the State, and approximately the same number were interested. (Please see map, Exhibit I, showing distribution of science clubs.)

Simultaneous with the ending of the above mentioned letter to the principals of the secondary schools, a letter was sent out to all of the members of the Virginia Academy of Science, over the signature of your President, in which it was pointed out that the Virginia Academy of Science had determined to make the development of science clubs one of its major objectives, and asking for suggestions. A copy of this letter is attached and becomes a part of the record. The response was not as great as it should have been.

The above mentioned letter to the secondary school principals contained the following paragraph:

> "The Virginia Academy of Science is providing a special speaker on this subject at the Thanksgiving meeting of the Virginia Education Association."

The speaker provided was Dr. H. H. Sheldon, Managing Trustee, The American Institute of the City of New York. Dr. Sheldon was introduced by Dr. William T. Sanger, President of the Medical College of Virginia. The audience was large and representative, and the interest was above expectations. Dr.

Sheldon also gave a radio broadcast with the able aid of Dr. Sidney S. Negus and Dr. George W. Jeffers, this being a part of the committee's plan to promote the science club idea. Also, there appeared in the November, 1939, number of the *Virginia Journal of Education,* an article by Dr. Jeffers, entitled "Science Clubs in the Schools".

In addition, Dr. Miller and the Chairman of your committee attended a district meeting of the Virginia Education Association in Danville on October 27, at which an interesting program on science club work was arranged. Dr. Miller was the principal speaker, and his address was on "Why A Science Club"?

An excerpt from a letter written by Dr. Miller to Dr. Sheldon of the American Institute, bearing on this meeting, is of interest.

> "Mr. Bird and I went to Danville, Va., last Friday to attend a meeting of District E of the Virginia Education Association. I enclose a copy of the program. We found that there are three rather successful science clubs in the Danville (the George Washington) high school.
>
> "Mr. Christopher, the principal of the school, had some of the students come in and tell something about their science club work. He had given them "carte blanche" to say anything they wished either favorable or unfavorable or both. These students all did very well. I was much interested, as I learned several things from them. The first one graduated from the high school last year and has now gone on into junior college and misses his science club work. After the meeting he asked me if it would be proper for him to organize one in his junior college. I told him to do so, of course, stating that there are science clubs in most of the colleges of Virginia.
>
> "The next one told of the difficulties caused by the lack of a suitable room for their science club work so that all of the equipment and supplies have to be taken down and put away each time. Because of this his club members have studied up on the periodic table of the elements and other advanced work rather than doing any experiments. The third boy was from a taxidermy club and called our attention to a glass case in the high school lobby filled with good work. A peacock, a crow, an alligator, pheasants, partridges, and numerous other objects apparently very well mounted. He said the work was all done by the students rather than by the sponsor.
>
> "The fourth boy spoke for the biology club and as he personally was interested chiefly in natural history he brought in and told us all about a live opossum, a live green snake, a ripe pod of the milk weed with its seeds equipped with parachutes and a tortoise shell."

Following the meeting of the Virginia Education Association at which Dr. Sheldon spoke, there was a lull in our activities, during which we attempted to answer some of the questions which had been asked as a result of the above mentioned questionnaire. The attitude of the committee is illustrated in two types of letter which were used.

I. "I have before me the post card you recently returned to Dr. Fred M. Alexander of the State Board of Education, and I note that you do not have a science club at the present time, but have had one in the past.

"A number of other high schools here in Virginia are in the same condition, and feel that it might be helpful to sort of pool our knowl-

edge. This letter is accordingly being sent to each of these schools. Will you, therefore, please write me concerning the reasons why your science club is not now functioning, and make any other comments you may wish concerning the place and function of science clubs in high schools, and the conditions that tend to make them successful.

"We may be able to use such information to the advantage of everyone concerned, in encouraging or discouraging other schools which are contemplating starting science clubs, and we know of forty-five that are considering such action right now.

"I can assure you that we shall be glad to pass on to other schools any information or suggestions you may send us."

II. "I have before me the post card that you recently returned to Dr. Fred M. Alexander of the State Board of Education, and am delighted that you have a science club.

"As a partial response to your request for aid, I am able to present you with a year's subscription to the *Science Observer* through the courtesy of the American Institute of the City of New York. I trust that you may find it helpful.

"The Virginia Academy of Science is also collecting suggestions for work projects and programs from science club sponsors and others, in order that it, in turn, may relay them to clubs that need them. Will you, therefore, send me a list of activities that you have found interesting and suitable for science club work? We can make available to you speakers on special subjects. These will come mostly from the members of the Virginia Academy of Science.

"If you think of any other way in which we can help you, please call on us."

Shortly thereafter, there appeared in our files the name of Mr. Hubert J. Davis, teacher of Science, Pocahontas, Virginia. He is now a member of the Virginia Academy of Science and has been appointed to your science club committee. The splendid work of this member from the secondary school group is gratefully acknowledged.

I should report at this point that as a result of a conversation between Dr. Jeffers and a representative from the Bausch and Lomb Optical Company, the Science Medal which has been made available by the company has been brought to the attention of science club sponsors by your committee. I have learned recently that some 1600 high schools throughout the country award this medal annually. (Data on this is presented as Exhibit II.)

As a part of a radio series, Dr. Jeffers gave a broadcast over WRVA during the holiday season on science clubs.

Reference to our files indicates that early in January, 1940, we were contacting the State Department of Education, pointing out through Dr. Sanger the value of science clubs as a method for informal instruction in education. As a result of that contact, a second letter went to the secondary schools in the State from the State Department, calling particular attention to the literature and assistance offered science clubs by the American Institute. A set of this literature is attached and becomes a part of the record.

As a result of this Science Club Committee, the Corning Glass Works sent to each science club sponsor copies of two booklets; one on Dalton, and one on Priestly.

Mr. Davis helped us meet the need for material to be supplied to science clubs by preparing an outline and suggestions for science club activities, a copy of which is attached and becomes a part of this report. About 75 copies of this have been sent to science club sponsors. Mr. Davis also prepared an article on "How to Organize a Science Club", which appears in the current issue of the *Virginia Journal of Education.*

A question which has bothered some of us from the beginning concerning science clubs has been, how could their activities be coordinated and their interest stimulated? Mr. Davis, the active member from the secondary school group, proposed the formation of a Junior Academy of Science such as they have in other states. Mr. Davis wrote to the science club sponsors, inquiring whether or not they would be interested in the formation of a Junior Academy. The response was splendid and there seemed to be a definite interest on the part of the secondary schools in the formation of a Junior Academy. This development led us to write to Dr. Otis W. Caldwell, whom most of you know, asking him to come to this meeting (the V. M. I. meeting of the Virginia Academy of Science) and discuss with us Science Clubs, the formation of a Junior Academy of Science, and related problems.

Dr. Caldwell will be here Saturday. We expect to have a meeting at 12:45 p. m. at the Dutch Inn. We hope that as many members of the Academy will attend as possible.

The formation of a Junior Academy of Science will raise some questions, particularly with reference to the relation between the Senior Academy and the Junior Academy and the relation of both to the American Institute.

Part II

As indicated in the first part of this report, Dr. Otis W. Caldwell arrived at the meeting in Lexington Saturday morning, May 4, at 10:30. He met with some of the members of the Virginia Academy of Science, a few sponsors of science clubs, and science club members. This meeting was very informal, but the interest in the formation of a Junior Academy of Science which would coordinate and cooperate on the science club work was manifest.

Later, Dr. Caldwell talked briefly to the members of the Virginia Academy of Science with particular reference to Junior Academy activities. At its business meeting, upon motion made by Dr. George Jeffers and duly seconded, the Virginia Academy of Science authorized the formation of a Junior Academy of Science, leaving the details to the incoming President of the Academy and the Council.

Following the adjournment of the Virginia Academy of Science, some of its members, eleven science club sponsors, and fifty members of science clubs met with Dr. Caldwell again. These sponsors and club members showed enthusiasm for the Junior Academy of Science idea and indicated their desire to support such an organization.

L. C. BIRD, *Chairman.*

NOTE:—The documents mentioned as forming a part of this report are in the Academy records, but cannot well be printed here.

Report of the Committee on Research

The Research Committee of the Virginia Academy of Science met in Charlottesville on November 18, 1939 for its regular Fall business meeting. Members peresent were: Drs. Apperly, Freer (ex officio), Geldard (Chairman), Larew, Miller (ex officio), and Vilbrandt.

The chief business of the meeting was the consideration of applications for research grants for the year. Funds available for distribution, representing the income from the endowment fund of approximately $13,000 and including the sum of $125 from the A. A. A. S., amounted to $650.15. All eleven requests for aid were considered carefully and grants were made as follows:

1. M. K. Cary, Medical College of Virginia, $75.00 to assist in a study of the relation of alkalemia and acidemia to resistance to infection.
2. E. Ray Casto, Emory and Henry College, $50.00 for student assistance in tabulation, correlation and graphing of data on the influence of climate on agriculture and manufacturing.
3. F. F. Ferguson and E. Ruffin Jones, Jr., College of William and Mary, Norfolk Division, $25.00 for traveling expenses on collecting trips for Turbellaria in the Dismal Swamp and Norfolk areas.
4. F. H. Fish, Virginia Polytechnic Institute, $50.00 for the purchase of a colorimeter for use in the study of organic analytical reagents.
5. C. C. Flora and W. C. Thacker, Virginia Polytechnic Institute, $25.00 for the purchase of parts for the construction of a water bath for use in the study of fat digestion in homogenized, boiled, and acidified milk.
6. A. T. Gwathmey, University of Virginia, $105.00 for the purchase of a camera for the photomicrography of the surfaces of single crystals of copper and other metals; title to the equipment to remain with the Academy.
7. J. F. Hall and R. L. Simpson, Jr., Medical College of Virginia, $50.00 for the purchase of materials used in the construction of bridges, etc., placed in the mouths of experimental animals.

8. K. A. Jamison, Virginia Polytechnic Institute, $50.00 for the purchase of canaries for use in a survey of the incidence and characteristics of malarial parasites in wild birds.
9. A. F. Meyer, Jr., Virginia Military Institute, $35.00 for the purchase of supplies in a study of the sterilization of utensils in public eating places.

Certain requests, containing too little information of a detailed nature to permit intelligent action by the Committee, were of necessity refused.

Total grants ($465.00) thus fell short of the amount available for distribution ($650.15). It is not felt that this represents any excessively conservative tendency on the part of the Committee. On the contrary, the Committee was disposed to make larger grants had the character of the applications warranted it. In one instance, indeed, it did increase the amount requested. It is strongly to be urged that a larger number of applications and more varied ones be submitted. The Committee's resources do not permit the making of large grants but it is vitally interested in supporting in some measure any worthwhile research project in Virginia.

The policy of keeping title to stable research equipment, a gradually evolving one in late years, was reaffirmed by the present Committee. The files of the Secretary of the Academy now contain a very considerable list of research pieces, originally purchased from Research funds, the use of which may with all propriety be requested by Academy members as the apparatus becomes available for redistribution. There was at least one exchange of this sort during the past year.

Another matter of general importance came out of the Committee's discussion at its Fall meeting. This concerns the laxity of some individuals in failing to submit reports of progress in connection with their grants. The Committee feels that it is more than a granting body, having been charged from its inception with broadly encouraging research in Virginia. It retains an interest in a research project sponsored by it throughout the life of the study, and it is not manners alone that dictate that reports of progress should be made periodically to it.

An event of special interest and importance during the year was the publication by Secretary Miller of his careful and searching analysis of the work of the Research Committee for the ten-year period from 1929 to 1938 inclusive. A printed pamphlet containing this review has been circulated to the entire membership of the Academy, to all Academies of Science in the Nation, to the members of the Executive Committee of the A. A. A. S., and to other interested individuals. In addition, a somewhat briefer form of the report was published in the issue of *Science* for March 8, 1940, this at the urgent request of Dr. Otis W.

Caldwell of the Boyce Thompson Institute and Dr. J. McKeen Cattell, editor of *Science*. The latter urged its publication as an example of "how much can be done with so little" and it is gratifying to the Research Committee to have this independent appraisal of its efforts. The report was many months in preparation, involved a prodigious amount of sheer labor as well as critical insight on the part of Doctor Miller, and the entire Academy is in his debt for this splendid service. The review amply demonstrates the wisdom of having restricted grants to relatively small sums, distributed to a relatively large number of qualified researchers and should dictate a continuation in the future of the Committee's present policy.

The customary notice of the annual competition for the Academy Award and Jefferson Gold Medal was sent out with the section meeting announcements. As is usual, a supplementary report will be made by the Committee concerning the annual awards following its Spring meeting.

Committee on Research:
C. C. Speidel,
F. L. Apperly,
F. C. Vilbrandt,
Gillie Larew,
F. A. Geldard, *Chairman.*

Report of the Committee on Junior Members

The following are the members of a committee-at-large who have been active for several years in securing junior members in the colleges and universities of the State:

Dr. Thomas D. Brown, Roanoke College.
Dr. W. E. Bullington, Randolph-Macon College.
Dr. Paul R. Burch, Radford State Teachers College.
Lieut.-Col. Robert P. Carroll, Virginia Military Institute.
Dr. George W. Chappelear, Madison College.
Dr. Donald W. Davis, College of William and Mary.
Dr. Joseph Elder, Lynchburg College
Miss Goldena Farnsworth, Hollins College.
Dr. W. J. Frierson, Hampden-Sydney College.
Dr. H. B. Haag, Medical College of Virginia.
Dr. Florence Hague, Sweet Briar College.
Miss Lena B. Henderson, Randolph-Macon Woman's College.
Dr. L. L. Hill, Washington and Lee University.
Dr. Ralph Hostetter, Eastern Mennonite School.
Dr. George W. Jeffers, Farmville State Teachers College.
Dr. E. Ruffin Jones, College of William and Mary, Norfolk division.
Dr. Leonidas R. Littleton, Emory and Henry College.
Miss Alice McKee, Virginia-Intermont College.

Dr. Joseph K. Roberts, University of Virginia.
Miss Helen H. Schultz, Mary Washington College.
Dr. G. M. Shear, Virginia Polytechnic Institute.
Dr. Robert F. Smart, University of Richmond.
Dr. Mildred E. Taylor, Mary Baldwin College.
Dr. Thomas W. Turner, Hampton Institute.
Dr. Harry Weimer, Bridgewater College.

All members of the Academy may consider themselves members of this committee, and many deserve mention whose names are omitted. I have the proof that these members have been efficiently canvassing their students, and that any failure to secure members cannot be attributed to their indifference or idleness. Some unusual circumstances have arisen in certain cases that have reduced the number of memberships. In other instances the number of memberships shows an encouraging increase.

Two questions arose that might be discussed further by the Academy Conference: (1) Some objection was expressed to asking non-participants to join the Academy while some students who are not members are allowed to take part in the program. (2) Some students did not desire to become members, but wanted to pay a registration fee for the privilege of attending the meetings.

The possibility of some special event for student members at each meeting was considered. Any suggestions concerning this work will be sincerely appreciated.

Committee on Junior Members:
PAUL R. BURCH,
ALBERT H. COOPER,
HELEN M. SCHULTZ,
G. M. SHEAR,
MILDRED E. TAYLOR,
WM. E. TROUT, JR., *Chairman.*

Report of the Committee on the Virginia Journal of Science

The large committee set up in 1939 to consider the publication of an Academy journal held only one meeting, but exchanged views freely by mail. The twenty-five members represented all sections of the Academy.

The following decisions were arrived at. For 1940-41, the Editor elected is Ruskin S. Freer; the Managing Editor, Robert P. Carroll. A temporary Editorial Board was set up to serve until the 1940 meeting of the Academy as follows: Preston H. Edwards—Astronomy, Mathematics and Physics; Paul R. Burch—Biology; William G. Guy—Chemistry; John A. Rorer—Education; D. H. Pletta—Engineering; E. C. H. Lammers—Geology; E. C. L. Miller—Academy at large.

The subscription price of the Journal was set at $1.00 for Academy members, $2.00 for non-members. Non-subscribing Academy members will continue to receive the Program and Proceedings without cost. The VIRGINIA JOURNAL OF SCIENCE was selected as the name. Numbers 1, 2-3, and 4 are the issues bringing publication to the date of the 1940 meeting of the Academy. Other numbers will appear during the year.

The Committee realizes that the success of the Journal will depend entirely upon the support given by members of the Academy, and urges upon all members hearty and generous cooperation so that the first year of the Journal may justify its continuance.

IVEY F. LEWIS, *Chairman.*

Report of the Finance Committee

An effort to reconstitute the Finance Committee failed and late in the year the President requested the present chairman to continue in office for this term. Only one matter of importance has come before the committee and that was submitted by mail by the secretary of the Academy and had to do with the financing of the Journal.

At a special meeting of the Council, an agreement as to allocation of funds was reached tentatively. As that will be reported by the secretary and come before the Academy for approval, no comment on the part of the Finance Committee is necessary. The committee will of course be ready to assist further, if further consideration of the matter is required.

T. McN. SIMPSON, JR., *Chairman.*

Report of the Publicity Committee

The Publicity Committee of the Academy was organized before the Richmond meeting of the A. A. A. S. and functioned well in the accomplishment of the work it was intended to do. During the past year only routine publicity in connection with places of meeting, programs, etc., has been attempted.

In consideration of the great amount of work that the Secretary—Dr. Miller—has had to do and upon his recommendation, an assistant secretary was named at the Lexington meeting. Dr. Miller and Dr. Negus will now be able to give the Academy's activities the type of publicity that we have not enjoyed heretofore.

W. F. RUDD, *Chairman.*

Report of the Flora Committee

The development of the work of studying and recording data relating to the flora of Virginia is progressing. The job of cataloging the authentic data and herbarium specimens is being pushed. The herbaria of the state are growing.

The chairman was especially encouraged during a recent visit, the first in a number of years, to the Department of Biology of Randolph-Macon Woman's College, to find a well-organized herbarium stored in metal cases and housed in a modern building. This collection of 8700 sheets contains 1000 Virginia species and a considerable number of specimens from other states. During the year the herbarium at the Virginia Military Institute has been moved to a very satisfactory space in a modern fire-proof building.

Claytonia, as a journal, has been discontinued in favor of the Academy journal, VIRGINIA JOURNAL OF SCIENCE. The Committee, or more specifically Professors Freer and Carroll, published this through five volumes, the journal being completely self-supporting through the period.

Mimeographed reports of several families are ready for typing and should be available soon.

A movement has been started recently by a number of botanists in Washington to prepare an enlarged revision of the Flora of the District of Columbia. The area covered will include a number of northern Virginia counties, hence will aid in our work on the flora of Virginia. The chairman of the Virginia Committee was asked to join the group and expects to cooperate with the district movement as far as possible.

A. B. MASSEY, *Chairman.*

Under new business, Dr. Smart brought up the question of a permanent change in the time of meeting. This was referred to the Council for action. (See page —).

Lt.-Col. Carroll made some announcements concerning places of meetings.

President Freer announced the appointment of R. L. Taylor, D. M. Allan and J. G. Harrar as a Committee on Resolutions.

The meeting adjourned at 10:00 P. M.

E. C. L. MILLER, *Secretary.*

Minutes of the Saturday Noon Business Meeting

The meeting was called to order Saturday, May 4 at 12 Noon in the Jackson Memorial Hall of the Virginia Military Institute. The Secretary presented the following report of the Council meeting which was adopted as a whole:

1. On motion of Dr. Stow the Council recommends that the Academy appropriate annually to the VIRGINIA JOURNAL OF SCIENCE a sum not to exceed $500.00. This appropriation to continue for a period of two years, if necessary.
2. On motion of Dr. Allan the Council recommends that the Editor and Managing Editor of the VIRGINIA JOURNAL OF SCIENCE be elected for a three-year period by the Council. That these two offices, together with a chairman to be appointed by the President, constitute a permanent committee on the Academy Periodical.
3. On motion of Dr. Myers the Council recommends that a standing committee on teaching science in the public schools be appointed by the incoming president. (See page 175).
4. On motion of Dean Rudd the Council recommends that, if possible, Dr. Miller should attend the Eighth American Scientific Congress in Washington next week, and that as many representatives of sections as possible should also go.
5. On motion of Dr. Jones the Council recommends that the incoming president be empowered to appoint a Committee on Long Range Policy as recommended by the President-elect. (See page 182).
6. On motion of Dr. Myers the Council recommends that the Council elect an Assistant Secretary as a permanent officer of the Academy. (See page 173).
7. On motion of Dr. Smart the Council recommends that the incoming president be authorized to appoint a committee to investigate the most suitable date for the Academy to hold its annual meeting. This committee to report back to the Council with recommendation well before the time selected. (See page 175).
8. On motion of Dean Rudd the Council recommends that each section of the Academy be authorized and requested to elect at least one person to represent its field of science; all of these persons to constitute an editorial board for the VIRGINIA JOURNAL OF SCIENCE. (See page 177).

Dr. Otis W. Caldwell, General Secretary of the American Association for the Advancement of Science, who was present, gave a short talk on the importance of science club work.

The President called for and received a list of the new officers of sections as follows:

Astronomy, Mathematics & Physics
Chairman, F. B. Haynes
Secretary, Isabel Boggs
Biology
Chairman, E. DeWitt Miller
Vice-Chairman, Lena Artz
Secretary, R. F. Smart
Chemistry
Chairman, W. G. Guy
Secretary, W. O. Swan
Education
Chairman, Paul G. Hook
Secretary, Earl G. Broadwater
Engineering
Chairman, Dan H. Pletta
Secretary, Paul S. Dear
Geology
Chairman, E. C. H. Lammers
Vice-Chairman, R. S. Edmundson
Secretary, Wm. M. McGill
Medicine
Chairman, R. J. Main
Secretary, Guy W. Horsley
Psychology
Chairman, W. M. Hinton
Secretary, Evelyn Raskin

EDITORIAL BOARD

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S. A. Mitchell, Astronomy
C. L. Albright, Physics
Biology
G. W. Jeffers
Chemistry
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Albert H. Cooper
Geology
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Medicine
Carl C. Speidel
Psychology
R. S. Henneman

Report of the Research Committee

At the spring meeting of the Research Committee held at the Virginia Military Institute, Friday, May 3, 1940 at noon, the following papers were in hand for consideration:

The Effect of Attrahents on Mosquitoes. I. Report of Exploratory Observations on Four Common Species.
By *K. B. M. Crooks.*
Experimental and Phylogenetic Studies in Cytology.
By *W. C. Gregory.*
A Comparative Cytological and Morphological Study of Mesostoma ehrenbergii ehrenbergii and Mesostoma ehrenbergii wardii.
By *Ladley Husted* and *T. K. Ruebush.*
The Formation of the Ovum of Chlorohydra viridissima.
By *W. A. Kepner, B. A. Perry, W. B. Atkinson,* and *J. R. Meyer.*
The Application of a New Class of Organic Reagent to the Detection and Determination of Palladium.
By *L. G. Overholser* and *John H. Yoe.*
The Effect of Changing Skin Temperature on Vibratory Sensitivity.
By *Joseph Weitz.*
The Solution of Differential Equations by Operational Calculus. Pt. 1.
By *A. Lee Smith.*

These papers had been submitted by their authors in competition for the prizes and had been evaluated by Dean Stanton C. Crawford of the University of Pittsburgh and members of his faculty. On Dean Crawford's recommendation, the Academy prize of fifty dollars was awarded to Walton C. Gregory, and the Jefferson prize of fifty dollars to L. G. Overholser and John H.

Yoe. This latter paper now will compete with papers from the academies of science of North Carolina, South Carolina, Georgia and Florida for the Jefferson gold medal.

Committee on Research,
C. C. SPEIDEL,
F. L. APPERLY,
F. C. VILBRANDT,
GILLIE A. LAREW,
F. A. GELDARD, *Chairman.*

Report of the Resolutions Committee

Dr. Raymond Taylor presented the following resolutions:

WHEREAS, the Virginia Military Institute, for the second time in four years and on very short notice, due to the necessary cancellation of Lynchburg as the place of meeting of the Academy, so generously and so cooperatively has extended to us its hospitality, *be it resolved* that the Virginia Academy of Science express its heartiest gratitude to Major-General Kilbourne, to Brigadier-General Anderson, to Colonel Steidtmann, to Lieut.-Colonel Carroll and to all of the members of the Local Committee on Arrangements, whose kindly and efficient services have made this meeting of the Academy such a pleasant and memorable one; and also, *be it resolved* that the Academy express its warm appreciation to Washington and Lee University for its share in the fine hospitality extended to the members of the Academy.

WHEREAS, the Virginia Academy of Science recognizes the signal services of President Ruskin S. Freer, Secretary-Treasurer E. C. L. Miller and the several committees of the Academy during this meeting and during the past year, *be it resolved* that the members of the Virginia Academy of Science and the Academy collectively extend a vote of thanks to all of these individuals for the devoted and efficient administration that has been given; and, further, *be it resolved* that the Academy commend the work of those connected with the development of Science Clubs throughout the Commonwealth and that the Academy hereby endorse such work and go on record as desiring continued and intensive work on this project.

WHEREAS, the Virginia Council on Public Administration has learned of our President-Elect's proposal to develop a long range and comprehensive program for the improvement of certain conditions in Virginia, notably the stream pollution problem and the need for increased vocational training; and *whereas,* an officer of the Virginia Council on Public Administration has offered, informally, full cooperation with the Virginia Academy of Science in working out such a program, *be it resolved,* that the Academy gratefully acknowledge this kind offer and, *be it resolved,* also, that the Council of the Academy or any appropriate committee that may be appointed to develop this program, be instructed, in turn, to cooperate in all feasible ways with the Virginia Council on Public Administration and with any other organization that is working constructively along these lines.

Respectfully submitted,
D. MAURICE ALLAN,
J. G. HARRAR,
RAYMOND L. TAYLOR, *Chairman.*

These were adopted.

The following resolution was presented by George W. Jeffers and Rodney C. Berry and was adopted:

RESOLVED, that the Senior Academy of Science sponsor a Junior Academy of Science, and that the incoming president be empowered to form a committee to work out details.

Dr. Vyssotsky as Chairman of the Section on Astronomy, Mathematics and Physics reported the following action of his section:

1. On motion of Dr. Loving, it was recommended to the Council that dues be raised to $2.50, 50c of which goes to the Journal.
2. On motion of Dr. Simpson, it was recommended to the Council that in lieu of a regular editor for mathematics that the Editorial Board be instructed to call on some mathematician for aid when needed.
   This was referred to the Council for further consideration.

The following resolution was presented from the floor at the Friday night meeting by Dr. Ivey F. Lewis and adopted.

WHEREAS, the term of Doctor John Shelton Horsley, Sr., as Chairman of the Research Committee of the Virginia Academy of Science has come to a close during the past year, and

WHEREAS, his genius has guided the activities of the Committee throughout the larger part of its existence, and

WHEREAS, the endowment fund which has made possible the furthering in a significant manner of scientific research in Virginia was established and has been augmented largely through his efforts and generosity,

BE IT THEREFORE RESOLVED, that the Virginia Academy of Science, in general session assembled at Lexington, Virginia on May 3, 1940, express both its grateful appreciation to Doctor Horsley for these services and its profound satisfaction in the continuance of his unfailing interest in the affairs of the Academy.

In the absence of the Chairman of the Committee on the Place of Meeting, Dr. Preston Edwards recommended that the Academy meet in 1941 at the Medical College of Virginia. This was adopted.

In the absence of the Chairman, Dr. T. McN. Simpson, Jr., reported for the Nominating Committee as follows: Dr. George W. Jeffers for President-Elect and Dr. H. H. Zimmerley as a Member of the Council. There being no nominations from the floor the report of the Committee was adopted.

E. C. L. MILLER, *Secretary.*

Tabulation of the registration cards at the close of the meeting gave the following table which shows the number of members and non-members that indicated preference for each section and the per cent of non-members formed of each section.

Sections	*Members*	*Non-Members*	*Total*	*% Non-Members*
Astronomy, Math. and Phy...	49	32	81	39.5
Biology	74	53	127	41.7
Chemistry	60	27	86	31.4
Education	19	1	20	5.0
Engineering	10	12	22	54.5
Geology	20	12	32	37.5
Medicine	35	9	44	20.4
Psychology	19	8	27	29.6
Science Clubs	3	5	8	62.5
Not indicated	8	7	15	46.6
GROSS TOTAL	297	166	463	35.9
Deduct for duplication	26	10	36	
TOTAL REGISTERED	271	156	427	36.8
% of total registration	63.5	36.5	100	

Minutes of the Section of Astronomy, Mathematics and Physics

A. N. VYSSOTSKY, *Chairman*

F. B. HAYNES, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

1. Photographic Determination of the Diameter of Mars.

Dirk Reuyl; *Leander McCormick Observatory, University of Virginia.*

Photographs in yellow light with the 26-inch visual refractor were obtained in the years 1934, '35, '37 and '39, when the planet presented diameters respectively of less than 5″, at greatest observable distance, 15″, 18″ and of 24″, at opposition. Measurements of the diameter and density were made on 480 exposures of 25 plates. Corrections depending upon density and definition were applied to the measured diameter values. With the evaluation of a constant term, common to all measurements, the derived diameter of Mars at unit distance amounts to 9″.43 ± 0″.06.

2. General Perturbations of Planets of the Hecuba Group Determined by Means of the Berkeley Tables.

Claude M. Anderson, Jr.; *Leander McCormick Observatory, University of Virginia.*

A discussion of the method used in computing the perturbations was followed by some examples of its application.

3. Photovisual Sequences from 15° South to 75° North Declination.

C. A. Wirtanen; *Leander McCormick Observatory, University of Virginia.*

These sequences constitute part of a larger program for the derivation of photovisual magnitudes as faint as $12^{m}.0$ in any part of the sky between declinations −20° and +80°. They were obtained by direct polar comparison, using the 10-inch Cooke triplet and will determine the zero point at the center of each of the 330 regions of the program. Two thirds of these have been measured involving about 2800 stars. A comparison of these magnitudes with those of the Harvard Observatory gives an independent check on the zero point and scale of the McCormick magnitudes, and shows that systematic errors are small. The probable error of a single magnitude is believed to be not more than $\pm^{m}.07$.

4. A Suggestion for Rational Musical Notation.

Preston Edwards; *Sweet Briar College.*

A system is described and illustrated, which, besides a somewhat modified staff, uses only one type of symbol, namely a heavy bar, whose position indicates the pitch of the notes, and its length their duration. Thus a multiplicity of signs and symbols is done away with.

5. Electrical Discharge Figures on the Surface of a Conducting Fluid.

A. J. Hodges and L. B. Snoddy; *Rouss Physical Laboratory, University of Virginia.*

The formation of electrical discharge figures on the surface of a $CuSO_4$ solution previously described[1] has been studied as a function of pressure and applied voltage. The length of both positive and negative figures increases with decreasing pressure and increasing applied voltage. Branching of the positive figure disappears at low pressure.

6. Graphical Evaluation of the Statistical Significance of Rate Differences.[2]

F. T. Holmes; *University of Virginia,* and T. L. Montgomery, *Jefferson Hospital, Philadelphia.*

A multiple of the standard error of the difference in rate of occurrence of a given phenomenon as observed between two finite series of counted events can be used as a criterion of significance of the observed rate difference. This multiple, e. g. 2σ, can be plotted as a function of other variables occurring in one of the equations for the standard error. The result is a family of curves which can be used to determine quickly the presence or absence of a significant contingency rate difference between two series of "counting data". A single graph covering a usefully wide range of the parameters involved can be made with a small sacrifice in accuracy. $\pm$ 15% of 2σ. Applications to many problems in medicine, industry, and the laboratory sciences are obvious.

7. Spectrophotometric Observation of the Minimum of Zeta Aurigae.

C. A. Wirtanen; *Leander McCormick Observatory, University of Virginia.*

The variation in brightness of Zeta Aurigae during the recent eclipse has been observed photographically at eight different wave-lengths by means of a coarse grating and a low dispersion prism mounted simultaneously in front of the objective of the 10-inch Cooke triplet. McCormick values for the loss of light in magnitudes agree with determinations made by others during previous eclipses. In the yellow the brightness decreases by about $0^m.2$, while in the violet the decrease amounts to $2^m.2$.

8. The System of Magnitudes of the Second McCormick Proper Motion Catalogue.

E. R. Dyer, Jr.; *Leander McCormick Observatory, University of Virginia.*

(Introduced by A. N. Vyssotsky.)

Photovisual magnitudes of 12,000 proper motion stars are being measured by the objective grating method, with corrected Harvard magnitudes as standards. Independent checks show that the relation of the McCormick to the International system is:

$$\text{Ipv} - 8^m.20 = .968(\text{McC} - 8^m.20)$$

but this correction may not be significant. The probable error of a single magnitude is

$$.144 \quad .015$$

[1]L. B. Snoddy and J. W. Beams, Phys. Rev. *55* (1939) : 663.
[2]F. T. Holmes, Phys. Rev. *56*, 844 (1939).

FRIDAY, MAY 3—2:00 P. M.

9. Business Meeting.

S. A. Mitchell and C. L. Albright were elected to serve as members of the Journal Committee to represent the section of Astronomy, Mathematics and Physics.

A motion was passed to permit the Journal Committee to ask for assistance from a mathematician.

The following officers were elected for the coming year:

F. B. Haynes, Chairman;

Miss Isabelle Boggs, Secretary.

10. Concentration of Chlorine Isotopes by Centrifuging at Dry Ice Temperature.

F. C. Armistead; *Rouss Physical Laboratory, University of Virginia.*
(Introduced by J. W. Beams.)

The concentration of the chlorine isotopes obtained experimentally at room temperature (300°A.) by the evaporative centrifuge method has been shown previously to be in accord with the theory of Lindemann and Aston and Mulliken. In the present paper the same theory has been checked at dry ice temperature (approximately 200°A.). The centrifuge was of the air-driven vacuum type. The hollow rotor (8 cm effective inside diameter) was spun inside an evacuated enclosure maintained at dry ice temperature. The tubular shaft (gauge 15) was about 15 inches long and made of stainless steel, to insulate thermally the rotor. Standing vibrations in the shaft were prevented by guides mounted in Bakelite. After placing about 10 cc of liquid ethyl chloride in the rotor, it was spun to 1245 r. p. s. and evacuated through the shaft. The ethyl chloride vapor was drawn off very slowly through the shaft and a long "plug" in the end of the shaft with a small hole through it, so that approximate equilibrium could exist in the rotor. A spider shaped piece was placed inside the rotor bowl to keep seven segments completely separate from each other, and thus help establish the same equilibrium. The vapor was collected in small samples in traps cooled by liquid air. The isotopic ratio measured by the mass spectrometer in the first and last samples differed by 14%, which is in fair accord with the theory.

11. Progressive Electrical Breakdown in a Conducting Liquid.

Hugh F. Henry; *Rouss Physical Laboratory, University of Virginia.*
(Introduced by L. B. Snoddy.)

The discharge which takes place between Cu electrodes in a $CuSO_4$ solution is produced in a manner similar to that previously described.[3] The time lag in the appearance of luminosity at the electrode surfaces and the maximum electrode separation for complete breakdown have been determined under a variety of conditions.

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[3]L. B. Snoddy and J. W. Beams, Phys. Rev. *55*, 879 (1939).

12. Effective Rotation Temperatures of Two Identical Electrodeless Discharges in Different Gases.

M. S. McCay; *Virginia Polytechnic Institute.*

A comparison of the effective rotation temperatures of different gases in similar electrodeless discharges was undertaken. Temperatures were deduced (1) by determining the maxima of intensity in the branches of emission bands, and (2) by locating the points of equivalent intensity and frequency for pairs of branches of emission bands.

The band spectra were photographed in the first order with the department's 21-foot, concave grating under a dispersion of 2.60 Å/mm. Line intensities were determined by means of a Bausch and Lomb microphotometer. The temperature values were found to be in rather close agreement with each other.

13. Temperature Variation in the Specific Heat of a Gas by a New Method.

R. A. Weiss; *Rouss Physical Laboratory, University of Virginia.*
(Introduced by L. G. Hoxton).

Results using the method of continuous flow calorimetry previously described[4] are presented.

Application is made to gases in which the changes in c_p, under varying temperatures from 42°C to 150°C and approximately atmospheric pressure, are compared.

The essential features of the calorimeter-design of Osborne, Stimson and Sligh[5] are incorporated. This relative method is applicable to other thermal properties of fluids and to varying pressures.

14. Construction and Performance of a Twenty-One Foot Grating Spectograph.

H. D. Ussery and E. S. Bishop; *Virginia Polytechnic Institute.*

A grating spectograph, recently constructed in the Physics Department at Virginia Polytechnic Institute, was described. Lantern slides showing the instrument, and sample spectrograms were presented. The defracting element is a 21 ft. concave grating made by Professor R. W. Wood and has a ruling of 30,000 lines/inch over a 6 inch aluminized pyrex surface. A unique feature of the instrument is a dual mounting of the grating, that is, it may be used mounted in parallel light, or on a modified Paschen mounting, the change being made from one mounting to the other without disturbing the focus adjustments. The plate dispersion in the first order for the mounting in parallel light, is 2.60 A/mm, and is constant to within a few thousandth part of an Angstrom/mm over the range of wavelengths between 2000 A and 4000 A.

15. The Solution of Differential Equations by Operational Calculus. Part I.

A. Lee Smith; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.*

The following equation

$$f(P) = P \int_0^\infty e - {}^{Px}h(x)\, dx,$$

is known as Carson's Integral Equation, on the basis of which is derived

[4]L. G. Hoxton, Virginia Academy of Science Proceedings, p. 28 (1931-32).
[5]N. S. Osborne, H. F. Stimson, T. S. Sligh, Jr., B. S. J. R. *20*, 119 (1925),

our operational calculus. Vigorous mathematics has been used in the derivations of its theorems, which are then applied to linear differential equations with constant coefficients, considering at the same time the initial conditions. Heaviside's Expansion Theorem has been derived by means of a simple partial fraction rule.

16. Growth Curves as Applied in Predicting School Enrollment.

Boyd Harshbarger; *Virginia Polytechnic Institute.*

Many problems of biology and economics follow the curve $y = ar^x$. A table has been prepared enabling one to calculate the constants a and r where the number of x varieties is between 0 and 40.

This curve has been used in predicting the school enrollment for both the state and the City of Lynchburg in the early years of growth. . Including the later years other functions must be used. These more complex functions are determined so as to be used for predicting the future trends of enrollment in Virginia and in Lynchburg.

17. A Sequence of Perspective Triangles whose Vertices are Determined by a Difference Equation.

B. Z. Linfield; *University of Virginia.*

The lines joining the vertices of any $\triangle$ uvw to any point

$$g = \frac{au + bv + cw}{a + b + c}, \qquad abc \neq 0,$$

intersect the opposite sides in the vertices of $\triangle\, u_1v_1w_1$.

The same lines intersect the sides of $\triangle\, u_1v_1w_1$ in $\triangle\, u_2v_2w_2, \ldots$

where
$$u_n = \frac{au\, t_n + bv\, t_{n+1} + cw\, t_{n+1}}{at_n + (b + c)\, t_{n+1}}, \ldots$$

$$2t_{n+2} = t_{n+1} + t_n, \quad t_0 = 1, \quad t_1 = 0.$$

Solving the last difference equation:

$$(2E^2 - E - 1)t_n = (2E + 1)\ (E - 1)t_n = 0,$$

we get
$$3t_n = \frac{2}{(-2)^n} + 1, \frac{t_n}{t_{n+1}} = 1 + \frac{3}{(-2)^n - 1} \equiv f(n);$$

$$u_n = \frac{au\, f(n) + bv + cw}{a\, f(n) + b + c} = P^n(u), \ldots$$

And, the equations of the sides of $\triangle\, u_nv_nw_n$ are

$$f(-n)\frac{U(z)}{U(g)} + \frac{V(z)}{V(g)} + \frac{W(z)}{W(g)} = 0, \ldots$$

with immediate generalizations to 3-dimensional or n-dimensional space.

[1]See Proceedings Virginia Academy of Science 1932-33, pp. 27-28, for definition of the persp. transformations $P(z)$ and $P^n(z)$.

SATURDAY, MAY 4—9:00 A. M.

18. A Preliminary Survey of the Physical Properties of Microscope Contrast Filters and New Filter Materials.

Lewis W. Webb, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.*

Object: The development of a more ideal set of contrast filters of maximum efficiency and minimum cost for use in photography and microscopy.
Method: A quantitative absorption spectrum has been obtained for 85 different light filters using the new Coleman Regional Spectrophotometer. Other tests and microscopic value ratings were described.

19. An Electronic Switch.

J. R. Cosby; *Virginia Polytechnic Institute* and C. W. Lampson; *University of Richmond.*

An electronic switch suitable for use with the usual cathode ray oscillograph has been constructed. By use of such a device the study of relative phase angle between reactive elements can be accomplished as well as the direct comparison of frequencies and the study of thyratron control. Its use as a square wave generator is also facilitated.
A demonstration of several of its uses was given.

20. A Simple Mercury Vapor Lamp, Operating on Direct Current.

S. M. Heflin; *Virginia Military Institute.*

This lamp is not new, but is easy to start, will operate on a minimum of accessories, and will continue to operate for long periods of time without re-starting.

21. The Radiometer in an Enclosure at Uniform Temperature.

L. G. Hoxton, *Rouss Physical Laboratory, University of Virginia.*

Demonstration.

22. Dynamical Model for Gyroscopic Precession.

Thomas Davis; *Virginia Polytechnic Institute.*

A model was described which by its motion demonstrates that the simultaneous existence of two rotations with axes perpendicular gives rise to equal and opposite accelerations necessitating a torque with its axis mutually perpendicular to the other two in accordance with Newton's Laws of motion.

23. Several Improved Experiments for an Advanced Mechanics Laboratory.

Herbert Trotter, Jr.; *Washington and Lee University.*

Several improved experiments for an advanced mechanics laboratory.
(1) Freely falling body.
(2) Simple harmonic motion.
(3) Coefficient of restitution of a golf ball.
(4) A physical pendulum.

24. Some Lecture Demonstrations.
Herbert Trotter, Jr.; *Washington and Lee University.*

25. A Demonstration of Contrast Filters and Filter Material.
Lewis W. Webb, Jr. and Frederick F. Ferguson, *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.*

(Permanent Demonstration).

The following microscopic light filters were displayed: "Cellopane"—DuPont, "Differential"—Bausch and Lomb, "Duraline wedge"—Harrison and Harrison, "Plexiglas"—Rohm and Haas, "Plastacele"—DuPont, "Wratten"—Eastman.

Methods of testing the filters and sample results were shown. Several simple devices have been constructed to facilitate the use of the filters in microscopic work.

F. B. HAYNES, *Secretary.*

Minutes of the Section of Biology

BRUCE D. REYNOLDS, *Chairman*
J. G. HARRAR, *Sub-Chairman*
LENA B. HENDERSON, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

1. Notes on the Control of the Fuller's Rose Weevil, *Pantomorus Godmani* (Crotch) on Kale.

Harry G. Walker and Lauren D. Anderson; *Virginia Truck Experiment Station, Norfolk.* (Lantern, 6 min.)

This is a report of an experiment for the control of an outbreak of the Fuller's rose weevil, *Pantomorus Godmani* (Crotch), in a field of kale at Norfolk, Virginia. In this test a derris-talc dust containing 0.75 per cent rotenone gave 26 per cent kill of the weevils. A pyrethrum-talc dust containing 0.2 per cent pyrethrins gave nearly 100 per cent knock down of the weevils within 30 minutes after the dust was applied. However, all but 23 per cent of them recovered and continued feeding on the treated plants. A dust containing about 40 per cent calcium arsenate, 10 per cent Paris Green and 50 per cent hydrated lime gave 85 per cent kill. An undiluted calcium arsenate dust gave 94 per cent kill. Statistically the differences in kill obtained with the two dusts containing calcium arsenate were not significant, but they were highly significant over those obtained with the derris and pyrethrum dusts.

2. A Perennial Woody Gall on Hickory.

Raymond L. Taylor and Alphonse F. Chestnut; *College of William and Mary.*

The apparently increasing abundance, in the vicinity of Williamsburg, of a perennial growth on the bitternut, *Carya Cordiformis* (Wang.) K. Koch, has encouraged the beginning of a general study of the phenomenon. It has not been seen by us on other hickories. It is uncertain at present whether the causative organism is *Pseudomonas tumefaciens* (S. & T.) Duggar, a bacterium with numerous hosts, or *Phomopsis sp.*, an ascomycete. Lepidopterous and dipterous insects found in the periphery of some of the galls are regarded as not responsible for the formation of these growths.

3. Concerning the Structure and Movement of Flagella.

Bruce D. Reynolds; *University of Virginia.* (Lantern, 15 min.)

Three different structural types of flagella are described and these are discussed with reference to the effect of form on movement. One of these drives the cell body through the medium (pulsella); the other pulls it (tractella); while the third is either pulsella or tractella, depending on the speed of vibration. The first two possess axial filaments, the third does not. At the distal end of the first type there is a vesicle which acts as a damper on the waves travelling towards the tip. At the distal end of the second type there is a vesicle and a terminal filament where the waves of contraction originate and travel towards the base. In the third type waves travel from the base towards the tip where, no vesicle being present, they are reflected back. The combined action of these waves causes the flagella to vibrate rapidly, resulting in a movement forward by sculling.

4. Making Animated Biological Movie Diagrams.

Lorus J. Milne, *Randolph-Macon Woman's College.* (Motion pictures, 25 min.)

The techniques of the Disney studio modified to the creation of teaching films illustrating biological processes through the use of animated diagrams. The steps in the procedure from the rough pencil drawings of successive stages, to a sample movie were demonstrated.

5. The Effect of Attrahents on Mosquitoes.

K. B. M. Crooks; *Hampton Institute.* (Read by title.)

Four well known species of mosquitoes, *Aëdes aegypti,* the yellow fever mosquito, *Culex pipiens,* the rain barrel or house mosquito, *Culex quinquefasciatus,* the filarial mosquito, the *Theobaldia melanura,* a notorious nuisance in the warmer parts of the U. S., were kept in culture for observation and experiments on the effects of environmental factors on them, particularly with respect to the effect of substance which attracted them.

The observations and experiments were grouped into two categories: the first included exploratory tests which attempted to determine suitable criteria and the most effective and consistent attractants for these mosquitoes. The several factors used in these tests did not prove convincingly attractive to mosquitoes of both sexes under the experimental conditions, but as the egglaying response is believed an exact and uniform phenomenon, oviposition was selected as the criterion for response to attractants, and a second set of tests, oviposition tests, therefore grew out of the work with the first. These latter aimed to discover the substances or factors which attracted female mosquitoes to lay eggs.

In the exploratory tests, our mosquitoes proved geo-negative, walked and flew with a gentle air current but turned to face a stronger current, moved towards warmth, and from light (though their phototropism was not well marked) and when given the choice came to rest in a temperature of 80 to 95 degrees Fahrenheit, and in the darkest available place. They preferred blue and were unable to see red, and were adversely influenced by low humidities, being attracted to high humidities. The sexes apparently attracted each other by sound and by ordor, but the males were much more responsive than the females. Chemicals did not prove good attrahents for these mosquitoes.

6. Time and Rate of Plant Nutrient Absorption by Bright Tobacco.

H. R. Davies and A. L. Grizzard; *Virginia Agricultural Experiment Station.* (15 min.)

In the fertilization of a crop, like bright tobacco which uses a special and complicated fertilizer formula, some of the main questions to consider are: (1) How efficient is the crop in utilizing applied nutrients; and (2) At what stages during its growth do maximum absorption and utilization of nutrients occur?

An experiment was designed in the spring of 1939 to answer these questions for the bright tobacco plant. Chemical analyses of bright tobacco plants were made at the following stages of growth: When the plants were ready for transplanting; 21 days after transplanting; and at 14-day intervals thereafter until the plants reached maturity. The tobacco was grown at Chatham on Granville sandy loam soil, and was fertilized with 900 pounds per acre of a 3-10-6 fertilizer.

Three weeks after transplanting, the plants had produced only 18.8 per cent of their total weight. It is important to note that 81.2 per cent of the total weight per acre was produced during the last 28 days of a 63-day growing period.

Chemical analysis made on the plants at the end of each growing period show that a total of 34.98 pounds per acre of nitrogen were absorbed during the nine weeks of growth. A maximum absorption of nitrogen occurred during the 6th and 7th weeks—21.75 pounds or 61.7 per cent of the total was used in this period. It appears that no nitrogen was absorbed after the 49th day. In fact, the data show a slight loss of nitrogen—0.77 pounds per acre during the 8th and 9th week of growth.

Fifty-five and one-half per cent of the total phosphoric acid utilized by the tobacco plants was absorbed during the 6th and 7th weeks of growth. During this same period of growth, tobacco utilized 61.3 per cent of the total potash absorbed; 61.2 per cent of the total magnesia; and 60.7 per cent of the total calcium were absorbed during this same period. Tobacco was found to be 100 per cent efficient in utilizing each applied nitrogen and potash. It used only 11.2 per cent of the applied phosphoric acid, 52.2 per cent of the calcium, and 55.6 per cent of the magnesia applied in the fertilizer.

7. The Relation of Timber Cutting to our Virginia Forest Types.

W. L. Gooch, Forester; *The Chesapeake Corporation, West Point, Va.* (Lantern, 15 min.)

Today, Man through his use of the saw and axe is probably the greatest single factor influencing the type of tree cover on the forest lands of eastern Virginia.

A generation ago commercial cutting of timber was spotted and confined only to the better quality stands. In the case of Pine only the largest trees in those days were profitable to cut. The smaller trees not cut were sufficient to maintain the pine restocking on land cut-over. In recent years saw mills have increased in great number and second growth pine is cut in these as well as in 64 stave mills and also for pulp wood and excelsior wood. The result is clean cutting of forest lands, leaving no opportunity for natural seeding of pine with results that thousands of acres of formerly pine producing areas are now reverting to hardwoods. These deciduous forest types formerly confined largely to the water courses are extending their range to upland areas and more and more restricting pine to abandoned farm soils.

To remedy the ill effects of close cutting of pine timber, the Virginia General Assembly in 1940 adopted legislation requiring that in certain counties of eastern Virginia; namely, King William, Hanover and Caroline, and optional with Boards of Supervisors in seven other counties; namesly, Essex, King and Queen, Richmond, Lancaster, Middlesex, Matthews and Gloucester, a certain number of cone or bur-bearing loblolly and shortleaf pines should be left standing for purposes of reseeding.

8. Some Foliar Characters for Peach Breeding.

Fred W. Hofmann; *Virginia Agricultural Experiment Station.* (Read by title.)

About five years ago conspicuous olive yellow green spots on the older full grown leaves were observed. Samples were submitted to some dozen leading pathologists and mycologists but in no case was a clear explanation received.

Numerous reciprocal grafts did not communicate this spotting from the spotted to the unspotted symbionts. It was, therefore, concluded that such spotting was uncommunicable, particularly when further tests made by numerous direct attempts to inoculate brought on no development of this character.

It is believed by the author that this character is due to a factor something like that which causes variegation in the chlorophyl pattern of the

leaves in Zea mays, Mirabilis, Althea or Antirrihinum. Further, this character is inherited on a single factor mendelian basis. Although it behaves as a single mendelian factor there are different degrees of development of such leaf patterns in the different strains of peaches observed.

In crosses between the large spotted pattern strains and no spot the first generation progeny shows an intermediate degree of spotting. Crosses between the smaller pattern spot and no spot hardly show any spotting whatever. Crosses between large-spotted and small-spotted patterns show up in an intermediate degree as is also the case between thickly spotted and sparsely spotted strains.

Another very valuable association already reported in some phases but not in the special feature mentioned by the author, is in the color of the first etiolated leaves and fruit flesh color. If the color of such leaves is yellow to yellow ochre, the fruit that will be produced will be yellow fleshed; if pale or light yellow the fruit will be white or at most cream. If the hypocotyl is reddish the fruit will be blushed, the more red the hypocotyl the heavier the blush as well as the red around the peach pit.

9. Some Fruit Bud Induction Observations.

Fred W. Hofmann; *Virginia Agricultural Experiment Station.* (Read by title.)

From the observations made over these past 12 years it is safe to conclude that the chances are much higher for heavier fruit-bud formation during seasons of above average late spring and summer moisture. Terminal growths that developed in such seasons on heavy fruit producing trees were found in many instances with as many as 36 fruit buds. The average number of fruit buds on shoot growth made in such seasons was found to be as high as 12. Such development would not obtain under conditions of excessive moisture, but the point remains that in seasons of more than average precipitation over the summer months in Virginia the chances are much better for heavier fruit-bud formation.

10. Phosphated Ammonia for Orchard Soil Fibre.

Fred W. Hofmann; *Virginia Agricultural Experiment Station.* (Read by title.)

In an orchard rye cover crop experiment with soil of a high phosphorus content, yields were significantly higher if phosphatic applications were made along with Calcium Cyanamide. Yields of dry matter were as follows: 5337 pounds for 1000 pound per acre application of 10-10-5 with ammonium phosphate as source of N; 4551 pounds for 1000 pound per acre application of 10-6-4 fertilizer with calcium cyanamide source of N; 4091 pounds for 1000 pound per acre application of 10-6-4 with sodium nitrate and urea sources of N; 2030 pounds where no fertilizer was used and 2030 pounds where only 475 pounds of calcium cyanamide on the equivalent N basis was used. With 504 pounds difference necessary for significance the value of phosphated ammonia is indicated.

11. A Report on the Prevalence of Helminth Parasites in Sheep in Southwestern Virginia, Together with Observations on Certain Anthelmintics Employed.

W. L. Threlkeld; *Virginia Agricultural Experiment Station* (Lantern, 15 min.)

This report is made in connection with a survey of the sheep parasite problem in Southwestern Virginia.

The findings on autopsy of twenty-eight sheep raised in Southwest Virginia show the frequency of the following parasites:

Cooperia curticei	20
Oesophagostomum columbianum	18
Haemonchus contortus	17
Nematodirus species	17
Moneizia species	16
Ostertagia circumcincta	13
Trichostrongylus vitrinus	11
Bunostomum trigonocephalum	11
Trichuris ovis	11
Trichostrongylus colubriformis	7
Trichostrongylus extenuatus	6
Cooperia oncophora	5
Cooperia punctata	4
Chabertia ovina	3
Strongyloides papillosus	1

The use of 2.5 to 3 cc of a ten per cent copper sulphate solution for stimulating closure of the oesophageal valve for directing anthelmintics in capsules not larger than 20 mm x 16 mm to the abomasum is 68.4% effective, and has a percentage value of 46.2% advantage over capsules administered without preliminary treatment with the copper sulphate.

Anthelmintics employed to date are copper sulphate, copper tartrate, copper arsenate, nemural, and phenothiazine. Comparative results based on autopsy of treated and untreated animals are reported.

12. The Relative Efficiency of Several Sources of Phosphate Fertilizer in Improving the Yield, Quality and Chemical Composition of Pasture Herbage.

R. E. O'Brien an dS. S. Obenshain; *Virginia Agricultural Experiment Station.* (20 min.)

In a large number of pastures in Virginia, soils that are capable of producing excellent herbage have been reduced to such a low state of fertility that good sods have been replaced by coarse, unpalatable grasses and weeds that are able to thrive under such conditions. Since good pastures are of primary importance in a balanced agriculture, it is of vital importance that they be given more careful attention than has been practiced in the past. In most Virginia soils, available phosphorous is the primary limiting factor in pasture production.

An experiment was designed to determine the relative efficiency of six different phosphate fertilizers, used with and without lime, in improving the yield, quality and chemical composition of pasture herbage. Over a six-year period yields have been increased as much as 242 per cent. The vegetative population has been changed from undesirable native wild grasses and weeds to a good sod of Kentucky bluegrass and other desirable grasses and white dutch clover. Phosphorus applied as against no phosphorus has increased the seasonal average P_2O_5 content as much as 66 per cent, resulting in herbage with an average P_2O_5 content of almost one per cent. Nitrogen content has also shown marked improvement resulting from phosphate fertilization.

13. A Green Alga in Salamander Eggs.

A. M. Showalter; *Madison College.* (10 min.)

Salamander eggs, collected in April 1939 from a mountain lagoon and taken to the laboratory for student observation, were found to have a non motile unicellular green alga inside of the gelatinous envelope. The alga increased rapidly and formed a considerable mass by the time the sala-

manders hatched. In one small lot which had been set aside for special observation the young salamanders were found, a few days after hatching, to have eaten the alga so completely that none remained visible in the water. The stomachs were distended with green masses and were clearly visible in the semi-transparent bodies of the young salamanders. The alga has been identified by Dr. G. M. Smith as *Oophila amblystomatis*, Lambert. Effort is being made to discover where and how the alga lives aside from the salamander eggs and how it gets into the eggs.

14. The Etiology of the *Beauveria* Disease of *Dendroctonus frontalis*.

J. G. Harrar and J. G. Martland; *Virginia Polytechnic Institute*. (Lantern, 10 min.)

Isolates of *Beauveria sp.* from the southern pine bark beetle were used in infection experiments on this host and a number of other insect larvae including the oriental fruit moth, the peach codling moth, a striped cutworm and hysterids, in order to determine the host range of this species. Results indicate a wide range of parasitism. Histological studies of infected larvae have served to demonstrate the mode of infection, action within the host and methods of fructification of the pathogen.

15. The Biology of a Species of *Beauveria* from the Southern Pine Bark Beetle.

J. G. Harrar and Ruth P. Ellis; *Virginia Polytechnic Institute*. (Lantern, 10 min.)

A species of *Beauveria* was isolated from larvae of the Southern pine bark beetle, *Dendroctonus frontalis*, during the spring of 1939. This organism was obtained in pure culture and its pathogenicity demonstrated on healthy *Dentroctonus* larvae. Subsequently growth characters, reproductive structures and nutritional requirements of the pathogen were studied in attempt to evaluate its potentialities as a biological control of the Southern pine bark beetle.

FRIDAY, MAY 3—2:00 P. M.

16. A Study of Avian Malaria.

King A. Jamison; *Virginia Polytechnic Institute*. (10 min.)

A survey made by intravenous injection of blood from wild birds into test birds (canaries), shows malaria parasites to be present in 20% of the birds of some species, while other species possess a natural immunity to the parasites. *Plasmodium relictum* and *P. cathemerium* are the species of malaria parasites most frequently found in wild birds.

17. Cold Resistance, Mutation, and Geographical Distribution in Plants.

Orland E. White; *The Blandy Experimental Farm, University of Virgiina*. (Lantern, 15 min.)

Plants vary by individuals, strains, clones, varieties, species, genera and families in their suspectibility to cold. In individuals, various parts of the plant react differently to temperature changes. Colycinth or bitter watermelon fruits remain unfrozen at temperatures much below those at which the vines freeze. In certain groups of plants the young foliage is more cold-resistant or frost-proof than the old foliage; in other groups, the reverse is true. Some systematic plant groups, i. e., families and genera,

are very susceptible; others are just the reverse; still others are mixtures in various degrees. Cold susceptibility and resistance in plants have been experimentally demonstrated to be hereditary, hence subject to the "laws" of genetics. While gene-carried, they are subject to environmental modifications. On present genetic theories, new genes arise as non-adaptive, chance phenomena, due to mutation. Although mutations are thought to affect changes in all the characters of an organism, they are limited in certain respects, due to the total genic constitution of the organism. Since mutations are non-adaptive in origin, and since they are chance phenomena, affecting most any character, it would seem that mutations for increased cold resistance should take and have taken place in most plant families, whatever the geographical or climatic location of these families. Experimental and observational data indicate this to be true, and that floras such as those of the Southeastern states and southern Texas are made up of various diverse elements in respect to cold resistance. Some species or individuals of species of these floras when transplanted to much colder regions survive; other elements seem to have reached the limit of their cold resistance. These data have a high practical significance to horticulture, forestry, and landscape gardening.

18. Miscellaneous Studies of Codling Moth Bands.

A. M. Woodside; *Staunton Field Laboratory, Virginia Agricultural Experiment Station.* (Lantern, 15 min.)

This is a second report on some phases of the study of chemically treated bands as an aid in controlling the codling moth. A report is made of results of tests of the relative attractiveness of treated and untreated bands to larvae, relative numbers of larvae trapped by two bands on each tree, distribution of larvae on the trees, survival of larvae removed from treated and untreated bands, and codling moths hibernating on the ground.

19. Experimental Studies on the Cultivation of Excised Anthers in Nutrient Solution.

Walton C. Gregory; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 10 min.)

In a report made before the Virginia Academy of Science, May 1939, on the results of cultivation of excised anthers of *Lilium longiflorum*, it was shown that (1) the reaction of the anther in the nutrient solution depended on the stage of development the anther had reached when it was excised, (2) that normal sporogenesis did not occur in any of the material cultured, and (3) that the different reactions of anthers of different ages in the same solution suggested some control of sporogenesis other than that furnished by the sporogenous cells themselves and the balanced nutrient used. In the present work further results of culturing excised anthers of *Lilium longiflorum*, *Lycopersicum esculentum*, and *Datura stramonium* are reported. The separation from the parent plants and cultivation in vitro of young anthers in *Lilium* and of anthers of all ages, in *Lycopersicum* and *Datura* led to meiotic failure in all three species. Meiosis proceeded normally in anthers of *Lilium longiflorum* excised and placed in solution as late as diplotene. These results together with certain preliminary experiments with cuttings and grafts of flowering stems of tomato indicate that the conclusion that the meiotic stimulus is not an inherent property of the sporogenous tissue but is furnished to that tissue by more remote portions of the plant is correct.

20. A Cytological and Morphological Study of the European *Mesostoma ehrenbergii* and a Closely Related American Form.

Ladley Husted and Trenton K. Ruebush; *University of Virginia* and *Yale University.* (Lantern, 15 min.)

In most hermaphroditic organisms homologous chromosomes associate at meiotic prophase and remain paired as bivalents until anaphase. Univalents or unpaired chromosomes are exceptional and when they occur, as a result of environmental conditions or the genotype of the individual, their number is variable. Cells with all univalents, bivalents and univalents, or no univalents at all are found in the same individual. In an American form of the European *Mesostoma ehrenbergii* having 4 pairs of chromosomes, this situation is not the case. At metaphase in the primary spermatocytes of this animal the maximum number of bivalents present is 3. At least 2 univalents are always found. Because the 4 pairs are distinguishable from each other it is possible to say that the bivalents present are always formed by the same 3 pairs of chromosomes. In the European *M. ehrenbergii*, the body structures of which are compared with the American form, there are 5 pairs of chromosomes, one more pair than is found in the American form. Only one of these can be distinguished morphologically from the others. In this animal the maximum number of bivalents is likewise 3 but at least 4 univalents are found in every cell. By means of a change in the structure of one chromosome (An inversion involving the centromere), which occurred spontaneously in one individual, it is possible to present evidence that the European and American animals, though they differ in the number and morphology of their chromosomes, show the same peculiar meiotic behavior. In both forms certain chromosomes are never found associated at metaphase I. A possible reason for this failure of pairing is proposed.

21. The Relationship between Boron and Thallium Toxicity of Tobacco.

G. M. Shear and R. L. Schnell; *Virginia Polytechnic Institute* and *Virginia Agricultural Experiment Station.*

It has been reported that arsenic toxicity to plants is a function of phosphate availability, rubidium toxicity of potassium availability, and strontium toxicity of calcium availability. These results all point to the basic assumption that the toxic effect of an element may be correlated with the availability of a chemically similar essential element. In view of these results, experiments were run to determine the effect of the essential element boron upon the closely related toxic element thallium.

In this study tobacco seedlings were grown in dilute nutrient solution to which thallium in toxic amounts had been added and the boron content varied over a wide range of concentrations. Samples of these plants were analyzed for boron.

22. A Simple Method of Diagnosing Plant Deficiencies.

G. M. Shear; *Virginia Agricultural Experiment Station.*

Chlorosis of Black Birch (*Betula nigra* L.) diagnosed as iron deficiency by the Roach method. The practical advantages of the method will be explained.

23. The Relative Importance of the Host Plants of the Tobacco Flea Beetle, *Epitrix parvula* F.

E. H. Glass; *Virginia Agricultural Experiment Station.*

A study was made in Pittsylvania County, Virginia, during the season of 1939 of the host plants of the tobacco flea beetle, *Epitrix parvula* F., in

relation to their importance in maintaining the population of this insect. From field observations, population counts, and rearing experiments it was found that plants of the family Solanaceae, especially tobacco, potato, tomato, jimson weed, horse nettle and nightshade, were the principal hosts of the adults and appeared to be the only hosts of the larvae. Tobacco in the plant bed and potato in the field were important in increasing the infestation of newly set tobacco. Tobacco was the principal host during the summer until the crop was harvested, at which time the beetles began migrating to numerous other hosts.

Joint Meeting of Biology and Geology

FRIDAY, MAY 3—4:00 P. M.

Continental Displacement and its Relation to the Origin and Dispersal of American Floras.

Dr. W. H. Camp; *New York Botanical Garden.*

Botany Division

SATURDAY, MAY 4—9:00 A. M.

1. Studies of the Germination, Growth and Propagation of Seeds, Berries, and Root Fragments of *Berberis canadensis Mill.*

   G. E. Matheny and R. S. Mullin; *Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.* (Lantern, 15 min.)

These studies were initiated for the purpose of studying the influence of various environmental factors on the propagation and distribution of the native American barberry in southwest Virginia. The plantings in this experiment were made in the counties of Montgomery, Pulaski, Carroll, Grayson, and Wythe, in each of the following exposures: in sunlight on a southern slope; in sunlight on a northern slope; in shade on a southern slope; and in shade on a northern slope.

One-half of the seeds were selected from live bushes and one-half from bushes killed by salt after the berries were mature. Approximately equal numbers of seeds were planted as shelled seeds and as seeds in whole fruits. Twenty-five per cent of all plantings were protected by screen wire to prevent possible disturbance by mice, and burned limestone was added to one-fourth of all lots of seeds planted. Freshly dug root fragments were planted at each of the four exposures.

Observations and readings were made on August 27, 1938 and May 3, 1939. It is planned to make other readings during the latter part of April, 1940. A report will then be made on the results to that time and an interpretation of the influence of the various environmental factors under study will be attempted.

2. Diploidy, Polyploidy, and the Degree of Winter Hardiness in the Flowering Plants.

   Wray M. Bowden; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

This paper summarizes the results of a two-year study of the relationships between winter hardiness, chromosome number and geographical distribution in the flowering plants.

Since many species can be grown far north of their natural ranges, and since the geographical situation of a plant is not a measure of its ability to withstand low temperatures, it is important to establish an adequate scale of hardiness. From a survey of temperature, latitude, and elevation, in relation to vegetation, it is seen that latitude alone cannot be used to compare plants as to their degree of hardiness. The scale used in this investigation is based on data obtained by growing plants under experimentally controlled conditions. Much information on the hardiness of many species of plants has been obtained by plantsmen, arboreta, etc. By combining Rehder's zones, and using the most recent weather bureau map of the lowest monthly mean temperature for January, the following scale has been established: very hardy = survives below Zero F. to 10°; hardy = 10°-20°; fairly hardy = 20°-25°; less hardy = 25°-35°; non-hardy = freezes easily.

From a study of the chromosome number lists of Gaiser and Tischler, and the current literature; and from my own determinations of the chromosome numbers of more than 100 species of angiosperms, the following conclusions can now be stated: (1) In most cases, the differences in the degree of winter hardiness of related species are not correlated with chromosome number differences, and the evidence indicates that the degree of winter hardiness is genotypically controlled. (2) The whole range of variation in the degree of winter hardiness is found within the diploid species of single genera. In other groups of diploid species, striking differences in the degree of hardiness are observed. (3) Several diploid species are the northernmost representatives of tropical families and are hardy. (4) The whole range of winter hardiness can be found within tetraploid species of single genera. (5) The tetraploids compared to related diploids, are either hardier, less hardy, or of the same degree of hardiness. (6) Within single genera, striking differences in the degree of hardiness can be found within both diploid and tetraploid groups of species.

These conclusions do not support the assumption of Müntzing (1936) that "northern distribution means increased hardines", nor his conclusion "that polyploids are on an average more hardy than diploids and hence better adapted to a northern or alpine distribution".

3. Cytology and Phylogeny in the Ranunculaceae.

Walton C. Gregory; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 10 min.)

The chromosomes of 19 genera and 109 species and varieties of the Ranunculaceae have been studied cytologically from the standpoint of evolution and phyletic relationship within the family as well as from the taxonomic position of the Ranunculaceae in relation to the Monocotyledons and to other primitive Dicotyledons. The chromosome numbers of the following are herein reported: *Aconitum reclinatum* Gray, n-8, 2n-16; *A. uncinatum* L., n-8, 2n-16; *Aquilegia baikelensis*, 2n-14; *A. coccinea* Small, n-7; *A. dichroa* Freyn, 2n-14; *A. einseleana* Fr. Schultz, 2n-14; *A. glandulosa* Fisch., 2n-14; *A. hirsutissima*, 2n-28; *A. jucunda (glandulosa?)*, 2n-14; *A. longissima* Gray, 2n-14; *A. skinneri* Hook., n-7, 2n-14; *Clematis addisonii* Britton, n-8; *C. armandi* Franch., 2n-16; *C. "Baron Veillard"*, 2n-16; *C. brevicaudata* DC., 2n-16; *C. crispa* L., 2n-16; *C. dioica* L., 2n-16; *C. douglasii* Hook., 2n-16; *C. fremontii* Wats., 2n-16; *C. globosa (orientalis?)*, 2n-16; *C. ochroleuca* Ait., 2n-16; *C. scottii* Porter, 2n-16; *Delphinium bulleyanum* Forrest, 2n-32; *D. carolinianum (azureum?)*, 2n-32; *D. caucasicum* C. A. Mey., 2n-32; *D. duhmbergii* Huth, 2n-32; *D. flexuosum* Rafin., 2n-32; *D. formosum* Boiss. & Huet., 2n-32; *D. gayanium (ajacis?)*, 2n-16; *D. grandiflorum* L., n-8, (also, 2n-32); *D. penardi* Huth, n-8; *D. peregrinum* L., n-8; *D. pictum (requienii?)*, 2n-16; *D. scopulorum* Gray, n-8; *D. tricorne* Michx., n-8; *D. yunnanense* Franch., n-8 (also, 2n-32?); *D. "Wrexham hybrids"*, 2n-32; *Helleborus abschaisicus*, 2n-32; *Ranunculus armeniacus (ane-*

monaefolius?), 2n-14; *R. cassius* Boiss., 2n-14; *R. lomatocarpus* Fisch & Mey., 2n-32; *Thalictrum coriaceum* (Britton) Small, 2n-70; *Th. majus*, 2n-28; *Th. revolutum* DC., 2n-ca.133; *Trollius yunnanensis*, 2n-16.

4. The Nomenclature and Characteristics of Species of Rosa in Virginia.

A. B. Massey; *Virginia Polytechnic Institute.* (Lantern, 10 min.)

Four species of roses are recognized as native to Virginia. These are *Rosa carolina* L. of 1753 (*R. humilis* Marsh in Gray's Manual), *R. palustris* Marsh (*R. carolina* L. (of 1762 not 1753) in Gray's Manual), *R. virginiana* Mill. (as in Gray's Manual) and *R. setigera* Michx. (as in Gray's Manual). The nomenclature of these were discussed and their characteristics shown by slides.

5. The Identity of the Evergreen Rhododendrons of Virginia in the Dormant Conditions.

A. B. Massey; *Virginia Polytechnic Institute.* (Lantern, 10 min.)

When seen side by side the two evergreen species of Rhododendron (*R. catawbiense* and *R. maximum*) are easily distinguishable. When separate, however, they are readily confused.

R. maximum. The leaves are oblong-obovate or oblong to lanceolate oblong, 4-8 inches long, acute or short-acuminate, dark green above paler beneath and with close thin, often tawny, tomentum, rarely glabrous, and arranged around the conspicuous flower buds in a loose rosette. *Flower buds surrounded by narrow leaf-like bracts.* Flowering season late June and July.

R. catawbiense. The leaves are elliptic to oblong, 3-5 inches long, obtuse, rounded at base, lustrous above *whitish beneath and glabrous,* not in a rosette arrangement beneath the flower bud. *Flower buds are not surrounded by leaf-like bracts.* Flowering season late May and June.

6. Plants at the Edges of Their Ranges.

Lena Artz; *Arlington, Virginia.* (10 min.)

This consists of brief summaries of two papers which deal with the significance of plants at the edges of their ranges. These summaries are followed by reports on some northern plants, that, as far as is now known, reach their southern limits in Virginia.

7. Corticolous Bryophyte Societies at Mountain Lake, Virginia.

Paul M. Patterson; *Hollins College, Virginia.* (Lantern, 15 min.)

Nine well developed corticolous bryophyte societies are recognized at Mountain Lake. Their individual occurrence and distribution are found by analyses of their environments to depend upon different levels of evaporational stress and different moisture holding capacities of the bark substrata.

8. Physiological Studies on Mosses. II. The Viability of Old Spores.

Samuel L. Meyer; *Miller School of Biology, University of Virginia.* (Lantern, 15 min.)

The literature on the physiology of the Musci contains varied reports concerning the retention of viability by moss spores over a period of years.

Results of investigations with thirteen collections of spores of *Physcomitrium turbinatum* (Michx.) Brid., dating from 1868, and nineteen collections of spores of *Funaria hygrometrica* (L.) Sibth., dating from 1828, are presented. A physiological basis for the retention of viability by moss spores under herbarium conditions is suggested.

9. Physiological Studies on Mosses. III. The Influence of the Moisture Factor on the Development of Leafy Moss Plants in Liquid Media.

Samuel L. Meyer; *Miller School of Biology, University of Virginia.* (Lantern, 15 min.)

The development of leafy moss plants from primary protonemata submerged in water cultures is a complex process which may be influenced by such factors as light intensity, hydrogen ion concentration, concentration of the nutrient solution, and oxygen supply, as well as by the liquid medium. Results of investigations with liquid and solid substrate cultures of *Physcomitrium turbinatum* (Michx.) Brid. and *Funaria hygrometrica* (L.) Sibth. indicate that the moisture factor exerts a marked influence on both the rate of leafy plant differentiation and the number of plants formed while those morphological modifications observed in plants grown from protonemata submerged in water cultures are due to the liquid medium in which the plants develop.

10. Coprophilous Ascomycetes from Charlottesville and Vicinity.

Edwin M. Betts and Samuel L. Meyer; *Miller School of Biology, University of Virginia.* (Lantern, 10 min.)

A preliminary list is given of the coprophilous Ascomycetes from Charlottesville and vicinity, with special reference to the Ascobolaceae.

11. Three Unpublished Letters of Raffinesque to Jefferson.

Edwin M. Betts; *Miller School of Biology, University of Virginia.* (10 min.)

These letters give additional information about Jefferson's relations to a botanist of his time.

Zoology Division

SATURDAY, MAY 4—9:00 A. M.

1. Elk in Virginia.

Roy Wood; *Virginia Cooperative Wildlife Research Unit, Virginia Polytechnic Institute.* (Introduced by C. O. Handley.) (Lantern, 10 min.)

The presence of the American elk or wapiti (*Cervis canadensis*) in Virginia was first recorded by Capt. George Weymouth in 1606 in his "Voyage to Virginia". The distribution and abundance of elk during the early days of colonization is commemorated by numerous old settlements and locations to be found in various parts of Virginia which still retain "elk" incorporated within their name. Opening up the land for agriculture and relentless hunting on the part of settlers exterminated the elk from Virginia, the last record of an elk that we possess is that of one killed in Clarke County, 1855.

For 62 years the elk was extinct in this state until 1917, when the

Department of Game and Inland Fisheries imported 150 of these noble animals from the Yellowstone National Park and released them in various parts of the State. No preliminary study was made of those regions into which the elk were to be stocked, and failing to make an adjustment with their new environment, they were exterminated by 1926 in all but two areas, the range in Giles and Bland Counties, and one of lesser importance in Botetourt. In 1935 another shipment of elk was secured, 6 of which were introduced in the Botetourt Range, and the remainder in the Giles-Bland Range.

A recent census in the Giles-Bland Area shows that there is a population of about 100 elk in this range. Since the first open season in 1922 they have offered considerable sport each year to over 250 hunters of big game from many parts of the country, but as the elk cause a great deal of damage to agricultural crops, their establishment in this State is questionable. However, since their value to the State and to the sportsman cannot be evaluated in actual dollars and cents, we should strive to maintain these herds. The Cooperative Wildlife Research Unit at Blacksburg is studying the "Ecology of the Elk in Virginia" in an attempt to work out a satisfactory method of management that will cope with present and future problems.

2. The Correlation of Bird Migration and Wind Direction.

Ruskin S. Freer and John Mahan; *Lynchburg College.*

This paper is a report of an attempt at correlation between wind direction and bird migration conducted at Lynchburg in the Spring and Fall of 1939 and the Spring of 1940. The belief back of the experiment is that birds pick a time for migration in which the wind blows in the direction in which the birds wish to travel. The report is as yet inconclusive but the correlation found has been high enough to justify the belief that wind direction *is* a factor in migration.

3. Some Observations on the Spadefoot Toad, *Scaphiopus halbrookii.*

Hazel Poff and Paul R. Burch; *State Teachers College, Radford, Virginia.* (5 min.)

This is a brief report on the natural history of the spadefoot, a toad of nocturnal habits.

4. The Heart of *Cryptobranchus allegheniensis* Daubin.

William B. Atkinson; *University of Virginia.* (Introduced by Chauncey McLean Gilbert.) (Lantern, 10 min.)

The morphology of the heart of *Cryptobranchus* has been reviewed, with notes on the histology added. The neuro-muscular atrio-ventricular connection has been found and described.

5. A Description of the Venous System of *Cryptobranchus allegheniensis* Daubin.

William Sangster, Jr.; *University of Virginia.* (Introduced by Chauncey McLean Gilbert.) (Lantern, 15 min.)

This report is a description of the venous system of *C. allegheniensis,* with especial reference to the cutaneous system. A description of the veins within the cranium, the vertebral column, and the liver will be included.

6. Banding Chimney Swifts.

C. O. Handley; *U. S. Biological Survey and Virginia Polytechnic Institute.* (Lantern, 10 min.)

The development of the funnel type chimney swift trap. Experiences in banding some 14,000 chimney swifts. The distribution of chimney swifts as shown by returns from birds banded in Southern Georgia.

7. A Synopsis of the Genus *Mesostoma* Ehrenberg 1837.

Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division,* and W. J. Hayes, Jr.; *University of Wisconsin.* (Read by title.)

This paper, nearing completion, is a taxonomic summary of the work upon *Mesostoma.* Stress is placed upon ecology, distribution, general anatomy, diagnoses of valid species, species dubiae and an extensive bibliography.

8. Studies on the Turbellarian Fauna of the Norfolk Area.

I. *Macrostomum ruebushi* var. *kepneri* new variety.

Frederick F. Ferguson and E. Ruffin Jones, Jr.; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Opaque projector, 10 min.)

This paper describes the anatomy of a new flat-worm of the genus *Macrostomum* which attains an intense morphological variation in the eastern United States. While it presents the general structure of a *Macrostomum* it has many unique features, the most singular of which being the absence of rhabdites in part of the epidermis and the presence of a male gonopore which is almost terminal in position.

9. Studies on the Turbellarian Fauna of the Norfolk Area.

II. *Jensenia lewisi* n. sp.

E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Opaque projector, 10 min.)

This is a preliminary report on a new species of the genus *Jensenia* (Dalyelliidae). Only two species have previously been described and both of these are European. The present form, which has been collected in the vicinity of Norfolk, Virginia, differs in a number of ways from the European animals.

10. Studies on the Turbellarian Fauna of the Norfolk Area.

III. Ecology and Distribution.

Frederick F. Ferguson and E. Ruffin Jones, Jr.; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Read by title.)

This paper gives a list of the Turbellarian species of the region, thirty of which have been identified; many others await identification. Distribution charts, ecological data, photographs, and drawings of representative forms are included in the work.

11. Studies on the Turbellarian Fauna of the Norfolk Area. IV. *Macrostomum norfolkensis* n. sp.

E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Opaque projector, 10 min.)

This paper describes the morphology and ecology of a new species of *Macrostomum* (Rhabdocoela) which possesses several unique features of classifactory value. The anatomy of the excretory system is unusual.

12. A Synopsis of the American Turbellaria.

Part I. American Acoela, Rhabdocoela and Alloeocoela with notes on Distribution and Ecology and a diagnostic key to families and genera.

M. A. Stirewalt, F. F. Ferguson and W. J. Hayes, Jr.; *Miller School of Biology, University of Virginia.* (Demonstration.) (Read by title.)

I. Preface.
II. Table of Contents.
III. Introduction.
IV. Classification with characterizations of the families of the group and of the American genera.
V. Alphabetical list of American genera with included species (82 genera, 256 species) with ecological notes.
VI. Key to families and American genera.
VII. Distribution of American species by stations. Distribution map.
VIII. Bibliography of 195 papers on American forms from 1821-1940,
IX. Index.

13. The Effect of High Frequency Radio Waves upon *Microstomum lineare* (Mull) O. Schmidt 1848.

W. A. Kepner, M. A. Stirewalt and C. I. Malis; *Miller School of Biology, University of Virginia.* (Lantern, 15 min.)

This is an investigation of a possible specific effect of short wave radiations upon animal tissue. The microstomas were irradiated at 9.5 meters (30,00 K. C.) in the condensor field of a 100 watt oscillator. A cooling method was used which made the heat effect of the waves extremely small, and reasonably accurately measurable.

Gross and histological studies of the irradiated animals as compared with controls and heat treated animals indicate a definite specific effect of the irradiations. These histological and physiological effects were discussed.

14. The Elaboration and Transportation of Yolk in *Microstomum lineare* (Mull.) O. Schmidt 1848 (rhabdocoele Turbellarian).

M. A. Stirewalt; *Miller School of Biology, University of Virginia.* (To be read by title.)

The yolk has been found to be produced in the assimilatory cells of the endoderm where it may be found in large globules after osmic acid fixation (medium Fleming's). These yolk globules are broken into smaller bodies and passed through the basal membrane of the endoderm where they lie within the meshes of the parenchymal net. Here they are ingested by

amoebocytes similar to those concerned with the manipulation of metabolic wastes and nematocysts. Metabolic waste materials and nematocysts are carried to the epidermis to be eventually discharged. The yolk, on the other hand, is carried by these amoebocytes to the young oocytes in which it is deposited. Amoebocytes and their enclosed yolk may be considered, therefore, to take part in the nutrition of the oocyte.

15. A New Turbellarian Worm (Alloeocoele) from Beaufort, N. C.

M. A. Stirewalt, W. A. Kepner and F. F. Ferguson; *Miller School of Biology, University of Virginia,* and *U. S. B. F., Beaufort, N. C.* (Read by title.)

A third species is described for the genus *Archiloa,* to be named in honor of the late Dr. E. V. Wilson of the University of North Carolina who showed great interest in the biological developments at the U. S. B. F. at Beaufort. The new species differs from Beauchamp's *A. rivularis* and Maristo's *A. spinosa* in not having a "vagina"; in body shape and size; in the structure of the statocyst; in the position of the mouth; in the size of the vesicula granulorum; and in the morphology and relationship of the ducts of the female reproductive system.

An homology between the accessory male duct of *Otoplana intermedia* and the posterior region of the female genital canal of the new species may be indicated. Homologies between anatomical features of the new species and the triclads are also suggested.

16. An Outline of the Development of the Ovum of *Chlorohydra viridissima.*

William A. Kepner, Bruce A. Perry, W. B. Atkinson and J. R. Meyer; *University of Virginia.* (Lantern, 10 min.)

The oogonia develop through proliferation and growth of interstitial cells. Some of these surpass the others in growth and display synezesis in their nuclei. These represent incipient primary oocytes. One of the primary oocytes grows at the expense of the other primary oocytes and oogonia, which later undergo cytolsis. This oocyte eventually becomes a very large amoeboid cell with an extensive area applied to the mesoglea. Yolk is next developed from material supplied by a locally enlarged endodermal epithelium. With the formation of yolk completed, the amoeboid cell retracts its pseudopods. As the last pseudopods disappear, the first and second meioses ensue. The chromosome number for this species is greater than $x = 6$ and $2x = 12$ which are recorded for *Hydra grisea.*

Throughout the life of Hydra and especially during periods of viscissitude, many cells are sacrificed in the interests of the organism. Likewise during the first phase of the nutrition of the ovum of this polyp many cells are sacrificed, in cytolysis, in the interests of a new organism. An hydra may be defined, therefore, as an hierarchy of cells presided over by an effort to sustain an individual.

17. Morphology and Histogenesis of the Blood of the Mealworm (*Tenebrio molitor L.*)

Herbert William Jackson; *Virginia Polytechnic Institute.*

The blood of the mealworm, *Tenebrio molitor* L., consists of a fluid plasma, the hemolymph, and formed elements or cells, the hemocytes. Four types of hemocytes are found.

Micronucleocytes arise in the midline from the upper layer of the inner cell mass and macronucleocytes from the lower layer, oenocytoides arise from cells on the neural crest. These cell types separate from the germ

band at 30 to 36 hours of age and migrate throughout the yolk mass, returning to the germ band before the formation of the yolk membrane at 42 hours. They are found in the hemolymph throughout the rest of the life of the organism. The first two types comprise the bulk of all hemocytes.

Spherule cells appear deep in the lateral regions of the mesoderm early in embryonic life. They never leave the germ band, but seem to penetrate tissues at will, including the hemolymph. They collect in certain tissues at the time of the completion of the heart when the blood begins to circulate, and are there absorbed.

Oenocytoides are colorless in early embryonic life, but after the blood begins to circulate, stain deeply.

Numbers of hemocytes of all four classes are maintained and increased by means of mitotic division in the blood stream. Amitosis occurs rarely in senescent cells.

Hemocytes do not lose their identity during metamorphosis.

The hemolymph or plasma is clear and colorless in early embryonic life, but as circulation commences, becomes filled with stain absorbing materials. It thins out again only in senescent imagos.

18. Origin of the Midgut in *Tenebrio molitor L.*

Herbert William Jackson; *Virginia Polytechnic Institute.*

The endoderm rudiments in the mealworm, *Tenebrio molitor*, arise directly from the germ band as large cell masses. Cells move cephalad from the posterior rudiment and caudad from the anterior rudiment in typical "endoderm ribbons". They follow along the under side of the yolk membrane which is suspended between the mesoderm ridges like canvas between the two sides of a hammock. Hemocytes may play some part in the formation of these endoderm ribbons. The yolk membrane is entirely non-nucleate and is apparently a product of the fusion of ental membranes surrounding neighboring vitellophages.

LENA B. HENDERSON, *Secretary.*

Minutes of the Section of Chemistry

W. J. Frierson, *Chairman*

W. G. Guy, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

1. The Influence of the Crystal Plane in the Electrodeposition of Copper on a Single Crystal of Copper.

Allan T. Gwathmey; *University of Virginia.* (15 min.)

The physical form, and therefore the chemical properties, of electrolytically deposited metals are dependent on the crystal form of the individually deposited grains. A study of the forms of the electrodeposit on a single crystal of copper in the shape of a sphere, ⅝ in. in diameter, at varying rates of deposition, has been made. The sphere was given a high electrolytic polish in order to remove any strained or amorphous layer which might influence the deposit. Through the use of a sphere all possible crystal planes were present at some point in the surface.

At a current density of about 2 ma. per sq. cm. the deposit retained the crystal orientation of the underlying single crystal. After 450 hours the sphere was converted into a polyhedron due to the development of certain preferred planes, especially the (111) and (120) planes. At a current density of about 20 ma. per sq. cm. for about 5 hours on a freshly polished sphere, the deposit in the regions whose surfaces were approximately parallel to the (100) planes was polycrystalline while the deposit in the remaining areas largely followed the orientation of the underlying single crystal. With a current density of about 75 ma. per sq. cm. the deposit soon became polycrystalline over the entire surface of the sphere.

Thus it is concluded that below a certain current density the rate of growth of the individual crystal and the rate of formation of new crystal nuclei are dependent on the crystal plane which is parallel to the surface. This effect should be of importance in an understanding of electroplating processes.

2. Rate of Xanthation of Soda Cellulose.

P. C. Scherer and L. C. Ikenberry; *Virginia Polytechnic Institute.* (10 min.)

In this investigation the study of the rate of xanthation was continued from the point of view of the effect of state of subdivision. Previously developed methods were improved and average values of the effect of "bulk number" obtained.

3. Cellulose Containing Amino Nitrogen.

P. C. Scherer and J. M. Feild; *Virginia Polytechnic Institute.* (10 min.)

The methods used to prepare cellulose amine derivatives in liquid ammonia were modified. A new nitrogen containing cellulose derivative was prepared and studied.

4. Sulfur Forms in Crude Viscose Rayon.

P. C. Scherer and J. R. Leonards; *Virginia Polytechnic Institute.* (10 min.)

An investigation of several types of viscose rayon has led to the identification of the forms of sulfur present. New methods of extraction and analysis were developed.

5. The Action of Chloromethyl Ether on 4-Methyluracil.

Margaret M. Endicott; *Hollins College.* (10 min.)

When 4-methyluracil and chloromethyl ether were heated together in glacial acetic acid, 5-acetoxymethyl-4-methyl-uracil (65%) and bis-(4-methyl-2, 6-dioxypyrimidyl-5)-methane (35%) were formed. A study of the reaction revealed that the initial product was the 5-acetoxymethyl-4-methyluracil and that this condensed with unchanged 4-methyluracil to give the bis-(4-methyl-2, 6-dioxypyrimidyl-5)-methane.

5-Chloromethyluracil was the chief product obtained when 4-methyluracil was heated with an excess of chloromethyl ether in a sealed tube at 100° C. The structure of this pyrimidine was established by its conversion to 5-acetoxymethyl-4-methyluracil. Its chemical behavior was also studied by application of a series of transformations leading to the formation of characteristic derivatives.

6. A Study of the Procedure for the Determination of Glycogen in Oysters.

H. N. Calderwood and Alfred R. Armstrong; *Bureau of Fisheries, United States Department of the Interior, Virginia Commission of Fisheries, and the College of William and Mary.* (15 min.)

A study was made of the alkaline disintegration of the ground whole carcass of the oyster (*Ostrea virginica*) to find how conditions of time, temperature and alkali concentration alter the properties, purity and quantity of the glycogen obtained.

Experiments were made to ascertain the optimum conditions of acid concentration, temperature and time necessary for complete hydrolysis of the glycogen to glucose.

A revised procedure is given for the quantitative estimation of the glycogen content of oysters.

7. A Micro-Method for the Determination of Tissue Lipids.

E. L. Outhouse, B. E. Leach, and J. C. Forbes; *Medical College of Virginia.* (20 min.)

A new method for determination of neutral fat, phospholipids; and free, total and ester cholesterol is described. The advantages and applications of this method are discussed.

8. Physico-Chemical Studies of Soils.

Howard Kincer, Beulah Wood, and H. I. Johnson; *Roanoke College.* (10 min.)

In seeking to discover the properties that give soils a desirable nature for plants, methods were devised for determining the relative number of various sized particles. Their soluble, partially soluble, and insoluble components were followed by an electrophotometer. Shrinking and swelling phenomena were measured photographically.

9. The Recovery of Gallium from a Nelson County Virginia Feldspar.

W. S. Peterson and F. H. Fish; *Virginia Polytechnic Institute.* (10 min.)

In 1939 it was discovered by means of the spectroscope that a feldspar found in Nelson County, Virginia contained an appreciable amount of gallium. Professor H. D. Ussery of the Physics Department of V. P. I. later found the gallium content of this feldspar to be approximately 0.2%.

Since the procedures for separation of gallium given in the literature are based upon the acid decomposition of the ore, the separation of gallium from a feldspar presents a new problem.

Various methods of extraction are used and the efficiency of each is discussed. Concentrations were checked at intermediate points by means of the spectroscope.

FRIDAY, MAY 3—2:00 P. M.

10. The Kolbe Synthesis with Alkyl-o-Phenylphenols.

Sidney Harris and J. Stanton Pierce; *University of Richmond.* (10 min.)

5-Ethyl-2-hydroxydiphenyl, 5-n-propyl-2-hydroxydiphenyl, and 5-n-hexyl--2-hydroxydiphenyl were carboxylated by heating to 225° in a sealed tube with potassium carbonate and carbon dioxide, introduced as dry ice. The products are germicidal but not so much so as the uncarboxylated alkyl-o-phenylphenols.

11. Separation of Fatty Acids and Rosin from Crude Tall Oil by Selective Chlorination.

J. M. Crockin and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (15 min.)

Tall oil is a mixture of rosin acids, fatty acids, and non-acids resulting from the acidification of the soaps separating out from the Kraft pulp process evaporator liquor.

The present uses of tall oil center chiefly around its fatty acid content, but is limited for some purposes because of the rosin content. Separation of these constituents makes each available as such. The rosin, as crystalline abietic acid, has specific potentialities as a raw material.

Rosin and fatty acids are separated chiefly by distillation, although chemical means and extraction have been proposed to overcome objections such as corrosion and losses as pitch incurred in distillation. Chlorination is used as a step in the purification of tall oil, or to produce a sticky chlorinated oil, but no separation based on the use of chlorine appears to have been proposed.

It was the purpose of this investigation to chlorinate the fatty acid double bonds in hopes that the properties of this product would be such as to permit of a separation. The effects of solvent, catalyst, light, and heat were studied to determine the optimum conditions for such a reaction, and the effect of chlorination upon the rosin and fatty acids, respectively, under specific conditions was determined.

It was found that the use of CCl_4 solvent and ultraviolet light accelerate chlorine consumption and promote the addition of chlorine, but do not entirely stifle the substitution reaction. Rosin and fatty acid double bonds are attacked to about an equal extent under these conditions. The chlorinated oil is entirely soluble in most common solvents at room temperatures. Petroleum ether insolubles are increased slightly upon chlorination.

It is recommended that the range of chlorination conditions be extended to a more complete knowledge of the possible results, and that other chemical attacks be investigated.

12. Separation of the Constituents of Tall Oil—The Selective Reaction of Sulfuric Acid.

Paul E. Chapman and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

In the Kraft process for the production of paper pulp, a dark colored, odorous oil consisting mainly of rosin and fatty acids is formed. In order to make this material available for commercial use, it has to be refined or refined and separated into its main constituents.

In this investigation three methods were tried for refining the tall oil. The first was to remove those impurities insoluble in kerosene, gasoline, petroleum ether and toluene. The second was to oxidize the tall oil with atmospheric oxygen and then remove impurities insoluble in gasoline. None of the tall oil refined in these ways was much better in color and odor than the original material.

Therefore, sulfuric acid was tried. The temperature and time of reaction and the quantity of 95 per cent sulfuric acid used were varied. It was found that for temperatures from 0° C. to 50° C. and for a time of reaction from 15 minutes to 3 hours, that practically all the color and odorous impurities were removed with two parts of acid per 100 parts of tall oil.

Tall oil refined in this way was treated with from 20 to 200 per cent of the theoretical amount of sulfuric acid required to sulfonate or sulfate (28.3 grams of H_2SO_4 per 100 grams of tall oil calculating the fatty acids as linolenic) while the temperature of reaction was varied from −14° to +20° C., the time of reaction varied from 1 to 6 hours, and the concentration of acid varied from 50 to 95 per cent. It was found (1) that concentrations of acid below 90 per cent have little effect on the rosin and fatty acids; (2) that the temperature of reaction has little effect on the separation; (3) that the time for the reaction to be completed varied with the amount of acid used from less than 15 minutes up to about 3 hours when four and thirty parts respectively of 95 per cent acid are used; (4) that the amount of 95 per cent acid used has the greatest effect on the separation; and (5) that the best separation is obtained with about 28 or 30 parts of 95 per cent sulfuric acid.

13. Alkylation of Benzene with Ethylene by the Use of Several Phosphoric Acids as Eka-Catalysts.

A. B. Rabinkoff and F. C. Vilbrandt; *Virginia Polytechnic Institute.* (10 min.)

Alkylation of benzene with ethylene by the use of phosphoric acids as catalysts was studied under conditions of varying temperatures and reactants used. No conclusive results were obtained.

Results have been obtained at high pressures, but to date there has been no work reported in the literature for this reaction at low pressures. This fact and the fact that an adequate mechanism has not as yet been proposed prompted the investigation.

The equipment used consisted of four distilling flasks in series immersed in an insulated oil bath and maintained at a desired constant temperature. These were equipped with agitators, reflux condensers, and sample take offs.

Analyses were made on the progress of alkylation and the nature of the product.

A series of investigations using various activators in conjunction with the phosphoric acid was then made. Various halides and oxides were used as promoters and the data recorded. Attempts were made to establish a better understanding of the eka-catalytic mechanism as proposed by Ipatieff, and the controlling factor for the reaction.

Second Symposium on

Organic Analytical Reagents

(Papers #14 through #26 comprise the symposium.)

For several years eight institutions in the state have been cooperating in an extensive research program on organic analytical reagents under the direction of Dr. John H. Yoe. Last fall Tulane University of Louisiana joined the group, and this spring the University of North Carolina was added. Investigations at Tulane are under the direction of Professor Thomas B. Crumpler; those at North Carolina are under Professor Edwin C. Markham. Dr. Oskar Baudisch, Research Director of the New York State Research Institute, Saratoga Springs, New York, is cooperating with them in the application of organic compounds as concentrating reagents in the spectrographic analysis of trace elements.

At the Danville meeting of the Academy last May, a symposium was held in which each cooperating institution participated. So much interest was shown at this meeting that it seemed desirable to hold a second symposium for the purpose of presenting brief progress reports from the cooperating members and to discuss certain phases of the subject. The papers presented in this symposium have been printed in the October 1940 issue of the VIRGINIA JOURNAL OF SCIENCE. Their titles are given below:

14. Introduction.
    John H. Yoe; *University of Virginia.*

15. A Summary Report on 500 Organic Compounds.
    W. J. Frierson; *Hampden-Sydney College.*

16. Progress Report on Organic Analytical Reagents Research at V. P. I.
    J. R. Noell, B. H. Kemp, and F. H. Fish; *Virginia Polytechnic Institute.*

17. A Study of the Reaction Between 2-Acetoamino-6-amino Benzo-thiazole and Iridium.
    J. R. Noell and F. H. Fish; *Virginia Polytechnic Institute.*

18. The Solubility of the Alkali Earth Salts of the Higher Fatty Acids.
    B. H. Kemp and F. H. Fish; *Virginia Polytechnic Institute.*

19. A Summary Report on 100 Organic Compounds.
    W. E. Trout; *Mary Baldwin College.*

20. A Summary Report on 100 Organic Compounds.
    A. R. Armstrong; *College of William and Mary.*

21. A Progress Report.
    J. T. Ashworth, B. M. Keys, and Ira A. Updike; *Rondolph-Macon College.*

22. A Progress Report.
    W. O. Swan; *Virginia Military Institute.*

23. Structure of Some Organo-Metallic Complexes.
    James W. Cole; *University of Virginia.*

24. Chelation in Relation to the Periodic Classification.
    J. R. Taylor; *Washington and Lee University.*

25. Structure of Metal Derivatives of Oximes.
    Alfred Burger; *University of Virginia.*

26. The Application of a New Class of Organic Reagents for the Detection and Determination of Palladium.
    Lyle G. Overholser and John H. Yoe; *University of Virginia.*

SATURDAY, MAY 4—9:00 A. M.

27. Chemical Industry in Colonial Virginia.

    W. S. DeLoach; *College of William and Mary-Virginia Polytechnic Institute, Norfolk.* (10 min.)

Chemical industry in Virginia dates from the very beginning of the colony. Products of chemical industry were exported to England in 1608. The various industries occupied a significant, although not dominating, position throughout the colonial period. The attitude of England in giving bounties and levying taxes greatly influenced the industries.

28. Series Reactions in Organic Chemical Laboratory.

    J. B. Lucas and W. B. Downey; *Virginia Polytechnic Institute.* (12 min.)

Series reactions suitable for an organic chemical laboratory course were discussed. One series starts with benzene and goes through to methyl orange. Another starts with benzaldehyde and goes through to fluorene. A third starts with cyclohexanol and goes through to simple dicarboxylic acids.

29. Petroleum Bases. Reactions of 2, 3, 8-Trimethyl Quinoline.

Alfred Burger and Luther R. Modlin, Jr.; *University of Virginia.* (10 min.)

A number of reactions of the kerosene base, 2, 3, 8-trimethyl quinoline, leading to substances which will serve as starting materials in the preparation of products of pharmacological interest, is described. Among these reactions are nitrations, oxidations, and reductions involving mainly positions 2 and 5 of the quinoline system.

30. The Halogenation of Salicylic Acid.

L. H. Farinholt; *Washington and Lee University* and A. P. Stuart; *University of Delaware.* (15 min.)

The mono- and disubstituted halogen derivatives of salicylic acid have been prepared by previous investigators, usually by the simple addition of the free halogen to a solution of salicylic acid in a suitable medium. The tri- and tetrahalogenated salicylic acids have not been reported in the literature and numerous experiments were carried out with the preparation of these compounds in mind.

Starting with 3, 5- diiodosalicylic acid, various methods were applied with the object of obtaining higher iodinated derivatives but with negative results in each case. With 3, 5-dichloro- and 3, 5-dibromosalicylic acids as starting materials, the usual methods resulted in either replacement of the carboxyl group by halogen or no reaction at all. Finally by carrying out the halogenation in fuming sulfuric acid, trichloro-, tribromo- and tetrabromosalicylic acids were obtained in good yield. It was found necessary first to prepare the dihalogenosalicylic acids by known methods and use them as starting materials for further halogenations since attempts to start with unsubstituted salicylic acid yielded only water-soluble products. No iodine derivatives could be prepared by this method.

The positions of the halogen atoms in the polyhalogenosalicylic acids were determined (a) by decarboxylation and identification of the resulting halogenated phenols and (b) by substitution of the carboxyl groups by bromine or chlorine and subsequent identification of the phenols. It was shown that the third halogen enters the position (6) adjacent to the carboxyl group.

31. The Brominating Action of 1, 2-Diaroylbromo-ethanes.

Monroe Couper and Robert E. Lutz; *University of Virginia.* (15 min.)

The bromine of 1,2-diaroylbromo-ethanes is activated by the α-carbonyl group. We have found it to possess powerful brominating action in the presence of hydrogen bromide as catalyst, the products depending on the nature of the acceptors present.

Hydrogen bromide in acetic acid reacts with *trans*-1, 2-dimethyl-1, 2-dibenzolethylene to give 1, 2-dimethyl-1-(p-bromo-benzoyl)-2-benzoylethane in good yield. The saturated bromodiketone first formed has itself acted both as brominating agent, and as acceptor at the *para* position of the terminal aromatic nucleus. This orientation implies bromination of an intermediate enolic modification, which would be expected to be generated continuously in the mixture through 1, 4- addition and elimination of hydrogen bromide to the diaroylethylene.

Other unsaturated diketones reacted with hydrogen bromide analogously. The second *para* position could be brominated, stepwise. When both were blocked, however, the solvent apparently became the bromide acceptor, for

only the corresponding saturated diketone was isolated. Brominating action was demonstrated here by the addition of β-naphthol, and recovery of α-bromo-β-naphthol.

Absence of the methyl groups decreased the brominating tendency, the molecule being stable except in the presence of β-naphthol. The reported self-bromination in the aliphatic chain by di-(trimethylbenzoly)-bromoethane is now understandable, and was shown to be avoidable by the addition of the stronger acceptor, β-naphthol.

The function of hydrogen bromide in catalyzing these brominations is discussed.

32. An Improved Experimental Still for the Isolation of Volatile Oils from Logging Wastes.

H. N. Calderwood; *University of Wisconsin.* (15 min.)

A description with illustrations of an improved apparatus used in studying the production of voltatile oils from spruce and balsam fir pulpwood logging wastes. This still holding from 500 to 800 pounds of chopped waste could be opened, discharged, recharged, closed and the next distillation started within thirty minutes by one man.

By means of a simple constant-level device, the aqueous distillate was reused, which not only decreased the losses of volatile oil, but also made possible estimations of the heat requirements needed in the production of volatile oils from logging wastes of the species studied. This apparatus was constructed from materials easily obtainable, and was operated by the class of labor ordinarily available in logging camps.

33. A Chemistry Open House.

R. C. Krug, T. S. Tutwiler, and A. I. Whitenfish; *University of Richmond.* (15 min.)

The exhibits at a recent science show given at the University of Richmond included examples of Chemiluminescence, Induction Period, and a low cost potentiometric titration assembly with Magic-Eye indicator suitable for neutralization, oxidation-reduction, and precipitation reactions. Experiments were performed with explanations. Circuit diagrams for the potentiometer were given.

At the conclusion of the papers the Section was called to order by the Chairman for a business meeting. The report of the nominating committee was read by Dr. John H. Yoe and the following officers were unanimously elected:

Chairman: Dr. W. G. Guy, Professor of Chemistry, College of William and Mary.

Secretary: Col. W. O. Swan, Professor of Chemistry, Virginia Military Institute.

Representative on the Board of the Virginia Journal of Science: Dr. J. W. Watson, Professor of Chemistry, Virginia Polytechnic Institute.

The business meeting was then adjourned.

W. G. Guy, *Secretary.*

Minutes of the Section of Education

J. Alex Rorer, *Chairman*

Paul G. Hook, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

1. Evaluative Criteria of the Cooperative Study.

William R. Smithey; *University of Virginia.*

A Comparison of the Present Actions and Policies of the Four Regional Associations.

An analysis of the official actions reveals that the Middle States Association has adopted a program based upon the recommendations of the Cooperative Study of Secondary School Standards for the evaluation, accreditation, and improvement of its secondary schools; that the Northwest Association, North Central Association, and Southern Association have adopted programs for the use of the "Evaluative Criteria" of the Cooperative Study for evaluation and stimulation purposes only; and that all four of these associations plan, at least tentatively, to have all schools evaluated by the Evaluative Criteria in four or five years.

A careful analysis of the replies to the questionnaire indicates that thoughtful consideration was given to the questions proposed, that much uncertainty prevails in the Southern territory as to the use of the "Evaluative Criteria", and that the plan now in operation needs further consideration.

2. Photography as a College Course.

J. D. Shumacher; *Roanoke College.*

Photography is becoming more popular as a hobby and also as a scientific tool. Possible reasons for this increased popularity are cited.

Should photography be included in the college curriculum? This question is aroused by interest and demand for photography on the part of the students. It is considered from two angles: (1) the position of the college; and (2) the standpoint of the student.

The Position of the College.—A few colleges are offering students some experience in photography, but fundamental principles of chemistry and physics need to be included. Although the teaching staff of the average college is adequate for instruction in photography, a survey of Virginia colleges showed only a small per cent offering a course in photography. The cost of equipment is not prohibitive and the course may be altered to suit the needs of the institution.

The Standpoint of the Student.—A suggested list of lecture and laboratory topics shows the simplicity in organization of photography. A survey of Roanoke College graduates who took photography proves it is a practical course. Students display their interest by their eagerness to work in the dark room.

It is concluded, then, that photography is adaptable as a college course, both from the standpoint of the college and the student.

3. A Differentiated Reading Attack.

Eva Bond; *College of William and Mary, Richmond Division.*

Good readers read at different rates of speed different types of material. Some make a conscious effort to adjust their rate of reading to the difficulty and familiarity of the material and to the purpose for which they are reading. Others quite unconsciously increase or decrease their speed in accordance with their purpose and material. But less effective readers seem to have just one reading rate which they use all the time, regardless of what they are reading or why.

One hundred students in the College of Education, University of Minnesota, were given four types of material to read. The average rate at which they read the four types was as follows: simple story type, 374 words per minute; Shakesperean material, 283 words; zoology textbook material, 265 words; *World Almanac* material, 248 words.

As a second phase of the experiment, the students wrote what they remembered of each passage. Their statements about the simple story told, in a general way, what the passage was about. They showed that the students were reading to note the general significance of the passage. In writing about the Shakesperean material, the majority gave an interpretation, which showed that they were reading the material to draw inferences. Their discussion of the selection from the zoology text was concerned with an organized presentation of what they had read. The factual reports of the *World Almanac* passage indicated that the students had noted details as they read.

The effective reader, thus, adjusts his reading to meet the demands of his purpose and material.

4. Physical Education Programs in Virginia Colleges.

Clarence Hale; *University of Virginia.*

The Status of Physical Education in Institutions of Higher Learning in Virginia is a questionnaire study which was made to try to determine the status of the service curriculums in physical education for men in the colleges and universities of the Commonwealth of Virginia. The thirteen schools included in the study were classified according to the male enrollment into seven classifications. Questionnaires were sent to three schools outside the state for each classification to be used for comparisons. Nineteen questionnaires were filled out and returned. Items included in the questionnaire were (1) the extent of the programs in physical and health education; (2) length of the programs in health and physical education; (3) time allotment in health and physical education; (4) size of classes in physical education; (5) activities offered; (6) credit in physical education; (7) the extent and thoroughness of the medical examination; (8) method of handling absence excuses; (9) number of instructors and assistants; (10) teaching load of each instructor; (11) grading plan; (12) and equipment. The main standard of measurement, however, was The Physical Education Curriculum (A National Program) compiled by Wm. R. LaPorte. The opinions of one or more well known authorities were used as a standard of measurement for those items not specifically covered in The Physical Education Curriculum. The service curriculums, on the basis of the comparison with the standard of measurement, were classified as very good, good, fair, or poor. The service curriculums were found to be very good in two of the thitrteen schools studied, good in six, fair in four, and poor in one.

The service curriculums on the whole were good in the time allotment for both health and physical education, the length of the program in health education, having a physician give the medical examination, the thoroughness of the medical examination, the teaching load, and the method of teach-

ing. They were fair in the extent of the program for both health and physical education, the length of the program in physical education, the size of classes in physical education, granting credit in physical education, the extent of the program for the medical examination, the method of handling the absence excuses, the number of instructors in physical education, the grading plan in physical education, and the provision of equipment. They were poor in the program of activities.

FRIDAY, MAY 3—2:00 P. M.

5. The Living Conditions of the White Teachers in Bedford County, Virginia.

Samuel J. Coffey; *University of Virginia.*

From a questionnaire filled out by 130 teachers, statistics were gathered to give a picture of the real conditions under which teachers were living while attempting to carry out their teaching duties. The study reveals particularly the importance that teachers put on living conditions, the difficulty of obtaining desirable boarding places in rural areas, and the very great lack of opportunity for recreation.

It is the purpose of this study to bring to the front a problem related to teacher efficiency which seems to have been overlooked.

6. Negro Education in Bedford County, Virginia.

O. T. Bonner; *University of Virginia.*

A recent study of Negro education in Bedford County revealed a number of interesting facts concerning distribution of population, population trends, interest in education shown by Negro patrons and teachers, qualifications of teachers, curriculum, teaching equipment and materials, etc.

In this paper special emphasis is placed on equipment and materials in the Negro schools in Bedford County. The study shows that all schools need additional materials but the real problem is in getting personnel that know how to use materials after they are obtained and how to obtain local materials that are free and of most value to teaching. The study also shows that there is approximately equal treatment of Negroes and whites in the county even though the Negroes pay only a small percentage of the local taxes.

7. Health Conditions and Health Activities in Negro Schools of Fauquier County, Virginia.

W. G. Coleman; *Principal, Marshall High School.*

As a part of a more comprehensive study of Negro education in Fauquier County, information concerning health conditions and health activities was obtained by inspection of the school plants and personal interviews with teachers. Among other things, the data revealed the following: toilets were in good condition; sources of water were far removed from the school and possibly contaminated; less than half of the school rooms had windows properly placed; all buildings were heated with unjacketed stoves; all buildings depended on windows for ventilation; such play equipment as was available had been provided through the efforts of pupils, teachers, and parents; the program of physical inspection was satisfactory; several schools were attempting to supplement pupil lunches with hot soup or cocoa.

8. Techniques of Research in Apprentice Teaching.

Boyd Graves; *Mary Washington College.*

At the December 1938 meeting of Section Q of the American Association for the Advancement of Science, held in Richmond, there was a prolonged discussion of the methods currently used in educational research. The consensus was that research should be carried on for the value to the locality in which the study is made, as well as for the immediate benefit of the researcher.

In guiding the research studies of the apprentice teachers from Mary Washington College, an attempt is being made to carry out this point of view. The principal of the school, the local elementary supervisor, the participating teacher, the apprentice and the director of apprentice teaching from the college confer and agree upon a local problem to be studied.

Most of the studies by the apprentices are non-statistical in nature. While they thereby lose some of the objectivity that is so desirable and possible in the more exact sciences, their usefulness in improving educational practices make them no less significant, especially since the more important areas of education lie at present outside the compass of scientific measurement. Although in process of refinement, this attempt to develop a program of educational research has at least removed the researcher from the ivory tower to the immediate school situation which expects and usually gets some direct benefit from the investigation.

9. Control of School Accounting Exercised by State Requirements and Recommendations.

Charles K. Martin, Jr.; *Mary Washington College.*

Problem

This study answers the following questions: What general principles for state control of school financial accounting can be established? What changes need to be made in present practices required or recommended by the states?

Purpose

Proper control over school financial accounting is basic to the safeguarding of school funds, to the calculation of educational costs, and to the budgeting of school expenditures. Lax state control, at present, has resulted in inefficient school accounting practice, and research in school financial accounting has been neglected more than research in any other phase of school finance. Because of the importance of fiscal accounting, the inefficiency of present practice, and the lack of research, this study is offered as a contribution to school finance.

Procedure

1. The historical trends in the development of school financial accounting were taken from the literature to give orientation and background to the study.
2. The place of state control of school financial accounting was established through principles chosen for examination from the literature on the basis of frequency of mention, carefully defined to decrease ambiguity and to increase exactness of meaning, examined to insure completeness and prevent overlapping, and weighed by supporting evidence to eliminate those statements for which there is not sufficient evidence. From a jury composed of 144 experts, judgments concerning the validity of the principles were obtained.

3. The extent to which present practice, as defined in bulletins and forms published by the state departments of education and other agencies controlling accounting for public monies, agreed with the validated principles for state control of school accounting is reported.

Conclusions

Twenty principles were established, namely: uniformity, adequacy, educational emphasis, control, accuracy, simplicity, flexibility, safety, timeliness, economy, reportability, utility, permanence, efficiency, legality, authorization, evaluation, availability, unity, local responsibility. An enormous lag was found to exist between theory of school financial accounting and the control of such school fiscal management by the forty-eight states of the union. The extent of this lag is reported. Steps are recommended to aid the states in bridging this gap between theory and practice. Suggestions are made for further study.

PAUL G. HOOK, *Secretary.*

Minutes of the Section of Engineering

ALBERT H. COOPER, *Chairman*

D. H. PLETTA, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

1. An Apple-Milk Confection for Partial Utilization of Surplus and Cull Apples.

Frank C. Vilbrandt and Robert D. Sieg; *Virginia Polytechnic Institute.*

In the apple industry during a time of five years, an average of over three million bushels of apples a year were not harvested because of market conditions. There are around 120,000 tons of fruit culled out by the fruit packing plants of this country annually. In the dairy industry 53 billion pounds of skim milk are processed, and only 26 per cent finds economical utilization.

The high nutritive value of both these foods indicates that an ideal food would result from their coagulation into one material. The higher mineral content of the milk and the higher carbohydrate value of the apple along with its regulative properties should blend together to a nutritive food.

Apples were reduced to juice and pulp. Both of these materials were dried satisfactorily on a vacuum double-roll dryer.

A mixture as high as 3 to 5 parts by weight of apples to milk was found to be applicable for confection products. Apple juice-milk mixtures dried under modified drying conditions to give a light-colored, pasty, confection-textured product with a slight tart taste. Apple pulp-milk mixtures dried under high drying conditions to give a dark-colored, chewy, flaky cereal-like confection base product.

2. Heat Transfer Coefficients for Condensing Organic Vapors.

Harvey E. Henderson and Albert H. Cooper; *Virginia Polytechnic Institute.*

An investigation was made to determine the film heat transfer coefficients of various members of homologous series of organic compounds during condensation. Studies were made on alcohols, esters, and azeotropic mixtures. A correlation between the actual film coefficients obtained and the theoretical Nusselt values was made. An attempt was made to correlate the heat transfer coefficients with the physical properties of the liquids used.

3. Utilization of Saltville Wastes for Production of Chlorine.

J. T. Gormally and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

The disposal of wastes from the ammonia distiller in the ammonia-soda process has been a source of trouble to this industry since it first began large scale operations. The waste, for purposes of this study, is essentially a solution of calcium and sodium chlorides. Other materials present are

small amounts of CaO, $CaCO_3$, insolubles from the limestone (principally silicates), and traces of NH_3.

It is proposed to utilize this waste by a reaction with oxides of nitrogen to produce chlorine, with a mixed calcium and sodium nitrate as a by-product. The mixed nitrate can be used directly as a fertilizer or as a source of raw material for further purification. One volume of nitrosyl chloride is formed for each two volumes of chlorine. Optimum conditions were found for the reaction.

4. Industrial Conversion of Nitrosyl Chloride to Chlorine.

H. C. Shockey and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

Utilization of carbonate wastes from Solvay process for production of gaseous chlorine from the waste calcium chloride brine by conversion of nitrosyl chloride through hydrolysis and neutralization.

5. The Use of Test Filtration Data in the Prediction of Filter Capacity.

Ralph A. Troupe and Robert A. Fisher; *Virginia Polytechnic Institute.*

This work was undertaken for the purpose of evaluating the usefulness of equations that have been proposed for the calculation of the capacity of industrial filtration equipment. These equations are for compressible homogeneous slurries at constant pressure.

1. Ruth equation:

$$(V + V_c)^2 = K(\theta + \theta_c).$$

2. Lewis equation:

$$\frac{P\theta}{(V/A)} = \frac{r''vP^s\mu}{2}(V/A) + \rho'\mu P^m.$$

A large number of tests were made on a "Sperry" plate and frame filter press to determine the value of constants required in the equations. The equations with the experimentally found constants, were then used to calculate the expected capacity of a "Feinc" rotary continuous filter, after which tests were made on the "Feinc" filter to determine the degree of accuracy of the filter cloth, and type of solid in the slurry.

6. Design, Construction and Operation of a Carbon Dioxide Generator from Fuel Oil for Experimental Absorption Tower Studies.

I. Resnick and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

The design of a low capacity furnace for generation of carbon dioxide for experimental absorption tower studies and for municipal water plant carbonation required calculations of furnace capacity, two-step cooling of furnace gases, to reduce temperature of gases, first, by heat of vaporization of spray water, and second, by condensation of vapors generated and reduction to absorbent liquor temperature. A D. F. C. oil furnace burner was used, with four double spray nozzle cooling units in series. Details of construction and operation are given.

7. Countercurrent Liquid—Liquid Extraction of Lubricating Oils in a Spray Column.

Alfred S. King and Albert H. Cooper; *Virginia Polytechnic Institute.*

The necessity, principles, and methods of solvent extraction as applied to lubricating oil refining have been reviewed with particular emphasis on the countercurrent method.

The possibility of applying a basic transfer equation to the solvent extraction of lubricating oils by means of furfural in a spray column was investigated, and the transfer coefficients were calculated on the basis of a modified equilibrium diagram, rate of flow of solvent, and the area of contact.

The effect of the area of contact and the ratio of the solvent to the oil on the transfer coefficients were also investigated and contrasted.

8. Drying and Warping Properties of Scherer Insulation.

M. Singer, P. C. Scherer, Jr. and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

Scherer insulation is produced by physically incorporating viscose, lime, gypsum, and aluminum, awaiting subsequent chemical reaction for evolution of gas.

The colloidal nature of the mix offers the major difficulty to drying. The product shrinks considerably upon drying and forms a skin on the top immediately after forming which prevents the passage of water into the main air stream. If the rate of drying is not the same at all surfaces, caused by the skin formation and by the excessive edge and corner drying, one or more of the surfaces dries out more rapidly than the others, thus shrinking more rapidly, causing cracking and warping.

To prevent this skin formation, a plate was placed upon the top of the specimen after its formation in the pans. To eliminate the warping during drying, it was found advisable to either steam the specimens after forming or to apply a dry heat treatment at the temperature of 150° F. on forming or the day after.

9. Mixing and Forming Characteristics of Scherer Insulation.

S. C. Hyman, P. C. Scherer, Jr. and F. C. Vilbrandt; *Virginia Polytechnic Institute.*

Investigation was made on an insulation created by P. C. Scherer, consisting of viscose, lime, gypsum, and aluminum. The mixing problem consisted in the efficient dispersion in a very short time of the lime, gypsum, and aluminum powders throughout the high viscosity dough-like viscose. Because of the tacky and adhesive nature of the mixture, its forming presented a problem. The processes of mixing and forming were limited to a very short time.

Two procedures of mixing were considered: (1) the dispersion of the aluminum powder throughout the mixture of lime, gypsum, and viscose, and (2) the dispersion of a dry mixture of aluminum, lime, and gypsum throughout the viscose. The second procedure was discarded in favor of the first.

Two methods of forming were considered: (1) rolling, and (2) casting. Adherence of the material to the rolls made the first method impractical. The casting method was adopted.

It was found that the physical properties of the dried material are in the range of commercial insulators.

10. Effect of Operating Variables on Individual Plate Efficiencies of a Bubble-Cap Column.

Stuart B. Row; *Virginia Polytechnic Institute.*

The operation of a continuous bubble-cap column, especially of the laboratory size, is attended by much difficulty in regard to obtaining steady and uniform operation. Individual plate efficiencies are apparently subject to great variation and duplication of results is difficult. Very little experimental data are available in the literature on the effect of the various variables such as feed rate, feed temperature, reflux ratio and vapor velocity.

The purpose of this investigation was to determine the range of accuracy and applicability of individual plate efficiencies and to determine the effect of some of the operating variables. The equipment consisted of a fifteen-plate, eight and one-half inch diameter bubble-cap column. Each plate contained one tangential opposed type bubble-cap, one plate being equipped with a glass section to permit visual observation of conditions existing on the plate.

11. Business Meeting, Appointment of Nominating Committee.

The meeting was called to order by Dr. A. H. Cooper, Chairman, at the conclusion of the presentation of the papers at the morning session.

The minutes of the last meeting were read and approved. A nominating committee, consisting of Prof. S. B. Rowe and Maj. Walter Lowry, was then appointed to select officers for the coming year. The meeting was then adjourned until after lunch.

FRIDAY, MAY 3—2:00 P. M.

12. Continuation of Business Meeting.

At 2:00 P. M. the business meeting was again called to order. The nominating committee presented a slate of candidates as follows: Chairman, D. H. Pletta; Secretary, P. S. Dear; Associate Editor, A. H. Cooper. There were no further nominations from the floor and a unanimous ballot was cast for the nominees.

The secretary then explained the limitations as to page lengths and cuts allowed without cost for Journal articles, asked for support of this publication and requested those wishing to submit articles for consideration or to amend their abstracts to do so in the near future.

The meeting was concluded at 2:20 P. M. with the resumption of the presentation of papers for the afternoon session.

13. Gasoline Engine Exhaust Gas Analysis.

J. L. Dilworth; *Virginia Polytechnic Institute.*

For some time various types of instruments have been used to analyze the exhaust gases from gasoline engines in an attempt to determine the optimum air-fuel ratio. This practice is based on similar procedure which has been followed successfully in steam power plants for a number of years.

Extensive research has shown that combustion in an engine cylinder is considerably different from that in a furnace, however, and this fact has led many engineers to question the accuracy of engine exhaust as an indicator of combustion efficiency. It is the purpose of this investigation to determine the effect of important variables in engine design and operation on the relation between air-fuel ratio and analysis of the products of combustion. To this end, a number of different makes of analyzers representing each of the four common types were obtained and tested in order to observe the effect of numerous different conditions on their accuracy.

14. Accidents in Virginia Industries.

W. B. Davis; *Industrial Commission of Virginia.*

This paper covers a discussion of accidents occurring among the industries of Virginia, with statistics on accident frequency, accident costs, and the basic causes. The engineer's part in accident prevention was also stressed.

15. Work Simplification Engineering.

R. B. Davenport; *Work Simplification Engineer, Larus & Bros. Co., Richmond, Va.*

In recent years not only are many concerns facing the problem of higher manufacturing costs, but also customers are demanding a higher quality than ever before; therefore, the objective of every company should be a better product at a lower cost.

Is Work Simplification the answer? Not only the answer, but years ago Frank Gilbreth, Industrial Consultant, said, "There is no waste of any kind in the world that equals the waste of needless, ill-directed, ineffective motions and the resulting unnecessary fatigue. Because this is true, there is no industrial opportunity that offers a richer return than the transformation of ill-directed and ineffective motions into efficient activity."

Increased productivity should come from the use of improved methods and the elimination of wasted energy—not by over-speeding the worker. This should be done by getting everyone in the organization from the janitor to the president thinking about his or her job and ways of improving it through the tools of Work Simplification (sometimes referred to as "Motion Economy".) This is best accomplished by having a trained man in the organization hold a definite series of conferences with executives, foremen, mechanics, operators, etc., for the purpose of learning, discussing, and exchanging ideas; all working together toward one objective—to produce a better product at a lower cost.

With this paper, motion pictures of actual operations, and old and new methods, were shown to bring out points of Work Simplification as developed at Larus & Brother Company.

16. Miniature Camera Color Photomicrography Applied to Ceramic Technology.

Paul S. Dear; *Virginia Polytechnic Institute.*

The use of photomicrography in relation to many fields of industrial and scientific work is becoming increasingly important and beneficial. Photomicrographs offer a convenient method of preserving records of structural and phase relations in the many kinds of ceramic products, not only during the manufacturing process but also after the exposure of the finished products to service.

A simplified, composite apparatus by means of which miniature cameras may be adapted to the work of petrographic photomicrography was described. An assembly drawing of the various component parts was included, and examples of the application of the apparatus to problems in

ceramic technology were given through the medium of color film-transparencies.

17. Development and Possibilities of Zoisitic Aplite as a Ceramic Raw Material.

Paul S. Dear and John W. Whittemore; *Virginia Polytechnic Institute.*

The chemical and mineralogical content, and the physical properties of zoisitic aplite rock, mined in Amherst County, Virginia, and milled in Nelson County, Virginia, were investigated. The possibilities of various ceramic uses of zoisitic aplite were discussed.

18. Design Constants for Fixed-End Roof Trusses.

J. E. Spagnuolo and D. H. Pletta; *Virginia Polytechnic Institute.*

This paper investigates the possibility of developing data concerning a simpler design analysis than has heretofore been advanced for framed bents in which the top or horizontal member is a truss having parallel or even parallel chords.

The structurally indeterminate type of bent is attacked by the method of moment and thrust distribution which appears to be easily applicable to this particular type of frame with all its accompanying advantages of simpler analytical procedure.

In accordance with the requirements of this method, the design constants (stiffness factors, carry-over factors and fixed-end moments) are determined in terms of the length and depth of the truss, area of members, loads, etc., so that almost any span and load condition can be easily and readily analyzed.

19. The Behavior of Helical Springs.

F. J. Maher and D. H. Pletta; *Virginia Polytechnic Institute.*

Ordinarily spring designers use torsional flexure ($S_s = Tc/J$) and deformation ($\Theta = TL(GJ)$ equations, as they apply to straight circular bars, for analysis of helical springs. As regards stress, bar curvature is now usually cared for by employing the Wahl correction factor. Recent tests reported on in this paper indicate, however, that the load on the spring is usually eccentric even when the spring is compressed between parallel planes; and the helix, in its deflected position, is no longer helical but assumes a warped shape, the individual coils closing most rapidly on the side nearest the eccentric load. Theoretically, zero eccentricity results only when the number of free coils is an integer plus 0.511 coils, but practical manufacturing technique precludes perfect concentricity of the individual coils. Hence a factor for load eccentricity should always be included in stress analysis.

Other tests reported on indicate that the usual practice of cold-working springs after heat treatment affects their ultimate behavior. As strain hardening increases the stiffness of the spring decreases, the load-deflection curve changes from one that is concave upward to one that is concave downward, and the number of active coils tends to remain more nearly constant with increase in load mainly because progressive end-seating diminishes.

D. H. Pletta, *Secretary.*

Minutes of the Section of Geology

EDWARD C. H. LAMMERS, *Acting Chairman*

WILLIAM M. MCGILL, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

The Section of Geology met in the Geology Lecture Room of Professor Steidtmann in Maury-Brooke Hall, at the Virginia Military Institute, on Friday, May 3, 1940. Two session were held: one from 10:00 A. M. to 1:10 P. M., and the other from 2:00 to about 4:10 P. M. In the absence of Dr. E. R. Casto, Chairman, who was unable to attend because of illness, the Vice-Chairman, Dr. E. C. H. Lammers, presided at both sessions. As soon as the morning session was called to order, a resolution offered by Mr. Sniffen was unanimously passed, extending to Dr. Casto the regret of the members of the Section for his recent illness and inability to attend and preside over the meeting, and expressing the hearty wishes of all for his complete and speedy recovery. A total of 42 people registered at the two sessions and several visitors, who did not register, but attended the presentation of papers in which they were especially interested, augmented the attendance. Much interest was shown in the various papers. Discussions of each paper added to the success of the meeting. The following papers were presented:

1. Diatomite in the Petersburg Area, Virginia.*
   William M. McGill; *Virginia Geological Survey.*

A brief discussion of the results of recent preliminary studies of diatomite in the vicinity of Petersburg, Virginia. The occurrence of diatoms of a great variety of forms, apparently in beds of both marine and non-marine origin; the stratigraphic and topographic relations of the diatomite beds or zones to the enclosing Calvert formation; variations in thickness and character of relatively closely-spaced, apparently related exposures; together with characteristic and distinctive features of freshly exposed beds and long-exposed outcrops are described. Commercial possibilities are discussed.

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2. Problems of Coastal Plain Geology and Hydrology.*
   D. J. Cederstrom; *U. S. Geological Survey.* (Introduced by Arthur Bevan.) (Slides, 15 min.)

Present information regarding the Coastal Plain of southern Virginia has been obtained from outcrops of strata, well logs and geophysical investigations. Although these three sources offer incomplete information, data are at hand which bear on the following geologic problems: configuration and origin of the bedrock surface; distribution of Upper Cretaceous marine

sediments; structure in the Cretaceous and Tertiary sediments, the origin of these structures and their relation to the granitic bedrock.

Problems of hydrology to be considered are as follows: manner of recharge of Cretaceous water-bearing formations; the chemistry of softening and origin of bicarbonate and fluoride content of Coastal Plain water; the relationship of fresh water to salt water; and problems concerning the amount of storage, the amount of recharge, and safe yield of wells.

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3. Notes on Varvelike Clay at Buena Vista, Virginia.*

Robert O. Bloomer; *University of North Carolina.* (Introduced by Wm. M. McGill.) (5 min.)

On the northeastern outskirts of Buena Vista, Rockbridge County, Virginia, a small patch of alternately dark brown and white, laminated, clay occurs on the eastern slope of a knoll in Rome shale and Shady dolomite. The dark colored layers in the clay contain numerous plant remains.

A coarse boulder clay underlies about four feet of laminated clay. The deposit occurs in a large cut in the side of the knoll made by the Dickerson Brick Company.

Investigation has shown that the varved material originated from the waste of a wash plant which was located on top of the knoll some thirty years ago. The plant was used to prepare iron ore from the Blue Ridge Mountains. No evidence of this plant is now on the site.

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4. Map Showing Distribution of the Petersburg Granite in Southeastern Piedmont Virginia.*

Arthur A. Pegau; *University of Virginia.* (Map, 12 min.)

A presentation and brief discussion of a map showing the distribution of the Petersburg granite in southeastern Piedmont Virginia, prepared by the author as a result of field investigations made in the summers of 1931, 1937 and 1939, sponsored and financed in part by the Virginia Geological Survey, and by a Grant-in-Aid from the Virginia Academy of Science. Shown on the map are (1) Pre-Cambrian undifferentiated schists and gneisses; (2) Pre-Cambrian Aporhyolite; (3) Paleozoic Petersburg granite; (4) undifferentiated sediments of Triassic age, and (5) undifferentiated Coastal Plain sediments of Cretaceous and Tertiary ages.

As shown by detailed mapping the Petersburg granite in this area occurs not as a single body, but as three distinct units. The easternmost unit is covered in large part by Coastal Plain sediments on the east and by Teritary sediments on the west. This body traverses from north to south parts of Hanover, Henrico, Chesterfield, Dinwiddie, and Sussex counties. The second unit or belt is confined largely to Brunswick and Greensville counties; whereas the third belt underlies parts of Dinwiddie, Nottoway, and Brunswick counties. Commercial workings have been confined almost entirely to the eastern belt, but a good grade of stone is found locally in both of the other belts.

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5. A Virginia Piedmont Paleozoic Limestone Belt.

Arthur Bevan; *Virginia Geological Survey.* (Presented by title.)

As shown on the geologic map of Virginia, published in 1928, areas of limestone are found along the western part of the Piedmont province from Potomac River southwestward into Pittsylvania County. Some of these bodies of limestone have been interpreted as pre-Cambrian whereas the limestone in the belt extending northeastward from Fluvanna County into

Culpeper County has been interpreted as Ordovician. The problem under consideration involves the extent of these limestone bodies, the characteristics of the limestones, their geologic relations, evidence of their ages, and interpretations of paleogeography and geologic history based on their distribution, character, and age. The problem remains in part unsolved and awaits further field and laboratory study.

6. A Granite as a Thrust Fault Carrier East of the Blue Ridge in Virginia.

Wilbur A. Nelson; *University of Virginia.* (Slides, 12 min.)

A major thrust fault carried by a granodiorite, named the Greenwood granodiorite, is mapped and described in detail where it traverses the Waynesboro and University quadrangles just to the east of the Blue Ridge. In places this pre-Cambrian granodiorite is thrust over basal Unicoi sandstones and shales, in places over Catoctin greenstone, whereas in the Whitehall region more than one mile of Unicoi sedimentary rocks lie west of the fault.

The geologic column in this area shows no unconformity between the base of the Unicoi and the top of the Catoctin, the only unconformities being 600 feet above the top of the Catoctin and at the base of the Catoctin; the Catoctin being several thousand feet thick. The Greenwood granodiorite lies below the Catoctin and is separated from it by about 200 feet of slate.

The fault plane at elevations of 600 to 700 feet above sea level has a dip toward the southeast of approximately 15° to 20°, whereas at higher elevations the plane of the fault steepens until at elevations of 1400 to 1500 feet above sea level the fault plane dips 50° to 55° to the southeast. Schistosity in the fault zone parallels the dip of the fault plane, and differs from the dip of the regional schistosity which averages 47° to the southeast.

It is shown that thrust faulting of the Appalachian Valley type occurs in the Piedmont east of the Blue Ridge and that normal faulting of the Piedmont type with vertical displacements of hundreds of feet, occur in the Appalachian Valley.

7. Application of Some Biogenic Laws to Stratigraphy.

A. A. L. Mathews; *Virginia Polytechnic Institute.* (12 min.)

A close study of fossil faunas reveal biogenic laws to be as applicable to the living past as they are to the living present. Granted that fossil remains establish the type and character of the living organism, the problem of this thesis is to outline certain characters in reference to stratigraphic sequence, and apply biogenic laws to those organisms involved.

This paper merely suggests the application of the thesis to practical use of any of the phyletic groups when properly analyzed and applied to stratigraphy. This point of view seems to be most important, since the great mass of field data for determining the age of strata contain only fragments of the included fossils. Therefore the approach to the study of stratigraphic paleontology should include this point of view for a clearer and more exacting training for useful after-years in the field.

8. Some New Features of the Internal Structure of Receptaculites.

John W. Harrington; *Virginia Polytechnic Institute.* (Introduced by Roy J. Holden.) (5 min.)

Several specimens of Receptaculites have been found in Russell County, Virginia. Longitudinal sections show tubes which do not connect with the outside but are completely enclosed by what was once living tissue. Tan-

gential sections disclose a change in tube shape from rhombic on the surface to roughly circular below. Just below the surface there are projections which partially close the tubes in a regular manner. These characteristics confirm the generally accepted idea that Receptaculites is related to the sponges rather than to the corals.

9. Geological Study of Core from Chickamauga Dam, Tennessee.

Cecil B. McGavock, Jr.; *Tennessee Valley Authority, Chattanooga, Tenn.* (Slides, 10 min.)

Chickamauga Dam, on the Tennessee River in Southeastern Tennessee, is located on soluble Chickamauga limestone of upper Ordovician age. After completion of the earth embankments it was decided to grout, on a geometrically planned pattern, all known and suspected area of cavitation, in order to prevent slumping of the fills and formation of sinks. Since some of these holes penetrated cavities up to 10 feet or more in thickness, and accepted upwards of 30,000 cubic feet of clay-cement grout, it was thought advisable to explore a typical area with a large diameter drill hole. Such a hole would permit studies of the geological conditions inside as well as the effect of the grout and its relation to the geological conditions. The hole was drilled through a large and a small cavity. Valuable information was obtained in overburden, in rock, and in the cavities. Numerous questions regarding the local geology and grout fillings were easily answered. Results of the test hole and studies of core obtained are discussed and illustrated by maps, charts, and slides.

10. A Barite Vein Near Lexington, Virginia.

Edward Steidtmann; *Virginia Military Institute.* (Maps, 12 min.)

A barite vein, cutting granite, outcrops in a road cut on Big Mary Creek in the northeastern part of Rockbridge County. The vein is nearly 18 inches wide. It is nearly vertical and has a northeasterly alignment. A few irregular fragments of granite are embedded in it. The color, specific gravity and other characteristics indicate that the vein is nearly pure barite.

11. Geology in Soil Survey Work in Southwest Virginia.

H. C. Porter; *Virginia Agricultural Experiment Station.* (Maps, 15 min.)

Soils, as natural bodies, are the result of the action of climatic forces on the geologic material from which the soil is formed. The degree to which properties are impressed on the soil by the geologic material or climatic forces is dependent upon the relative development of the soil. In southwest Virginia, due to steepness of topography and the resistance of certain rocks, the soils are all relatively young and the properties of the soil are in a large manner inherited from the parent geologic material. On the skeleton soils, it has been almost impossible to prepare a good field map or to formulate a satisfactory correlation of the soils as mapped in the different areas, without very close study of underlying geologic material. This procedure was not clearly followed at the inauguration of our soil survey program in southwest Virginia. However, after sad experience it was found that use of the available geologic data was necessary for the satisfactory classification of these young soils. Among the most valuable sources of geologic data for this part of the state were Virginia Geological Survey Bulletin No. 42—Geologic Map of the Appalachian Valley of Virginia with Explanatory Text by Charles Butts, and personal assistance from geologists in Virginia.

FRIDAY, MAY 3—2:00 P. M.

12. Land Use Capability Classification for Farm Planning.

T. C. Green; *U. S. Department of Agriculture, Soil Conservation Service.* (Introduced by Wm. M. McGill.) (Slides, 20 min.)

A conservation survey is a comprehensive inventory of physical land features delineated on an aerial photograph base map. The survey shows soil type, kind, degree and extent of erosion, gradient of land surface and present land use.

The classification of these physical survey factors according to their use capability by a simple grouping of like factors within the classes will make possible a better interpretation and utilization of the conservation survey information, thereby providing a sound basis for farm planning. The arable lands within the Southeastern Region of the Soil Conservation Service will fall into one of five land use capability classes, the first three of which will be recognized as cultivation classes, and the remaining two classes as vegetative classes.

The basic conservation survey will be photographically reproduced for planning purposes and a nation-wide color scheme of classification of land according to its use capability will be superimposed on the conservation survey.

13. Field Trip in the Buchanan-Cove Mountain-Jennings Creek Area, Virginia.

R. J. Holden; *Virginia Polytechnic Institute.* (Maps, 15 min.)

A brief description of the main features, high points and scheduled "stops" of the annual Geology Section field trip, made this year in the Buchanan-Cove Mountain-Jennings Creek area, Virginia. The area covered by the trip is underlain by igneous metamorphic and sedimentary rocks of Archean and Algonkian (pre-Cambrian), and early Cambrian ages and numerous good outcrops afford interesting, and in places striking, illustrations or examples of the various formations, contacts, complicated and overturned structures, and interesting structural, metamorphic, and petrographic characteristics and relations of the various formations and beds. A columnar section and brief explanations prepared by the author as a result of many years of detailed field and research investigations in this and other parts of Virginia together with a "route and scheduled stop" map provide additional information and serve as a guide to the interesting geological and complex structural features of the area.

14. Geology of Frederick and Clarke Counties, Virginia.*

Charles Butts; *Virginia Geological Survey.* (Map, 15 min.)

A geological survey of Frederick and Clarke Counties, Virginia, has been in progress for several field seasons, and a preliminary geologic map is exhibited to illustrate this discussion. The rock formations present extend upward from the pre-Cambrian Catoctin schist of the Blue Ridge on the east to the top of the Devonian Hampshire ("Catskill") formation at the West Virginia State line on the west. A little northeast of Gainesboro, the south end of Sleepy Creek Mountain of West Virginia with rocks of Mississippian (Pocono) age on the summit just comes down to the State line. All the formations, belonging in ascending order to the pre-Cambrian, Cambrian, Ordovician, Silurian, and Devonian systems, are estimated to aggregate a thickness of 20,000 to 25,000 feet.

The rocks have been folded by lateral compression, and generally are steeply inclined. In places, as at the north end of Great North Mountain, they are intricately compressed into a series of minor interfingering folds.

The major structures are the Massanutten Mountain Syncline just east of Winchester, a composite structure occupied by a thick body of Martinsburg shale, and the Great North Mountain Anticline, 10 miles west of Winchester. Between these two main structures are the Little North Mountain overfolded anticline, the southeast limb of which is faulted out, and a conspicuous syncline west of Little North Mountain carrying along its axis the Hampshire formation, the youngest and stratigraphically highest formation of the region except the Pocono (Mississippian) rocks which occupy a very small area at the south end of Sleepy Creek Mountain.

Following the southeast limb of Little North Mountain is the great North Mountain overthrust fault which brings the Cambrian, Elbrook, limestone up over the Martinsburg shale.

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15. The Role of the Tuscarora Sandstone in Little North Mountain, Virginia.*

Raymond S. Edmundson; *Virginia Geological Survey.* (Slides, 10 min.)

Little North Mountain in northern Virginia, which includes the ridge-making Tuscarora sandstone, is characterized topographically by a series of water and wind gaps. The interstream remnants, short linear ridges and isolated rounded hills, have an averge summit altitude of 1,200 feet. It is believed that the marked variation in thickness, and even absence of the Tuscarora sandstone at different localities along the ridge can be explained by assuming that the sandstone was deposited on an unstable belt of the sea floor subject to many oscillations. When compressional forces became active late in the Paleozoic, the area of the mountain, with its initial sedimentary irregularities, acted as a weakened zone which determined the locus of the structure. The role of the Tuscarora sandstone is also well shown by the water and wind gaps. These gaps occur at places where the sandstone is thin or absent, and the higher altitudes of Little North Mountain correspond to a thickening of the formation.

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16. Problems Related to the Appalachian Geosyncline.

Edward C. H. Lammers; *Washington & Lee University.* (15 min.)

Stratigraphic, petrologic, and structural evidence was presented in support of the following conclusions: (1) The Blue Ridge arch was initially uplifted at the close of the Cambrian; (2) during the Ordovician there were two geosynclines in Virginia separated by the Blue Ridge geanticline; (3) the sediments in the eastern or Piedmont geosyncline were compressed into a folded mountain range during the Taconic Revolution; (4) this range was the source of the sediments deposited in the western geosyncline subsequent to the Ordovician.

17. Detailed Study of the Valley Peneplain in the Vicinity of Lexington, Virginia.

Uriah F. Coulbourn; *Washington & Lee University.* (Slides, models, 10 min.)

The following conclusions were reached after a study of projected profiles and contour maps of summit elevations had been completed: (1) The Valley or Harrisburg surface was a surface of maturity and not a

true peneplain; (2) little or no warping has occurred in the region since the surface was first formed; (3) the Harrisburg drainage pattern is essentially the same as that of today. In such cases of piracy as were noted subsequent streams had been beheaded by either resequent or obsequent streams.

18. Heavy Minerals of Some Silurian Sandstones in Virginia.
James H. Bierer; *Washington & Lee University.* (Slides, 5 min.)

This study was carried out in order that the heavy mineral content and variety in the Silurian sandstones at the Iron Gate anticline, Clifton Forge, Virginia, might be determined.

Principal minerals found were tourmaline, zircon, ilmenite, leucoxene, rutile, and apatite. Several samples contained many specimens of detrital tourmaline with a secondary growth of authigenic tourmaline. These appeared only in samples devoid of iron. In none of the samples was there found any minerals of direct crystalline rock derivation. The species of minerals, together with their well-rounded shape, indicate that they were derived from a provenance of sedimentary rocks and represent material of at least a second cycle of sedimentation. Hence it follows that the source of material composing the Silurian sandstones under question was an extensive area of sedimentary formations.

These conclusions are further substantiated by similar studies of the Athens formation (Ordovician) made by M. H. Stow and J. C. Bierer in 1937.

19. Detailed Stratigraphy of Two Silurian Sections in Virginia.
John S. Hunter, Jr.; *Washington & Lee University.* (Maps, 5 min.)

The lithology and stratigraphy of the Silurian sections exposed in Iron Gate Gorge and in the valley of Falling Springs were described in detail. Relative thicknesses of the various formations in the two sections were compared.

There is a notable increase in the amount of shale in the exposures of the Falling Springs section over the amount exposed in a similar section at Clifton Forge which would be expected as the source of sediments was closer to the Iron Gate area and deposits there should be coarser.

20. Insoluble Residues of Some Silurian and Devonian Limestones in Virginia.
Homer D. Jones, Jr.; *Washington & Lee University.* (Slides, 5 min.)

Insoluble residues from upper Silurian and lower Devonian limestones in the Iron Gate Gorge, Clifton Forge, Virginia, were sufficiently different to be diagnostic of the stratigraphic units in which they were found.

Immediately following the presentation of the last paper, a brief business session was held at which matters of interest to the members were discussed and, upon recommendation of the nominating committee composed of Messrs Stow, Pegau and Sniffen, the following officers were elected for the next year: Dr. E. C. H. Lammers, Chairman; Dr. R. S. Edmundson, Vice-Chairman, and Wm. M. McGill, Secretary. Dr. Lammers was elected as the representative of the Section on the Editorial Board of the VIRGINIA JOURNAL OF SCIENCE.

Promptly at 4:10 P. M. the regular meeting of the Section was adjourned and the members and guests proceeded to the Auditorium of Nichols Engineering Hall, where at 4:15 P. M., a special talk on "Continental Displacement and Its Relation to the Origin and Dispersal of the American Floras," by Dr. W. H. Camp, of the New York Botanical Garden, arranged for a joint meeting of the Sections of Biology and Geology, proved one of the high-lights of the annual meeting. Dr. Camp's talk was concluded about 5:30 o'clock.

SATURDAY, MAY 4—8:30 A. M.

On Saturday morning, May 4, 32 members and guests of the section assembled at the Limit Gates and left at 8:30 A. M., in automobiles, for a geological field trip in the Buchanan-Cove Mountain-Jennings Creek area, under the leadership of Drs. Roy J. Holden and Edward Steidtmann. The trip was without question one of the most interesting field trips ever made by our group. An even dozen "stops" were made to permit members of the party to examine the excellent exposures of Cambrian and pre-Cambrian formations, contacts, structures, and the interesting structural, metamorphic and petrographic characteristics and relations of the various formations and beds exposed in the area visited. A mimeographed outline of the trip prepared by the Field Trip Committee and a Columnar Section prepared by Dr. Holden, who, as Leader explained the features and points of interest at each "stop", contributed to the success of the trip, and permitted the trip and "stops" to be made on scheduled time. A picnic lunch at the Middle Creek Picnic Shelter was an enjoyable feature of the trip and offered opportunity for additional discussion and comments on some of the "high spots" of the trip. After crossing New River on the Indian Rock Ferry the trip was concluded at the intersection of the Indian Rock Ferry road and the Lee Highway, about 4 P. M.

WILLIAM M. MCGILL, *Secretary.*

Minutes of the Section of Medicine

C. C. SPEIDEL, *Chairman*
GUY W. HORSLEY, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

1. The Relation Between Birefringence and Contractile Power of Atrophied and of Hypertrophied Muscles.

   Ernst Fischer; *Department of Physiology and Pharmacology, Medical College of Virginia.* (Lantern, 10 min.)

In denervated rat gastrocnemii, the loss in total contractile power corresponds at first to the loss in weight, and only after about ten days the power loss starts to surpass distinctly the weight loss. However, throughout the whole course of atrophy the specific birefringence of the muscle fibers parallels the contractile power per weight unit. Appropriate electrical treatment of the denervated muscles can retard the weight loss, but the loss in birefringence and in contractile power per weight unit is not essentially affected by the treatment. Electrical training of normal rat gastrocnemii increases their weight and their total power, but does not alter their contractile power per weight unit or their specific birefringence. The importance of the integrity of the untramicroscopical structure of the muscle for its contractile mechanism is discussed.

2. Effect of Food on the Serum Esterase of Rats.

   J. C. Forbes, E. L. Outhouse and B. E. Leach; *Department of Biochemistry, Medical College of Virginia.* (15 min.)

The oral administration of non-lipid foods (glycerol, sucrose, glucose and proteose-peptone) has no demonstrable effect on the serum esterase. The administration of neutral fat, oleic acid and palmitic acid leads to a marked rise in esterase activity which persists for several hours.

3. A Rapid and Accurate Method for the Determination of Total, Free and Ester Cholesterol of Blood and Serum.

   B. E. Leach, E. L. Outhouse and J. C. Forbes; *Department of Biochemistry, Medical College of Virginia.* (10 min.)

Total cholesterol is determined colorimetrically by application of the Liebermann-Burchard reaction to the doucil-chloroform extract of the blood or serum. Ester cholesterol is determined by the same colorimetric procedure after removal of the free cholesterol as the digitonide. Free cholesterol is obtained by difference.

4. A Study of the Methods of Sterilization of Glasses and Eating Utensils Used in Public Eating Establishments, and a Solution to the Problem.

   A. F. Meyer, Jr.; *Sanitary Laboratory, Virginia Military Institute.* (30 min.)

A brief discussion of the history and importance of this prime public health problem is given, followed by the results of a summer's intensive

field research in the city of Shreveport, La., with a brief resume of the statistical data compiled thereat. (This portion of the paper will be for the most part the same as the author's report to the Louisiana State Board of Health.)

An intensive series of carefully planned laboratory tests have been run, on every phase of the problem. These have included investigation of the best number of glasses to be sampled by the inspector, the different types of sterilizing methods and their efficiency, and the probability of contamination after sterilization.

The best arrangement of sterilizing, cleaning and rinsing solutions in the three vat sink method has been determined. The use of ultra violet rays has been given consideration, and tests seem to indicate that they must be used with caution. Steam and boiling water also have been given consideration, and different chlorine compounds and cleaners have been used.

A study of hand contamination of glasses during the sterilizing process also has been made.

A new and somewhat radical departure in cleaning and sterilizing has been devised using hot water at 56 degrees Centigrade and a hypochlorite in a 200 ppm concentration.

5. The Effect of Fresh Aloe Vera Jell in the Treatment of Third Degree X-Ray Reactions on White Rats.

T. D. Rowe; *Medical College of Virginia.* (15 min.)

Aloe vera jell is a mucilaginous jelly-like material found within fresh Aloe vera leaf. Since 1935 there have appeared several articles on its clinical use in treating X-Ray reactions. No reports have been made on controlled experimental work with the jell.

This paper presents the procedure followed, and the results obtained in treating groups of white rats with the fresh jell. The rats had previously been irradiated with sufficient X-Ray to produce third degree reactions.

6. Sunlight, skin cancer, and cancer immunity.

Frank L. Apperly; *Department of Pathology, Medical College of Virginia.*

The apparent discrepancy between those who claim that skin cancer and the general cancer rates very inversely when different localities are compared, and those who claim a direct relationship between these two forms of cancer is shown to be a matter of climate. In hot climates the relation is an inverse one, in cold climates a direct one.

The total cancer mortalities of the various American states and Canadian provinces are shown to fall with increasing solar radiation and with the number of people exposed thereto, and is independent of the production of skin cancer. The fall of skin cancer with increased exposure in cool climates is merely one example of this general rule. In warmer climates, however, skin cancer may indeed rise in spite of the relatively increased general immunity, i. e., the production of skin cancer is not necessary for the appearance of general cancer immunity, as claimed by some observers, but is merely an occasional accompaniment.

Symposium on Jaundice

FRIDAY, MAY 3—2:00 P. M.

7. Hepatic Physiology.

R. J. Main; *Medical College of Virginia.* (20 min.)

The functions of the liver will be reviewed briefly, stressing those aspects which are involved in jaundiced patients. This will include the formation, excretion, and toxicity of bile pigments and salts, and the absorption of fats and lipoid-soluble vitamins.

8. Pathological Anatomy of the Liver in Jaundice.

James R. Cash; *Department of Pathology, University of Virginia.* (Lantern, 20 min.)

This will be a demonstration of the pathological anatomy of the liver in jaundice, illustrated by lantern slides and microphotographs.

9. The Clinical Aspect of Jaundice.

Walter B. Martin; *Norfolk, Virginia.* (30 min.)

Source of bilirubin in the blood. Normal and pathological levels. Clinical conditions associated with overproduction of bilirubin. Classifications of jaundice. Regurgitation of bile into the blood stream. Differentiation of obstructive lesions from intrahepatic injury. Relative value of history, physical examination, and laboratory procedures. Application of our present knowledge to the differential diagnosis of jaundice and its treatment.

10. Laboratory and Hematological Diagnosis of Jaundice.

J. H. Scherer; *Medical College of Virginia.* (20 min.)

Discussion of laboratory procedures used in the diagnosis of liver disease and jaundice, with special reference to recent work on the value of the study of the blood smear.

11. Surgical Treatment of Jaundice.

Holcombe H. Hurt; *Lynchburg, Virginia.* (30 min.)

Fifty per cent or more of the cases of jaundice encountered are benefited by surgery. The pre-operative care in these cases is as important as the operative procedure. Post-operative care is a continuation of the pre-operation preparation. The main types of surgical jaundice with the operative procedures best designed to relieve that type are discussed.

GUY W. HORSLEY, *Secretary.*

Minutes of the Section of Psychology

RICHARD H. HENNEMAN, *Chairman*

WILLIAM M. HINTON, *Secretary*

FRIDAY, MAY 3—10:00 A. M.

The Psychology Section held two sessions on Friday, May 3, in Room 11, Scott Shipp Hall. The morning session was consumed with the reading and discussion of the papers abstracted in the program below. The members of the Psychology Section were fortunate in having Dr. S. H. Britt of the Department of Psychology at George Washington University, deliver a stimulating address, "Looking Ahead in Social Psychology", as the feature of the afternoon session. Attendance at both sessions was good, there being approximately thirty persons present for the reading of the papers in the morning and more than thirty for Dr. Britt's talk in the afternoon.

At the business meeting a motion authorizing the chairman to appoint a committee to investigate the status of clinical psychology in Virginia, was made and passed. At the proposal of the nominating committee the following officers were elected for 1940-41:

Chairman, William M. Hinton,
Secretary, Evelyn Raskin,
Editorial Board Representative, Richard H. Henneman.

1. The Measurement of Optimistic and Pessimistic Attitudes.

D. M. Allan and R. P. Barrell; *Hampden-Sydney College.*

To test the hypothesis that optimism and pessimism are generalized mental sets or tendencies to take a favorable or unfavorable view of present and future situations, a series of experimental forms of the opinionaire type was developed. These yielded two revised forms A and B, each consisting of 60 statements about current trends in economic, political, social, educational, medico-physical and religious affairs to be marked (+) or (—) by the subjects according to their agreement or disagreement. These forms appear to be empirically diagnostic of two radically opposing attitudes of a fairly high degree of consistency. Form B gives a split-half reliability of .82±.024, when corrected by the Spearman-Brown prophecy formula and the two forms yield a correlation of .70±.032 with each other. The scores of 102 college upperclassmen show a double-J curve distribution.

Optimistic scores give a negligible correlation of .003 with agreement scores and a positive correlation of .024±.055 with conservatism scores on the C-R Opinionaire. The optimistic quintile are less "neurotic", more "self-sufficient", more "extrovertive", more "self-confident" and more "soci-

able" than the corresponding pessimistic quintile. Of these differences, only those showing superior extroversion and sociability appear to be significant. There is evidence to support the view that what is measured here is "theoretical optimism" as opposed to "personal optimism" (optimism about one's own affairs).

2. Spontaneous Alternation of the White Rat in Running and Jumping Situations.

M. M. Jackson; *University of Virginia.* (15 min.)

The phenomenon of spontaneous alteration in white rats has been investigated by Dennis for a variety of maze situations. It was found that when rats were given two equidistant paths to food that on the second trial the rats tended to avoid the path previously taken. The present experiment was designed to see if this type of behavior was also shown in jumping situations.

A group of rats trained in the Lashley Jumping apparatus were allowed to make two successive jumps. The distance from the jumping stool to either the right or left aperture of the apparatus was equal and the animal was rewarded with food regardless of the direction of the jump. Instead of showing alternation between the second and first trials, position habits were established from the outset of training.

To see if the same rats would show alternation when running they were tested on the hollow square maze used by Dennis. In this situation animals, given two consecutive trials, alternated well above chance expectation. Since these differences in behavior were so striking, a Y-type maze was arranged so that jumping and running could be observed on the same apparatus. In order to obtain jumping on the Y-apparatus, the arms were moved, maintaining the same angle, 15 cm. from the starting block. Both the running and jumping procedures were repeated for a long series of trials. It was found that all the animals immediately set up position habits in jumping. In running, although all the rats initially showed alternation, with the interposition of the jumping trials, the alternation behavior dropped to the chance level or below.

3. A Simple Apparatus for Pattern Learning Experiments.

John M. McGinnis; *Hollins College.* (10 min.)

The construction of the apparatus will be described and its use briefly demonstrated. It can be used for experiments involving the learning of any of a large number of different patterns and hence should have various uses in the laboratory. It has advantages over, and can be substituted for, the bolt head type maze; and is very convenient for experiments on the deduction of hidden patterns, or on memory for patterns.

The apparatus is simple in principle and can be relatively easily and inexpensively constructed. Right and wrong responses are recorded as small and large perforations on sheets of paper. Patterns can be changed with a minimum of time and effort. More complicated modifications of the apparatus, which permit electrically controlled signals to accompany the right and wrong responses will also be described and demonstrated.

4. Time Measures of Individual Differences in Vision.

F. G. Tice; *University of Virginia.* (15 min.)

Under controlled experimental conditions wide individual differences in fusion frequency often appear. The factors responsible for these differences are at present undetermined. The variation seems to be unrelated to differences in retinal sensitivity as measured by the absolute limen or by visual acuity. Nor does it seem to be consistently related to either of the co-variables which have been hypothesized: chronological age and perseveration as measured by ideo-motor tests.

A method for measuring the fusion frequencies of a large number of subjects is briefly described. Methods are presented by which measures of initial-lag and after-lag may be obtained from the same subjects. It is postulated that, should individuals having fusion frequencies above or below the average also show consistent deviations from the average with respect to either of the other measures, some light will be thrown on the factors responsible for individual differences in fusion frequency.

5. The Effect of Changing Skin Temperature on Vibratory Sensitivity.

Joseph Weitz; *University of Virginia.* (15 min.)

Intensity thresholds were taken on a number of "spots" using as a stimulus a vibrating needle. Warming the area by means of a radiant heat source and restimulating the same "spots" it was found that with increasing temperature there was a decrease in the intensity threshold up to a certain point beyond which there was a subsequent rise in vibratory thresholds. Repeating the procedure, but substituting "radiant cold" for the warming it was found that with increasing cold there was a concomitant rise in the vibratory thresholds. Temperature of the skin area in question was obtained by means of a thermocouple. An attempt is made to interpret the results on a basis of chemical mediation of sensation.

6. Estimating Behavior and Interests from Photographs.

Charles M. Harsh; *Randolph-Macon Woman's College.* (15 min.)

Evidence as to the value of estimates of personal characteristics from still photographs has not been conclusive, owing in part to lack of control of pose or clothing in photos, to the small number of categories rated, or to the use of vague trait names rather than recognizable behavior tendencies. Attempting to overcome these limitations the present investigation utilized twenty full-face photographs of Harvard College men, photographed for a year-book, with similar rapport and instructions to "look natural". No collar or clothing showed. The photographed subjects were rated by their four closest friends (living in the same college hall) as to possession of twenty-one behavior tendencies, and also as to their main vocational interests. The judges, sixty-seven sophomore college women, were asked to estimate from the photographs the presence or absence of the same twenty-one behavior tendencies in each of the subjects. Later they guessed the vocational interests of the subjects. Ratings repeated three weeks later indicate the reliability of certain of the judgments.

Several statistical measures are presented to estimate "chance" success, and to justify the distinction of good and poor judges. The possibility that consistent stereotypes might produce successful judgments is considered. Evidence as to social experience and familiarity with men is considered in attempting to explain the success of good judges.

7. The Influence of Information on Changes in Racial Attitudes.

Evelyn Raskin; *Randolph-Macon Woman's College.* (15 min.)

The degree to which factual information or knowledge affects changes in racial attitudes was determined by giving a modification of the Bogardus and Likert attitude scales to approximately 200 college freshmen before and after attendance at a scientific symposium on "race".

Changes in attitude test score for the experimental group will be compared with those for a control group who were not exposed to the symposium material. The results of personal interviews used to determine the factors which are related to amount of attitude change shown will also be presented.

8. Isolated Children and the Fixity of Early Habits.

Wayne Dennis; *University of Virginia.* (15 min.)

So-called "wild children" have been reported for centuries. Within recent years new cases have been described by Squires, Kellogg, Foley and others. Some writers have cited the records of wild children as showing that if the individual is isolated from society for a certain critical period in early childhood, he shows permanent effects of this lack of early socialization. This theory of the permanence of early social habits is examined with reference to the literature on wild children and other isolated children, with relation to information about individuals born both deaf and blind, and with regard to data concerning the fixity of early habits in persons of normal social experience. The conclusion is reached that habits formed in early childhood have no greater fixity than do habits formed in later periods.

FRIDAY, MAY 3—2:00 P. M.

1. "Looking Ahead in Social Psychology."
   S. H. Britt; *George Washington University.*
2. Informal discussion of Dr. Britt's address by members of the Section.
3. Business Meeting.

WILLIAM M. HINTON, *Secretary.*

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Photography As A College Course

J. D. SCHUMACHER

INTRODUCTION

Photography, literally defined — to draw by light, and so named by Sir John Herschel many years ago, is now an important tool in science and industry not to mention its usefulness as a hobby. This ever increasing popularity in photography has opened up new fields of thought and study and leads one to ask the question, Should photography be included as a course in the college curriculum?

No one will deny that recent years have brought added interest and enthusiasm for photography from amateur and professional alike. In England, it is estimated that there are more people using cameras than there are driving automobiles, that one person in every eight of the King's subjects uses a camera of some kind.[1] In this country, the increased consumption of photographic materials shows that we are also becoming camera conscious.

Every enthusiastic photographer will have his own explanation for this increased popularity in the art of photography, but only a few such reasons need be mentioned here. First, and foremost in the mind of the average person, is the fact that photography is utilized to a greater extent today by all forms of the press than ever before. Newspaper accounts and magazine articles are accompanied by many pictures for the sake of illustration. Some readers may even say these photos are so numerous as to be distracting. Be that as it may, photography is taking a definite place in the journalism of today. Secondly, the enthusiasm for photography has grown because of an improvement in photographic technique. The cumbersome photographic operations of fifteen or ten years ago have been replaced by shorter and less troublesome steps. And it should be added further, the goal in photographic workmanship is far from being reached, for new methods and ideas are rapidly being formulated and are coming into popular usage. As a third stimulus for added interest, photographic equipment and materials have been greatly improved to keep step with the modern photographic technique already mentioned. Camera styles have been changed to match

the speed and streamlining of other modern equipment. The appearance of the miniature camera has served to enlarge the photographic field of equipment. Modern films are finer grained and faster than ever before. Color films and prints in color are added attractions for the photo-enthusiast, but one must admit that they necessitate greater financial resources. The movie industry has grown and has demanded photographic equipment unheard of a few years ago. And finally, the possibilities of photography in other fields of science and learning have helped to make it more prominent. Visual and audio-visual methods used in modern education are only two applications that might be mentioned here. For these and other reasons, we must prepare the way for further accomplishments of photography in the future.

Should we as educators include photography as a subject to be taught in a curriculum already crowded? In answering this question, we should consider the problem from the standpoint of the College, and also from the viewpoint of the student taking such a course as a part of his college education.

The Position of the College

The teaching of photography in the college or university has been practiced by a few institutions for some time.[2] Several very fine articles have appeared in the literature dealing with the organization of such a course.[3] A brief course in photography has also been included in some high schools as an elective study for juniors and seniors.[4] In many cases, although photography is not offered as a credit course, the student has an opportunity for photographic work through the agency of a school camera club. This serves very well in many instances since few students intend to follow photography as a vocation. In some schools, the student is introduced to photography by taking pictures for the school yearbook or paper. A few colleges and universities maintain their own publicity departments and do not rely on newspaper photographers for their publicity pictures.[5]

Regardless of the method used in educating the student photographically, certain questions will arise in his mind concerning various fundamental photographic problems. These questions invariably lead back to an understanding of physics or chemistry, since photography is based on the former science to produce the image, and the latter science to retain the image in a permanent way. The student should, then, have some knowledge of:

1. The phenomena of light as studied in elementary physics, and
2. Basic chemical information concerning photographic processes.

It is advisable, therefore, that a course in photography be taught

in either the department of chemistry or the department of physics. If that is not possible, instructors in these departments should at least assist in the teaching of the subject. By way of caution, it should be pointed out that if the course is taught in the department of physics, the instructor is very apt to emphasize the importance of his particular field in photography. Similarly, the instructor in chemistry will have the tendency to stress the chemistry of photography. Consequently, certain reservations should be kept in mind by the instructor regardless of his chosen field. Some educators have even suggested that a course in photography should really be taught in three college departments, i. e., chemistry, physics, and fine arts.

However, the average chemist has had enough training in the physics of light to be able to instruct the student thoroughly in the practical side of photography. And many chemists are artistic enough to provide the necessary instruction in photographic composition and lighting. In other words, the teaching staff of the average college already has the necessary man power for instruction in photography. Nevertheless, very few colleges are including photography in their curriculums. In 1930, E. W. Maphis writing in *American Photography* estimated that there were only four colleges in the United States offering courses in photography that could compare with similar courses as presented in the better trade schools.[6] The number has undoubtedly increased since that time, but no definite figures can be given by the New York office of the Association of American Colleges as to the number of colleges teaching photography at the present time. Since a survey of all institutions of higher learning in the country was practically impossible, the writer decided to make a survey of all colleges located in one state. The results show that in the twenty colleges in the state of Virginia, only five, or 25%, offered a course in photography in 1939. One other college planned to start such a course this year, but even so, the percentage remains unquestionably low. However, eleven of these same colleges, or over 50%, acknowledged that they did have some sort of dark room facilities available. The results of similar surveys in other states may or may not lead to the same conclusion as illustrated by the state of Virginia.

Many college administrators, when confronted with the question of including photography in their curriculums, will put the issue aside, stating that the expense involved is too great. Actually, photography may be expensive as a hobby, or it may be practiced in such a way as to fit any pocketbook. Similarly, a one-semester course in photography can be run economically in the college budget, or it may be lavishly expounded. The dark room is not complicated in its construction and requires no skilled labor for its erection. The equipment can be purchased

or it may be put together in the college workshop, depending on the needs and the funds available for this purpose. The following diagrams, Figures 1, 2, and 3, suggest several dark room arrangements utilizing different floor areas and equipment. For the most part, the dark room can be equipped from year to year, thereby distributing the burden of expense. The student fee for the purpose takes care of the films, chemicals, depreciation, etc.

The content of the course in photography may be altered according to the needs of the college or of the department in which it is given. In the survey of Virginia colleges already mentioned, photography was offered by the departments of biology, physics and chemistry, art, architecture, and journalism in as many different institutions. Fortunately, photography is flexible and adaptable enough to be changed to fit the needs desired in any of these fields of learning. This fact makes photography even more attractive to the small college.

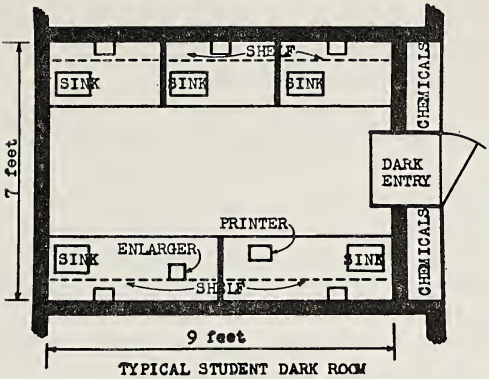
The Position of the Student

Let us now consider the student's viewpoint relative to the question, Should photography be included in the college curriculum? The student himself will probably ask, Is photography an interesting subject to study? Will photography prove to be of any practical value to me after I have studied it? And finally, Is the study of photography very hard?

To answer the last question first, the study of photography like that of any other subject, can be made difficult or it can be presented in a simple way. A comprehensive and detailed treatise on photography will present study problems similar to those in any other science. However, a one-semester course in photography must be brief because of the time element, and therefore

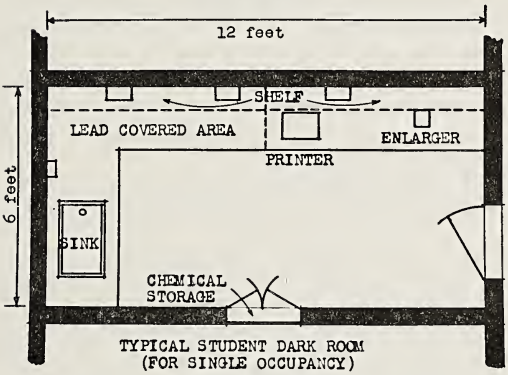
LECTURE SUBJECT MATTER IN PHOTOGRAPHY

1. General Subject Material
   - History of Photography
   - Practical Applications
   - Photo. Laws & Customs
2. Optics in Photography
   - Light
   - Types of Lenses
   - The Camera
3. Photographic Films
   - Types of Emulsions
   - Exposure
   - Orthochromatics
4. Processing the Film
   - Darkroom Equipment
   - Chemistry of Development
   - Chemistry of Fixation
5. Photographic Printing
   - Types of Printing Paper
   - Contact Printing
   - Projection Printing
6. Misc. Photographic Material
   - Composition & Lighting
   - Color Photography
   - Movies



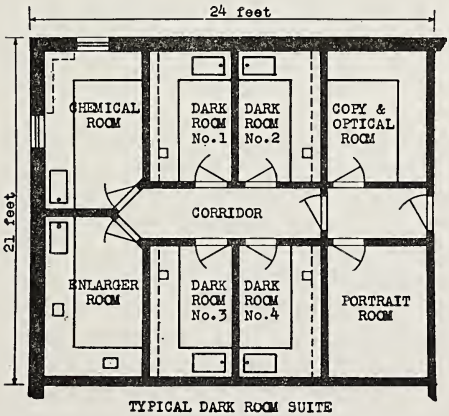
TYPICAL STUDENT DARK ROOM
(FOR MULTIPLE OCCUPANCY)

FIGURE 1.



TYPICAL STUDENT DARK ROOM
(FOR SINGLE OCCUPANCY)

FIGURE 2.



TYPICAL DARK ROOM SUITE

FIGURE 3.

simplicity must be practiced in organizing the subject material. The following lists suggest typical lecture topics and laboratory experiments for a one-semester course:

LABORATORY EXPERIMENTS IN PHOTOGRAPHY

1. The Pinhole Camera.
2. Lenses—Focal Length.
3. Check Student Cameras.
4. Prepare Solutions.
5. Exposure Latitude.
6. Film Processing.
7. Contact Printing.
8. Projection Printing.
9. Reduction: Intensification
10. Copying.
11. Lantern Slides.
12. Composition.
13. Lighting: Portraits.
14. Color Photography.
15. Individual Projects.
16. Individual Projects.

Both lecture and laboratory material should be kept fundamental and some instructors feel that if the student can successfully carry out the operations of photographic developing and printing, he has derived sufficient benefit from the course. At any rate, the primary emphasis should be on the fundamental photographic processes, and then, if time permits, a study of some of the side lights may be included.

There is a good selection of textbooks and references in photography, and the proper text may be chosen to satisfy the needs of the individual institution. The larger publishing houses usually have at least one such book to offer, and a complete list of photographic books is given by Miles J. Martin in *The American Physics Teacher* for April 1939. There are also a number of photographic periodicals suitable for student reference work. Several new photographic journals have started publication during the past few months, and one of these, *Collegiate Photographer*, first issued in November, 1939, is designed especially for the college student in photography. Another new periodical is technical enough in content to be used as a reference in advanced work.

Perhaps the best answer to the second question, Does photography have any practical value for the student, will come from college graduates who have taken the course themselves. The results of a survey of our students who studied photography during the four-year period from 1935 to 1938 inclusive, are as follows: Twenty-eight students registered for photography during this period, and of this number, seven are utilizing photography to gain all or a part of their remuneration. This means that 25% of the students taking photography during these four years have found practical value from the course in a material and financial way. Four of these graduates are staff newspaper photographers, one is working for a commercial photographer,

another graduate takes pictures of filling stations for an oil company, and one graduate has started a department selling photographic equipment and supplies in a store. Twenty of these graduates said they had received benefit from their course in photography as a hobby. The following quotations show a few of the comments made by some of these students regarding photography:

> "I find that it is of definite value and one of the really useful things that one can use after graduation."
>
> "Am planning to advance my Photographic Course by studying further at New York Institute of Photography."
>
> "The course furnished me a worthwhile and interesting hobby."
>
> "Your photography course started me on my life's work. Every journalism student should take this course."
>
> "Although not originally employed as photographer, that phase of the work has marked my progress. Am now staff photographer for the *Roanoke Times*."
>
> "This was one of my few college courses from which I derived an immediate tangible benefit."

When one stops to realize that each of the students mentioned worked only one semester in photography, and that he was really majoring in some other department, the results are even more surprising.

Little need be said regarding the last question, as to the interest aroused by photography in the minds of the students. Their willingness and eagerness to take pictures and to see their finished products is testimonial enough. At the beginning of the course, we usually have some difficulty in keeping students out of the dark room before they have had the necessary training, as they are eager to develop and print their own pictures. One reason for this interest unquestionably lies in the fact that the student can see an immediate result from his study and work in the dark room. It may be some time before he will actually utilize the data derived from some of his college courses, but in photography the results are forthcoming at once.

The college course in photography can be made more interesting by including individual student projects near the end of the course as suggested in the listing of the various laboratory experiments. This method has been found successful in several colleges offering short courses in photography.[7] The student majoring in biology will be interested in a project on photomicrography, the student of chemistry may desire to record photographically the results of certain experiments, and the physics or pre-medical student may want to try his hand at X-ray photography. The suggestion of an exhibit of prints or a print salon

may also serve to stimulate added interest in the course. The problem of student interest is not a serious one in photography, and the instructor will find his charges ready for library reading and other outside assignments in addition to the routine study required.

Summary

By way of summary, a course in photography is adaptable to the average college curriculum:

1. First, from the standpoint of the college
   a. Because the average instructor in chemistry or physics is qualified to teach photography,
   b. Because the expense is no greater than that of other laboratory sciences,
   c. And because photography may be taught in such a way as to fit the requirements of the institution.

2. And secondly, it is adaptable from the viewpoint of the student
   a. Because photography makes an interesting subject for study,
   b. And because photography has been found to be of definite practical value.

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Roanoke College.

Studies on the Turbellarian Fauna of the Norfolk Area. V.

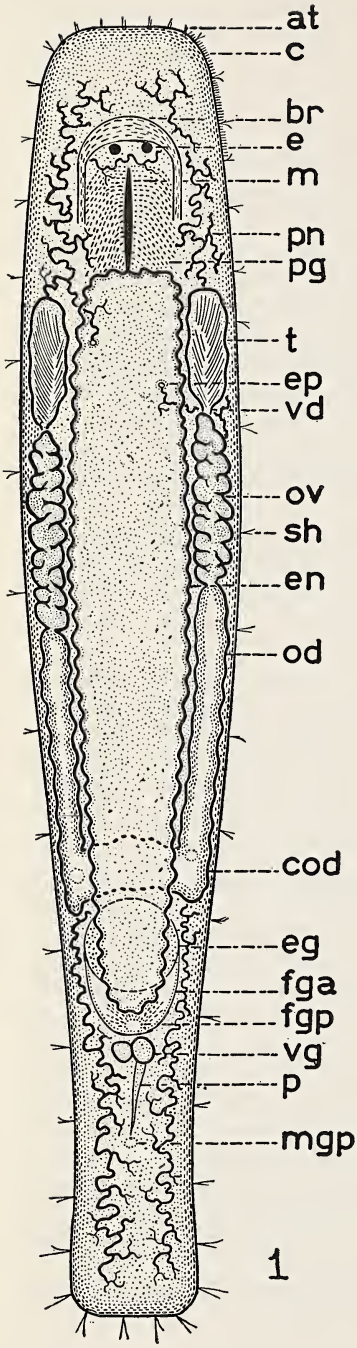
Anatomical Notes on the American Representative of Macrostomum orthostylum Braun 1885

FREDERICK F. FERGUSON AND E. RUFFIN JONES, JR.

Macrostomum orthostylum was first taken from the flowing fresh waters of Dorpat (Tartu) Estonia by Braun in 1885. Meixner (1915) also reports its occurrence in the fresh water lakes of the eastern Alpine country. It is now reported from fresh water pools in Williamsburg, Virginia and from flowing fresh water streams in the Norfolk area. It is associated with green algae, copepods, protozoans, and other Turbellaria. A cotype of this species is deposited in the U. S. National Museum as No. 22684. All anatomical measurements used are average figures.

Description[1]—Sides of the slender dorsoventrally compressed body (Figure 1) subparallel for the great part of the length of the animal, no lateral indentations, caudal region without spatulation, delimited by slight gradual depressions; body colorless except for black eyes and enteric inclusions; total length up to 1.1 mm. Epidermis of flat, roughly pentagonal cells bearing an even coat of cilia (5 μ long). Rhabdites (Figure 2) in packets of 7 to 10 fairly numerous on dorsum, relatively sparse on ventrum, posterior caudal rim of rhabdites prominent; "Rhamitten" sparse, no "Rhabditenstrassen"; closely packed ovoidal "Stabchen" in floor of female genital atrium radial to female gonopore (Figure 1, *fgp*). No "Haftpapillen". Sensory hairs (Figure 1, *sh*) very long postero-laterally (82 μ), frequently single laterally, arranged in short tufts anteriorly (Figure 1, *at*), no epidermal spines. "Brain" (Figure 1, *br*) crescentic, lacking median indentation at commissure, longitudinal nerve cords readily observable anteriorly. Eyes paired (15 μ in diameter), closely attached (Figure 4) at dorso-posterior part of "brain"; pigment material of eye extremely small and amorphic. Mouth median ventral (Figure 1, *m*) limited by ciliated lips. Pharyngeal glands (Figure 1, *pg*) weakly developed but extensive in latero-posterior direction. Enteron dorsal (Figure 1, *en*) saclike, laterally indented, ciliated, extending almost to female gonopore. Excretory system (Figure 1, *pn*) of paired latero-ventral main-stems extending almost from one end of body to the other, no commissures observable, but with extensive lateral branching in cephalic

[1]A part of the expenses entailed in the collection of this material was met by a grant from the Virginia Academy of Science.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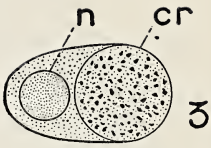
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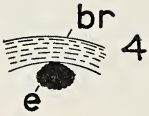
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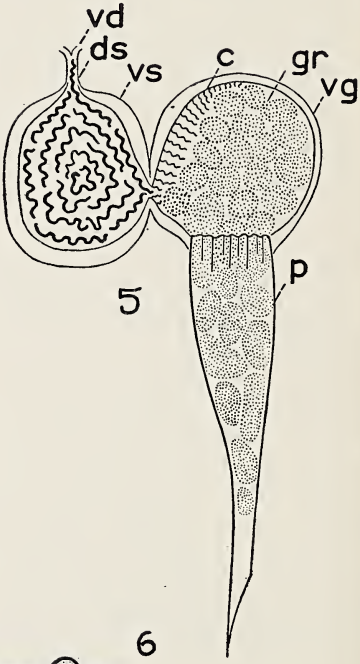
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region (Figure 1), external openings paired, dorsal and variable in nature near and median to testes (Figure 1, *ep*). Testes compact (Figure 1, *t*) roughly obovate, smooth walled, located latero-ventrally and only slightly posterior to anterior end of enteron. Vasa deferentia (Figure 1, *vd*) extend latero-posteriorly from each testis to posterior end of enteron, there uniting to produce ductus seminalis (Figure 5, *ds*). "False" vesicula seminalis not observed. Vesicula seminalis (Figure 5, *vs*) a contractile spheroidal organ of small volume (20 μ diameter). Entrance from vesicula granulorum to vesicula seminalis guarded by a sphincter. Proximal portion of vesicula granulorum ciliated (Figure 5, *c*), distal portion and genital canal of penis-stilette usually filled with ovoidal packets of granular material (Figure 5, *gr*); vesicula granulorum is relatively thin walled. Penis-stilette (Figure 5, *p*) entirely straight, thin walled, terminus sharply pointed, opening terminal, length 57 μ. Male gonopore (Figure 1, *mgp*) relatively distant from posterior tip of body. Mature sperm cells (Figure 6) highly mobile, 28 μ long unextended, divided into tail, body, and feeler regions with highly refractive unit in body region, without "Nebengeisseln". Female genital system typical for genus with exception of extreme posterior position of female gonopore in ventral floor of female genital atrium (Figure 1, *fgp*).

Species Diagnosis.—Body slender, color white to gold, various gradations in rhaboids, with or without "Haftpapillen" in tail region, penis-stilette elongate straight funnel shaped (length up to 142 μ), opening oval at very sharp terminus, mature sperm cell without "Nebengeisseln", ovaries heavily indented, body length up to 2.4 mm, distribution fresh waters of Estonia, Switzerland, and United States, cotype U. S. N. M. No. 22684.

Remarks.—This paper records the occurrence of *Macrostomum orthostylum* Braun in the United States for the first time. An advantage was taken of this opportunity to contribute anatomical notes upon the form and especially to present information and a drawing upon the gross anatomy. The morphology of the penis-stilettes of the American and European forms is practically identical, while there is a marked difference in size.

Legend to Text-figures

1. *Macrostomum orthostylum.* Dorsal aspect of gross anatomy in optical section. x 137.

at—anterior tufts of sensory hairs
br—"brain"
c—cilia
cod—common oviduct
e—eye
m—mouth
mgp—male gonopore
od—oviduct
ov—ovary
p—penis stilette
pg—pharyngeal glands

eg—egg
en—enteron
ep—excretory pore
fga—female genital atrium
fgp—female gonopore
pn—protonephridia
sh—sensory hairs
t—testis
vd—vas deferens
vg—vesicula granulorum

2. *Macrostomum orthostylum.* Packet of rhabdites. x 222.

3. *Macrostomum orthostylum.* Parenchymatous, concrement bearing cell. x 1000.

cr—concrement
n—nucleus

4. *Macrostomum orthostylum.* Diagram showing relation of eye to "brain". x 295.

e—eye
br—"brain"

5. *Macrostomum orthostylum.* Male sex apparatus. x 895.

c—cilia
ds—ductus seminalis
gr—packets of granules
p—penis stilette
vd—vas deferens
vg—vesicule granulorum
vs—vesicula seminalis

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Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula

Ernest W. Sniffen

The abundance of material ranging from pebbles to boulders, among which those classed as cobbles are especially conspicuous, that is encountered along the beach of Chesapeake Bay in Elizabeth City County, Virginia, prompted the preliminary study, here outlined, of the types of rock and of the localities represented.

The illustration, which shows the beach near the abandoned Back River Lighthouse, north of Grandview, gives an idea of the conditions at this point. The area studied falls within the lowest Pleistocene terrace designated as the Princess Anne by Wentworth,[1] the Talbot by Clark and Miller,[2] and the Pamlico by Stephenson.[3]

Figure 1

There is little doubt that these cobbles have the adjacent terrace as their immediate source. All rivers in the lower part of the Coastal Plain of Virginia are sluggish tidal estuaries, not competent at the present time to transport any but the finest sediments. Shallow dredging in the Recent terrace, on bars and in stream beds, brings up little but mud and sand. On the other hand, coarse material is present in varying amounts throughout the Princess Anne terrace, and the rock types correspond to those found on the shore. Naturally the cobbles are exposed in greater quantity in the vicinity of streams, where feeble erosion has revealed them by the removal of finer sediments. They are especially large and abundant in certain sections, as in the area

between the two main branches of Back River. A pipe trench recently dug along the Back River Road west of Langley Field revealed the Pleistocene resting directly on the Miocene at about six feet below the surface, which here is at about the ten foot contour line. At the base of the Pleistocene is a band of numerous large cobbles up to a foot in diameter. Most of these are well rounded but some are decidedly angular. One quartzite boulder preserved a typical slickensided surface. Subangular forms are common, but no definite glacial-type striations were observed.

The abundance of the cobbles on the beach near Grandview is accounted for as concentration by wave action during the encroachment by the sea on the land. In the illustration the rapidity of this shore erosion is shown by the tree stumps standing below normal high water mark. The extensive flats off shore at this point, known as the Horseshoe, appear to represent former land planed off by wave action.[4]

The prevalence of certain types of rock represented by the cobbles is conspicuous. Naturally they are chiefly the harder and more resistant rocks. However plentiful limestones, shales and similar rocks may have been originally, they could not survive the extensive reworking to which the formations have been subjected.

The table is a classification of the rocks most frequently encountered. The proportional quantities given are merely based on a rough estimate, and more detailed study would doubtless result in considerable revision.

TABULATION OF COBBLES

Item	*Rock*	*Est. % of all*	*System*	*Formation*	*Province*	*Probable locality*
1	Quartzite (Scolithus tubes common)	75	Lower Cambrian	Largely Erwin	Blue Ridge (Valley side)	Rockbridge County
2	Quartz	10	Not distinctive			
3	Greenstone (conspicuous amygdules of quartz and epidote)	2	Pre-Cambrian	Catoctin	Blue Ridge	Madison County
4	Chert	2	Cambrian	Shady dolomite or Watauga shale	Valley	Rockbridge County
5	Arkosic sandstone	2	Triassic	Manassas (Newark)	Piedmont	
6	Quartz with chlorite-sericite schist	1	Pre-Cambrian		Piedmont	
7	Fossiliferous sandstone	Rare	Devonian	Oriskany	Valley Ridges	Botetourt County
8	Anorthosite with blue quartz and rutile	Rare	Pre-Cambrian	Intrusive in Lovingston granite gneiss	Piedmont	Nelson County
9	Limestones and shales	0	Absent			
10	All others	8	Sandstones and conglomerates; feldspathic and micaceous rocks (much altered); some hornblende schist and basalt			

The table indicates the predominance of quartzite and quartz as would be expected. The quartz, and much of the quartzite, is not sufficiently distinctive in type to permit of assigning the source even approximately. Considerable of the quartzite, however, is a hard light colored rock with numerous scolithus tubes like much of the Erwin.[5] Megascopically it is exactly like the Erwin at the point where the James cuts through the Blue Ridge at Balcony Falls and this general locality would be a probable source.

The quantity of Item 3 may appear greater than is actually the case, as its color makes it conspicuous. The greater part of it bears so striking a resemblance to the greenstone along the Skyline Drive in Madison County as to make that general region the probable source. It is very resistant rock even against the action of seawater.

The chert, Item 4, was probably derived from the Cambrian dolomites of the Valley Ridges, though some may be from lower Ordovician rocks.

Items 5 and 6 are doubtless Piedmont rocks but their source is otherwise indefinite.

The Devonian fossils and other characteristics of the two specimens of Item 7 which have been found place them in the Oriskany, as confirmed by Dr. R. S. Edmondson. The only other fossils found are Miocene from the Yorktown, and undoubtedly of recent transportation.

Item 8 is rare, but three or four specimens have been found. Its distinctive type seemed to place it at once, and Dr. Clarence S. Ross, after examining a thin section, stated that not only could he identify it as coming from the Nelson County rutile-anorthosite, but he would almost be willing to localize it even more definitely. The feldspars in the specimens of this rock are quite fresh, which would suggest late transportation, perhaps Pleistocene ice-rafting as mentioned below. There are some feldspathic cobbles, chiefly it would seem derived from Piedmont rocks, but they are usually much altered and difficult of identification.

The contrast in size between these beach cobbles and the prevailing fine materials of the Coastal Plain arouses speculation as to whether or not the former have a different history than the balance of the sediments. That this is true of a portion of them is believed by those who have supported the theory of ice-rafted boulders of glacial type deposited erratically from Sunderland to Dismal Swamp time.[1,2] These are not as readily recognized along the shore as in the stream valleys near the Fall Line, since the best criterion, that of glacial striae, would be lost in comparatively brief milling by wave action. However, other indications are not lacking, such as exceptional size and faceted subangular forms, and to these characteristics might be added the unusual freshness of the feldspars in a few specimens.

Ice-rafting has doubtless played a part in the transportation of the cobbles, but to what extent is conjectural. It is probable that the great bulk of the coarse material has gradually moved across the Coastal Plain as the formations were worked and reworked, and their considerable size bears witness to the transporting capacity of even weak rivers working together with wave action.

As to the part played by the different rivers, the major role of the James is evident. The James had its course across the Piedmont and out onto the edge of the Coastal Plain established in the Cretaceous, and early in Pleistocene time followed approximately its present course across the Coastal Plain, though evidently not to its mouth.[2] The other rivers of Tidewater Virginia are, in part or entirely, consequent streams resulting from uplift after Chowan time, or in the case of the smaller streams, even after the Dismal Swamp terrace was formed.[1] It would follow that these streams probably played a lesser part in the transportation of the cobbles than others which are now non-existent.

If, as it appears, the finer sediments of the Coastal Plain terraces are composed mostly of the wreckage of the crystalline rocks of the Piedmont, and the coarser sediments are chiefly from the Blue Ridge and beyond, then most of the coarse materials have had a longer journey to their present resting place than has the bulk of the fine materials.

HAMPTON, VA.

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Soil Types and Their Significance in Agricultural Economy[1]

S. S. Obenshain

Although soils have been classified under some system or another since earliest times (1),[2] the system of classification as we have it today, has been developed during the past 40 years. In the early stages of its development the men assigned to the task of mapping soils and studying their relationships were trained geologists. It was, therefore, only natural that geology and the relation of geologic material to the soils was given major emphasis and that geologic nomenclature was largely used. In many cases, the soil maps and the geologic maps were almost identical. The geologic nomenclature has been so thoroughly stamped into the minds of soils men that it has been very difficult to get soil scientists to "cease and desist" using such terms as granite soils, limestone soils, etc.

With continued study and the development of soil classification, it became evident that soils which had developed over and from the same geologic materials were exceedingly different in many important characteristics. It was, therefore, evident that environmental factors were important influences in soil development. This new school of thought grew and ripened under the influence of certain soil scientists who were taking stock of the development of the field of soil classification in Russia where soil development seemed to be distinctly related to climatic influences. In fact some seemed to become over-zealous for the new school of thought, and began to minimize the influence of geologic material from which the soil is formed. As papers appeared in which the climate was over-emphasized, the geologist began to feel that soil scientists were becoming infected with a new malady which was influencing their clear thinking.

At present, it is rather generally agreed that the soil as a natural body is the result of the action of certain environmental factors on the geologic or parent material from which the soil is formed. The most important environmental factors responsible for soil formation are temperature, rainfall, topography, drainage or lack of drainage, natural vegetation and soil organisms. The extent to which the environmental factors have impressed themselves on the properties of the soil are dependent upon the relative development or age of the soil. Thus, a mature soil, or one in equilibrium with its environment, will have properties impressed upon it dominantly by environmental factors; while a young soil, or one still rapidly adjusting itself to environmental factors, has properties dominantly impressed upon it by

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[1]Paper presented before Section E, A. A. A. S., Dec. 29, 1938.
[2]Figures in parentheses refer to "Literature Cited", p. 294.

parent geologic material. Mature soils are formed only on gently sloping topography where environmental factors are permitted to exert their maximum effect. In Virginia, due to steepness of topography in certain areas, to restricted drainage under other conditions and in many other cases to resistance of geologic materials to weathering forces, the soils in general are closely related to geologic material.

Environmental factors affecting the development of mature soils place Virginia under the Gray Brown Podsolic great soil group which is common to states north of Virginia, and the red and yellow Podsolic great soil group which is common to states south of Virginia. Parent material, which exerts dominant influence on young soils, divides Virginia into the following physiographic divisions which are common to states north, south and west of Virginia: Coastal Plain, Piedmont Plateau, Blue Ridge Mountains, Limestone Valley and Upland, and Appalachian Plateau. Each of these large physiographic groups of soils has a wide adaptation to certain types of Agricultural Economy based on a wide or average adaptation of the soils and climate. Specific adaptations to different crops and management must be worked out for individual farms as well as field units on the farm.

For the purpose of this discussion, a soil type is considered as "a group of soils having similar differentiating characteristics, including texture and arrangement in the soil profile and developed from a particular type of parent material". The soil type is the unit of mapping which is given geographic expression when areas are definitely located on a soil map. The soil type is the unit of mapping and classification to which all agronomic data and technical soil studies are related.

Within any of the different physiographic divisions of the state a large portion of the soils have common characteristics which make the area suitable for certain types of farming. Also, the specific adaptations to definite soil types are the important things to the individual farmer who must make a livelihood from the soil. The Coastal Plain Province of Virginia, for instance, is characterized by a predominance of sandy soils. These soils, when one also considers the climate, are especially suited to the production of peanuts, cotton, vegetable crops and crops associated in their rotation. However, within this Coastal Plain area, there are larger areas of soils which are not suited to the above crops than there are of those which can be successfully used in their production.

For instance, in the Coastal Plain province, the soil development and resultant characteristics are dominated by internal drainage of the soil. The internal drainage is governed by the physical nature of the soil material and also by nearness of the water table to the surface. All of the crops mentioned above are

successfully grown only on soils which are naturally well drained or soils which have a coarse texture and are susceptible to artificial drainage. Where artificial drainage is necessary, the crop grown must have sufficient value to take care of the added expense. Only a comparatively small area is represented by the soil types which fall into the well-drained group, and a smaller area by the types falling into the group which are susceptible to artificial drainage. If land is not suited to the most common money crops listed above, what is the farmers' alternative? It should be to use the land for other purposes to which it is better suited. For instance, peanuts will produce best quality on Norfolk fine sandy loam and related soils. It has been found that peanuts produced on Lenoir and Bladen fine sandy loam give even higher yields, but the quality is far inferior. For the good of the individual farmer, as well as for the peanut industry, the land not suited for its use should be put into other crops. The Bladen and Lenoir, although not adapted to peanuts, vegetables and cotton, are far more fertile than the soils suited to these crops, and are much better adapted to the production of pasture, hay and corn if properly drained.

Taking the adaptation of soils to different uses as a foundation for a sound soil management program, the county agricultural agents in the Coastal Plain are now putting on a vigorous campaign to get the areas of different soil types into their proper use. Specific rotations of crops suited to different groups of soils have been worked out so that the farmer can have a sequence of crops on any of the important soils which are suited to crop production.

Agricultural men, including farmers, realize that the foundation of an economically sound agricultural farm program must be based on using the soil for the purpose to which it is best suited. Nevertheless it is almost impossible for a farmer to resist the temptation of going into the same type of farming or producing the same crops as a neighbor, who is unusually successful, even though his soils foundation is entirely different.

However, adapting our land to its proper use is not the only way in which soil type plays an important part in our agricultural economy. It has been clearly shown over and over again, that land suited to the production of the same crops has entirely different soil management problems. With increased competition, it is necessary that individual rigid economy be enforced in the production of any crop. Previous to our concept of soil types and their differences, it was the practice to make general management recommendations with the hope that they would cover all soil conditions, and then to disregard the loss from applying unnecessary fertilizing material to soils on which it was not needed. To emphasize this picture of soil type differences

requires a few specific illustrations. Hester (2) has shown that the plant food and reaction requirements for various coastal plain soils are decidedly different. He has shown, in contrasting three important coastal plain soils for the production of certain vegetable crops, that satisfactory yields of spinach could be obtained on Portsmouth loamy fine sand at pH of 5.0; while on Norfolk find sandy loam, the pH must be up to pH 6. For beets, the contrast was pH 5.4 for Portsmouth and 6.2 for Norfolk. If this difference in soil type requirement were not considered, it would mean a great loss either in the use of excess lime on Portsmouth or crop failure on Norfolk. The addition of extra lime to Portsmouth in order to bring it up to a pH of 6 would require approximately 7000 pounds or 3½ tons of a good quality of ground limestone per acre. Differences in plant food requirements are just as striking.

In the Piedmont plateau, the soils are essentially derived from crystalline rocks. The southern portion of the Piedmont is known as the bright tobacco belt of the state. In spite of the fact that the area is devoted principally to production of bright tobacco, there is a much larger area of soils not suited to the production of bright tobacco than of those which are so adapted. In Pittsylvania and Halifax Counties, the two leading bright tobacco counties in Virginia, the areas of good bright tobacco soils are approximately 17.7 and 11.7% respectively. However, this acreage is ample. The trouble comes from the fact that large areas of the soil types suitable to the production of high quality bright tobacco are used for purposes to which they are thoroughly unsuited, while large areas of soil types wholly unadapted to the production of bright tobacco are used for that purpose. Underwood (3), in some economic studies on tobacco farms in Pittsylvania County, Virginia, found some very significant facts in regard to proper use of soil types in the production of bright tobacco. He found an average of $78.00 more profit per acre on Appling sandy loam than on Madison fine sandy loam, or rather for 1933, the year of the survey, it was $78.00 less net loss. The same year the average sale price per pound of the tobacco was 15.9c per pound for that produced on the Appling soils and 8.34c per pound for that produced on the Madison soils. The return per hour of labor was approximately 20c per hour against 2c and the labor income on the farm on Appling was $244.00 per year more than on the Madison soils, where the annual labor income was $92.00 per year. These contrasts may seem extreme, but those who are familiar with the soils in question will recall that there are quite a number of soils in the same region which would rate below Madison for bright tobacco. The above figures should clearly indicate that growing bright tobacco on soils other than those to which it is suited is not a sound economic procedure.

The results of the use of commercial fertilizers on the same tobacco farms should be just as convincing. Underwood found that the use of commercial fertilizers in correct analysis and amounts tended to increase the labor incomes on the better soils, but this was not true on the poorer soils. In other words, commercial fertilizers would not overcome the handicap of a soil unadapted to its use.

In the realm of soil management, the following analyses (4) of some southern Piedmont soils should be of interest:

	Lbs. per acre (based on 2,000,000 soil)		
	Lime	Magnesium	Potash
Cecil Fine Sandy Loam—			
Topsoil	4,200	9,600	22,800
Subsoil	2,600	14,600	31,800
Iredell Loam—			
Topsoil	98,600	51,600	5,080
Subsoil	57,400	47,400	3,640

Experimental work in the field and greenhouse indicate that the problems on these soils are as different as the above analyses would indicate.

The Limestone Valley and Upland Province of the state is especially well suited to general farming and grazing. The silt loam soils developed over limestone are inherently fertile and produce blue grass and other palatable and nutritious pasture plants. Specific adaptation to smaller areas is governed by both soil conditions and topography of land. Large areas of soil types which would be suited to production of corn, small grain and hay, if on smooth relief, are relegated to pasture because of steep slope. In many other instances the adaptation is due to soil differences and not to slope. The following yields show clearly the difference in value of two soils for the same crops:

	Corn	Wheat	Clover
Berks Silt Loam	31.28 bu. (52%)*	17.04 bu. (70%)*	3,440 lbs. (70%)*
Dunmore Silt Loam	60.29 bu.	24.51 bu.	4,840 lbs.

These yields are from long-time rotation experiments on the two soil types.

It is evident that with Berks producing on the average of only 50% as much corn as the Dunmore, one cannot afford to use the former soil for the production of corn. On the other hand, the Berks produces 70% as much wheat or hay as the Dunmore soil.

Many other examples just as striking can be cited, but these few should suffice to clearly stress the importance of considering

*Per cent of yield on Dunmore Silt Loam.

soil type differences in trying to work out an economically sound farm enterprise. It is the collective economy of the individual units which make up the economic soundness of a community, county or state.

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Studies of the Germination, Growth, and Propagation of Seeds, Berries, and Root Fragments of Berberis canadensis Mill.

G. E. Matheny, R. S. Mullin and R. L. Shaver

Studies were initiated for the purpose of determining the influence that various environmental factors have on the propagation and distribution of the native American barberry (*Berberis canadensis* Mill.) in southwestern Virginia. The native barberry is indigenous to the Appalachian region of the Southeastern States, where it serves as the alternate host of the black stem rust fungus (*Puccinia graminis* Pers.), which is often responsible for severe damage to the wheat, oats, rye, and barley crops as well as to several susceptible wild and cultivated grasses. The plantings in this experiment were made in Montgomery, Pulaski, Carroll, Grayson, and Wythe Counties, in each of the following exposures: In sunlight on a southern slope, in sunlight on a northern slope, in shade on a southern slope, and in shade on a northern slope.

One-half of the seeds were selected from live bushes and one-half from bushes killed by salt after the berries were mature. Approximately equal numbers of seeds were planted as shelled seeds and as seeds in whole fruits. Twenty-five per cent of all plantings were protected by screen wire to prevent possible disturbance by rodents, and burned limestone was added to one-half of all lots of seeds and berries planted. One hundred freshly-dug root-fragments were planted at each of the four exposures.

These plantings were made on February 17, 18, and March 1, 1938. Observations and readings were made on August 27, 1938, May 3 and 12, 1939, and April 24, 25, and 30, 1940.

A brief preliminary analysis of these data seems to indicate that germination and survival of seedlings are greater in the shade on a southern exposure, whereas the tendency seems to be the opposite in the case of the growth and survival of sprouting bushes from root-fragments. The second-best condition for germination of seeds was shade on a northern exposure, followed by sunlight on a southern exposure. Germination was lowest in sunlight on a northern exposure.

Approximately 10 per cent germination has been recorded to date from both shelled seeds and those planted in the pulp. No significant difference can be noted to date between lots to which limestone was added and those to which it was not. Seeds from bushes that had been killed by salt soon after the fruit appeared mature gave higher germination than normally matured seeds collected from live bushes in February.

Not only did a greater number of root fragments produce growth in the sunlight on both exposures, but the percentage of

winter survival of the small sprouting bushes was also greater in the sunlight on both slopes.

It is proposed to continue observations on these plantings until the earliest date of fruiting of surviving bushes has been determined under the conditions of the experiment.

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE,
UNITED STATES DEPARTMENT OF AGRICULTURE.

EDITORIAL

THE VIRGINIA JOURNAL OF SCIENCE concludes the first year with this issue. An appraisal of the work of the year is therefore appropriate. There have been many suggestions from members of the Academy through the year, and for these we are grateful. We wish to have more through the coming year. What is especially needed, however, is the sort of interest which is manifest in a large subscription list. The JOURNAL should be self-supporting. It is not now.

The Editors greatly appreciate the generous support accorded the JOURNAL in the number of manuscripts submitted for publication. As yet there has never been any concern over this matter.

The JOURNAL has many enthusiastic supporters. The expressions of interest in the fate of the new publication have been frequent and cordial. Naturally these have been gratifying and encouraging to the management. On the other hand there have been many criticisms of the methods or policies relating to the JOURNAL, which, although they ruffle editorial composure, will probably, in the long run, do the JOURNAL more good than entirely favorable comment. They may be examples of the discontent with things-as-they-are which usually leads to improvement.

There have been two principal objections to JOURNAL policies. The first is the suggestion that papers should have more popular appeal. It seems to be a trait of scientists that they dearly love to write the results of their researches in highly technical form, but are contemptuous of technical papers in fields other than their own. How do you feel about this matter? Is the chief function of our JOURNAL to provide an outlet for technical publications on research in Virginia? Or should a paper by a chemist be so phrased that it provides thrilling reading for a worker in the field of education? Should the geologist "write down" for the biologist without special training in the field of geology? Should we all prepare our papers in a form which will be read and enjoyed by high school students interested in science? Is the JOURNAL a propaganda organ for science, for the education of

the general public in scientific matters, to represent Virginia science to scientific workers in other parts of the nation and the world? Or is it possible to serve several of these functions, without confining ourselves to *any one, solely?* The Editor-in-chief welcomes expressions from Academy members and subscribers to the JOURNAL on the proper functions of a state science publication.

A second suggestion frequently offered which calls for a change in Academy policies for the JOURNAL is that the Academy dues be increased to three dollars, making every member a subscriber arbitrarily. This would insure the financial security of the JOURNAL, provided it did not have the effect of reducing the number of members seriously. There would be the question of an adjustment of dues for the junior membership to consider also. Opinions of members on this question are also desired. They should go to the Managing Editor.

It is of interest to note the distribution of papers which have appeared in Volume I, among the Academy sections. The following table shows the number of papers and total pages used by the various sections. One paper (Agriculture) does not clearly belong to any one section. The Engineering, Medical Sciences and Psychology sections have contributed no papers.

	Number of papers	*Pages*
Agriculture	1	5
Astronomy	1	8½
Botany	9	42
Chemistry	14	47
Education	2	16
Geology	4	25
Physics	1	8
Zoology	4	30

Finally, are there other uses to which the JOURNAL may be put, for the good of readers, for the interests of science, or the Academy? Should its pages be open to the officers, so that they may present certain matters to the membership between annual meetings? If this is desirable and is to be effective, all members should be subscribers. Would a feature such as the column on Science Notes, contributed by Dr. Sidney S. Negus to *The Commonwealth,* organ of the State Chamber of Commerce, be desirable? Do we want news notes of persons and events of scientific interest in the State? Would it not be helpful if readers submitted notes on papers originating in the State but which are published elsewhere than in the JOURNAL? Let us have your opinion, please.—R. S. F.

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(The program number of the JOURNAL (No. 4, April) is not included in this index nor is its pagination (28pp.) included in the total for Volume I.)

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The Virginia Journal of Science

VOLUME II

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Observations on the Conservation of the Chesapeake Blue Crab, Callinectes sapidus Rathbun[1]

CURTIS L. NEWCOMBE AND ELLEN H. GRAY

It is a matter of common knowledge among conservationists that the blue crab supply of the Chesapeake is rapidly declining, being reduced from a level of about 17 millions in 1931 to that of about 10 million crabs in 1937. (Md. Rept. 1937). Numerous explanations have been advanced to account for this decline. One outstanding reason is the taking of such large numbers of "sponge" (berried) crabs and mated female crabs, a practice which undoubtedly reduces the potential supply of young crabs for the ensuing year.

Another menace to the survival of the blue crab lies in the way in which "soft crabs" are handled in the industry. The current methods of transporting and holding crabs on shedding floats are responsible for the loss of a very significant percentage of the total numbers taken. From a standpoint of practical conservation, no single one of our Chesapeake commercial fisheries merits more immediate attention than the blue crab fishery.

This paper embodies the results of observations made on the current practices followed by the industry in handling crabs, and the effect of these practices on survival rate from a conservation viewpoint. Field experiments have been conducted to show the extent of loss resulting from faulty methods and, furthermore, by careful observations made on crabs in commercial and experimental floats, it has been possible to give reasons for modifying certain industrial practices. Those applied phases of the study pertaining to moulting and growth are briefly described, the more theoretical aspects of the data having been treated elsewhere (Gray and Newcombe, 1938 and 1939). Emphasis is placed on the lines of study that need to be pursued and the current practices which should be modified in order to preserve the crab fishery (Compare Settee and Fiedler, 1925).

MATERIALS

The Chesapeake Bay is the main center of the soft crab fishery even though the blue crab ranges as far north as Cape Cod,

[1]Joint contribution from the Biological Laboratories of the University of Maryland; and from the Virginia Fisheries Laboratory and the Department of Biology of the College of William and Mary (Contribution No. 2).

Massachusetts and south to the Gulf of Mexico. Specimens used in this study were collected near Solomons Island and maintained on typical as well as especially constructed floats. Additional observations were made on the commercial floats at Solomons Island and at Crisfield, Maryland.

Crabs were kept in specially constructed crab floats containing several compartments. The linear dimensions considered are as follows—*width*, "W", referring to the shortest distance between the ends of the lateral spines of the carapace; *length*, "L", meaning the perpendicular distance across the carapace from a point immediately posterior to the rostrum to a point just above the first segment of the apron; *eye-to-spine*, "E", implying the distance from the first anterior lateral serration posterior to the eye and the tip of the right lateral carapace spine (Fig. 1). Measurements were made with a vernier caliper reading to a tenth of a millimeter. Male and female specimens were compared in respect to their growth characteristics.

Instead of following the growth of individual specimens through the several stages, a method of grouping was used, the width interval being 10 mm. By means of the average growth ratios obtained by this procedure, it has been possible to establish certain dimensional and moulting characteristics of the species, age differences and, in particular, differences between male and female crabs. These facts are helpful in any regulatory efforts aiming to preserve the crab supply.

Results

Individual observations of over 500 crabs in floats have indicated that there is a high death rate among "peelers" (crabs ready to cast their shells) kept on commercial floats. The lethal effect is due to a variety of causes. Polluted water surrounding the float constitutes one limiting factor in crab moulting. Efforts should be made to keep the floats in clean water, away from all refuse. The idea that a crab is a scavenger and normally consumes miscellaneous organic debris is a misconception. Although crabs do devour dead animals before decomposition begins, they avoid those that are in the later stages of disintegration. In an aquarium, the slightest morsel of decomposing material may subsequently prove fatal to the crab.

Another factor limiting survival in the floats is found in the common practice of breaking the claws. This *breaking* causes the soft membranes inside of the shell to swell, and hence, prevents the tissues from being readily pulled through the narrow joints (Hay, 1905). This produces either death or a legless condition (buffalo crabs). The claws are broken by the crabber in order to facilitate handling as well as to prevent cannibalism.

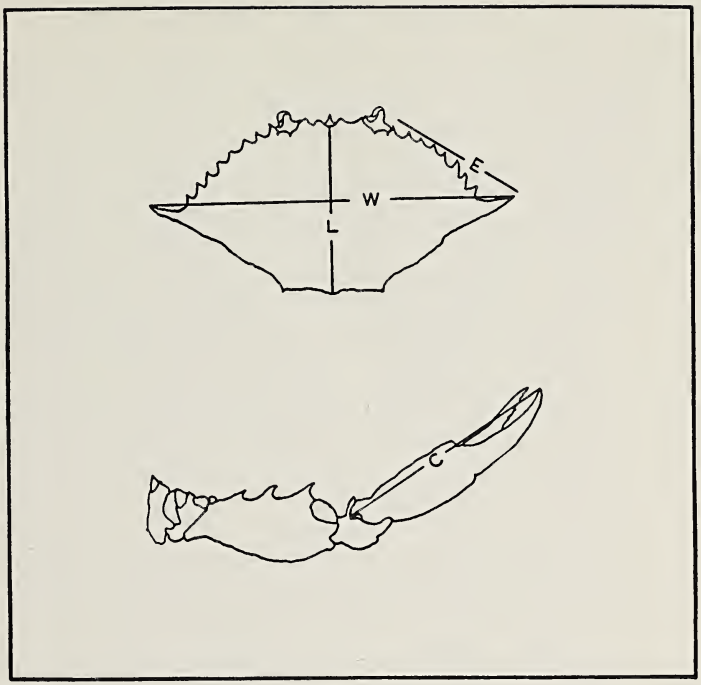

FIGURE 1. Outline drawing of the blue crab showing the dimensions measured. W = width; L = length; E = distance from eye-to-spine; and C = length of the propodite of the chaela.

A third factor that causes high mortality is the holding of "green line" crabs[2] on the floats. While these crabs are in the initial stages of moulting, a period of a week or *more* is frequently required before actual shedding takes place, hence they must have food to assure normal survival. Since they are not given food when on the floats, a large percentage (at least 25%) die of starvation. "Pink line" crabs are so close to moulting that food is not required until the process is completed. If only "red line" and "pink line" crabs, which do not eat, were kept on the floats, these last two causes of mortality would be automatically eliminated. In the study of over 500 crabs that were carefully handled on floats under favorable weather conditions, a 63% loss in the "green" crab moultings was observed and 27% loss in the "white line" crabs, as compared with 4% in the "pink

[2]"Green line" crabs are those with a green line in the back "fin" (fifth pereiopods), indicating the commencement of moulting. Subsequent stages in moulting are designated "white line", "pink line", and "red line". The "red line" stage immediately precedes the actual shedding process; actual moulting crabs are known as "busters". Other designations are also used.

line" and 9% in the "red line" crabs. The increase in mortality of "red line" crabs over those in the "pink line" stage is due to the fact that "red line" crabs being more delicate are to a greater extent subject to injury. Crab dealers recognize the fallacy of holding "green" crabs on the floats but are obliged to do so for a practical reason, namely, the crabber demands the acceptance of his entire catch regardless of the stages represented.

A fourth factor causing high mortality results from the use of faulty methods by the crabber in transporting his catch to the commercial floats. "Buster" crabs are frequently carried in the bottom of his boat. This exposes them to the air and produces a so-called "blister" between the two carapaces which prevents moulting. Furthermore, "red line" crabs are especially subject to injury by careless handling. In many instances, tin buckets instead of wooden vessels are employed to convey crabs from their point of catch to the floats. It is well known that this tends to weaken the crab at a time when it requires maximum strength.

Size is used as a criterion for selecting marketable soft crabs. Legal sized small individuals, having an initial width range of about 75 to 85 mm., moult with greater facility and, if handled properly, have a lower death rate than those larger than 90 mm. in width. This may be attributed to the fact that the time required for moulting is shorter in small crabs and fewer structural changes take place. Because of the higher mortality among large crabs during moulting, it might seem to be more economical to use the slightly smaller ones, which are, according to many tests, just as palatable. It is recognized that the number of small crabs—75 to 85 mm. group—required to meet the soft crab demand would be greater than the number of large specimens. However, the increase is not likely to be particularly significant on account of the known higher mortality of the mature moulting crab. These and related points pertinent to the crab fishery are being given further study at the Virginia Fisheries Laboratory at Yorktown.

Biometrical studies of moulting crabs have shown that females having an initial width of over 90 mm. will usually mature at their next moulting. It is also easy to distinguish this point by physical characteristics. "Virgin" females require a longer time for shedding at this moult than at any other, evidently because of the excessive modifications of the exoskeleton, whereby the triangular apron becomes rounded, the spines straightened and lengthened and the body excessively thickened.

The corresponding point of sexual maturity cannot be so readily recognized in *male* specimens, because the external modifications are not as conspicuous. At this point, there is, however, a slight modification in the exoskeletal structure, since the spines tend to curve anteriorly. This observation substantiates the find-

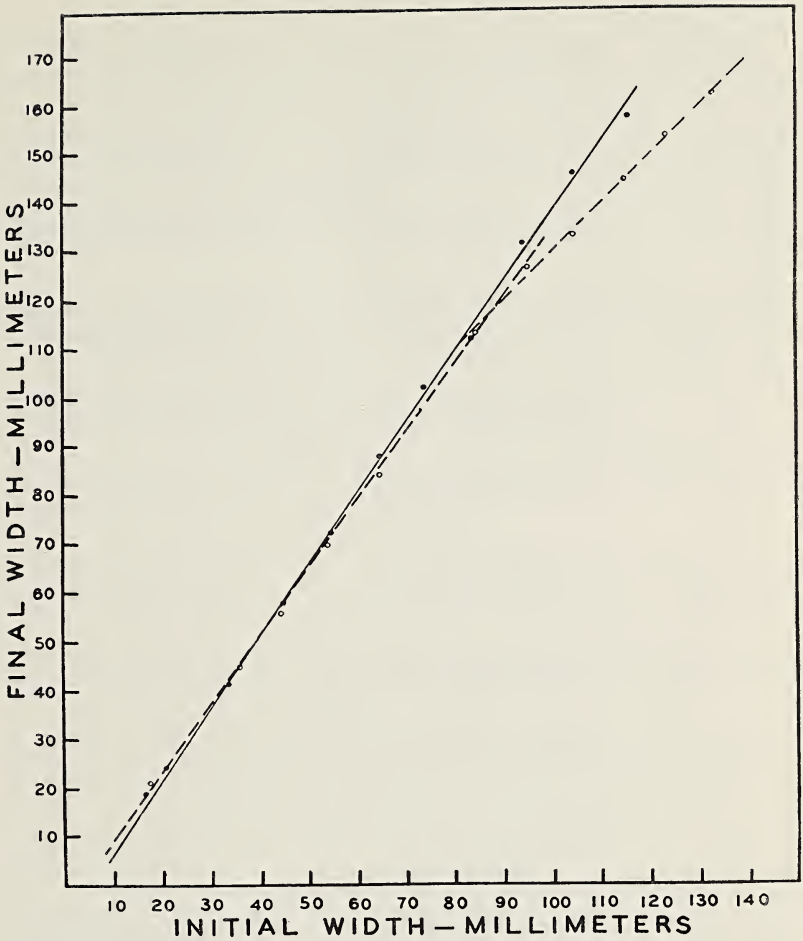

FIGURE 2. Showing the moulting increments of width in the blue crab. Continuous line = females; dashed line = males. Range of initial widths—males, 16.3 to 139.8 mm. and females, 13.0 to 119.4 mm. Observe the change in moulting characteristics of *males* at an initial width of 90 mm.

ings based on the following statistical data obtained during the period 1933-38 (Table 1).

It has been found that two distinct growth ratios, each representing a straight line relationship, prevail during the life of the *male* crab. The point of intersection, being at the initial width of about 90 mm., is evidently the result of physiological change in the organism that modifies the relative growth increments during moulting (Fig. 2). Identical conclusions may be reached by using

Table I
Moulting Increments of *C. sapidus*

Group No.	Width Interval	No.	Mean Width		Abso. Incr.	% Addition	Mean Length		Abso. Incr.	% Addition	Mean Dist. Eye-to-spine		Abso. Incr.	% Addition
			Initial	Final			Initial	Final			Initial	Final		
Females														
I	0— 9.9													
II	10— 19.9	8	16.76	18.76	2.00	11.93	8.92	10.53	1.60	17.93	6.15	6.93	0.78	12.79
III	20— 29.9	3	21.06	24.23	3.16	15.03	11.36	13.46	2.10	18.48	8.33	9.00	0.66	7.92
IV	30— 39.9	4	33.95	41.13	7.18	21.13	14.90	18.77	3.87	25.58	11.27	14.60	3.33	29.45
V	40— 49.9	29	45.31	57.93	12.62	27.86	22.13	28.05	5.92	26.75	16.47	21.77	5.32	32.17
VI	50— 59.9	52	55.38	71.90	16.52	29.82	26.83	34.04	7.22	26.88	20.71	27.04	6.33	30.59
VII	60— 69.9	66	65.02	87.52	22.50	34.59	31.23	40.22	8.99	28.78	24.65	33.46	8.81	35.55
VIII	70— 79.9	40	74.43	101.62	27.19	36.53	35.15	45.61	10.46	29.16	28.48	39.19	10.71	37.59
IX	80— 89.9	25	83.90	112.04	28.14	33.53	39.06	49.52	10.46	26.77	32.41	44.49	12.08	37.25
X	90— 99.9	14	94.56	131.33	36.77	38.87	43.16	54.02	10.86	25.15	36.96	51.90	14.94	40.43
XI	100—109.9	8	104.46	145.96	41.50	39.73	47.16	63.06	15.90	33.71	41.68	60.60	18.92	45.41
XII	110—119.9	5	116.34	157.58	41.24	35.44	50.34	64.24	13.90	27.65	50.16	74.32	24.16	48.16
XIII	120—129.9	3	122.00	165.13	43.13	35.35	55.00	67.96	12.96	35.75	48.93	67.56	18.36	38.08
XIV	130—139.9	2	131.50	176.25	44.75	34.03	57.25	69.90	12.65	22.09	54.00	70.90	16.90	31.29
Males														
I	0— 9.9													
II	10— 19.9	5	17.62	20.10	2.52	14.38	9.20	11.04	1.84	20.00	6.54	7.80	1.26	19.26
III	20— 29.9	0												
IV	30— 39.9	7	36.23	44.63	8.40	23.18	17.50	22.00	4.50	25.71	12.70	15.67	2.97	22.57
V	40— 49.9	13	44.81	55.78	10.97	24.48	21.79	27.26	5.47	25.10	16.62	20.37	3.75	22.58
VI	50— 59.9	25	54.43	69.40	14.97	27.50	26.42	33.19	6.76	25.60	20.84	26.26	5.42	26.02
VII	60— 69.9	31	64.91	83.96	19.05	29.40	31.40	39.53	8.13	25.92	24.91	32.92	8.01	32.14
VIII	70— 79.9	24	74.05	98.12	24.07	32.51	35.00	44.50	9.50	27.11	28.74	38.64	9.91	34.45
IX	80— 89.9	17	84.98	112.97	27.99	32.93	39.65	50.08	10.43	26.32	33.72	45.62	11.90	35.26
X	90— 99.9	12	95.41	126.08	30.67	32.14	44.65	55.75	11.10	24.84	37.02	50.28	13.26	35.81
XI	100—109.9	15	104.85	133.27	28.42	27.10	47.89	58.60	10.71	22.35	41.99	54.26	12.27	29.21
XII	110—119.9	19	115.22	144.33	29.11	25.26	52.80	63.52	10.72	20.31	46.17	57.33	11.16	24.17
XIII	120—129.9	13	123.69	153.45	29.76	24.06	55.76	66.70	10.94	19.63	39.74	61.32	11.58	23.27
XIV	130—139.9	8	133.40	162.27	28.87	21.65	58.96	69.43	10.47	17.72	53.28	64.18	10.90	20.46
XV	140—149.9	1	149.10	175.50	26.40	17.70	65.40	77.50	12.10	18.50	60.50	70.90	10.40	17.19
XVI	150—159.9	1	153.20	190.40	37.20	24.47	66.50	79.00	12.50	18.80	61.50	77.00	15.50	22.30

either the length, or the eye-to-spine dimensions. In these dimensions, the break occurs at a size (males) comparable to 90 mm. width. It is at this size that the male crab is believed to mature. In the case of female crabs, the difference in the moulting increments of width does not on the average exceed 4% until an initial width of about 89 mm. is reached. From this point on a significant sexual difference occurs. It has been pointed out above that in the case of male specimens a different ratio (initial width to final width) holds beyond the 89 mm. width. Female crabs maintain a fairly constant ratio throughout life as shown in Fig. 2.

In both sexes, the three dimensions measured exhibit a similar peak of expansion with respect to size. The peak in females corresponds with the size at which sexual maturity is reached and constitutes one reason for believing that the peak in the males also indicates the size of sexual maturity. (Table 1).

Variations in moulting between male and female crabs ranging in size from about 10 to 159 mm. are shown in Table 1. It is noted that differences exist between the sexes and also within the same sex depending on the initial sizes.

By means of the linear equations presented in Table II it is possible to determine the dimensions—length, eye-to-spine, and propodite of the chaela—corresponding to a specific width. One use of these equations is to estimate the percentage of crabs possessing regenerated claws and hence, may be helpful in solving the problem centering around the "buffalo" crabs.

The data that have accrued from this study permit a direct estimation from a width dimension, of the number of moults taking place in crabs exceeding 20 mm. in width. Using Fig. 2, the number of moults may be estimated for crabs ranging from 20 to 140 mm. in width. This result is shown graphically in Fig. 3. By way of illustration, a crab 20 mm. in width reaches, on moulting, a final width of 22 mm. (Fig. 2). Assuming this final width to be the next initial width, the corresponding final width after moulting is 24.8 mm. By continuing in this way, the number of moults for male crabs of this size has been calculated to be 11, being two more than the number for female specimens of the same initial size. (Table III).

In concluding this discussion of biometrical relations that typify crabs of this species, it should be recalled that significance is attributed here not to individual ratios and variations as occurring in living specimens observed during successive moultings, but rather, to the establishment of *group* ratios and *group* variations of known numerical values. To obtain moulting data of comparable accuracy by rearing individual crabs through to maturity would prove impractical on account of the inherent difficulties accompanying the rearing of such large numbers of crabs to a mature stage.

Summary

This study has shown that certain of the current practices of handling crabs followed in the Chesapeake Bay are detrimental to the best interests of the crab fishery. These procedures have been studied together with certain statistical aspects of moulting in this species.

It is well known that the mortality among moulting crabs on commercial floats would be greatly lessened if the dealer would guard against polluted water, and make certain that the crabber properly transports his daily catch. Our results stress the importance of these preventative measures.

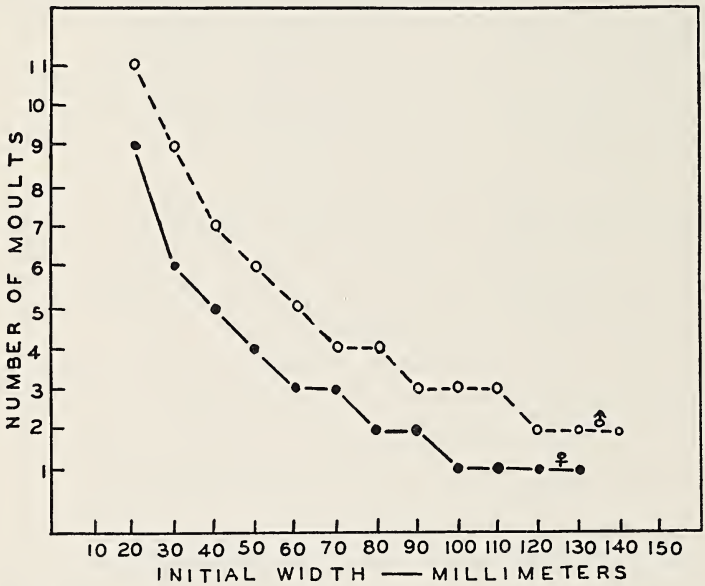

Figure 3. Relation of the initial width of the blue crab to the estimated number of moults. Continuous line = females; dashed line = males. Range of initial width, 20 to 140 mm.

Discontinuing the practice of holding so-called "green" or "feeding" crabs on floats, will save the current loss to the industry of more than 25% of the catch, a loss caused by starvation, cannibalism and broken claws.

Results of experiments in holding crabs on floats under favorable conditions have shown that there is a 63% loss in the "green" crab moultings and a 27% loss in the "white line" crabs, as compared with the 4% loss in the "pink line" and a 9% loss in the "red line" crabs.

The higher mortality of mature moulting crabs kept on floats has been pointed out and constitutes an important consideration in any study bearing on crab conservation.

The data provide evidence that the width of the male crab at sexual maturity is about 90 mm. The matter of preserving *male crabs* (most abundant in the upper bay) *of this size* may therefore be as vital to conservation as is the greatly agitated question of protecting the *female crabs* (dominant in Virginia waters) *in the "sponge" condition.*

These observations made in several of the principal crab packing houses of the Chesapeake indicate the need for improved methods, both of catching and of handling crabs throughout the entire region. They constitute only a few of the requirements of the crab industry that warrant serious consideration. Indeed, they strengthen our conviction that there is an urgent need for the dissemination of knowledge in matters pertaining to the applied aspects of the biology of the crab and for more comprehensive studies of the relative survival rates of mature and immature crabs kept on floats and, particularly, for a detailed investigation of the composition of the crab populations in widely different sectors of our waters.

At present, information is needed on the size-weight relations of *Callinectes*, on the composition of the commercial catch with respect to size frequency distributions, on the intensity of the present rates of fishing in relation to that which can be supported without danger of depletion, and on the *spawning reserve* essential to maintenance of the fishery. Steps should be taken immediately to find out our present rate of fishing and current trends in the fishery so that a basis may be established for interpreting future increases and declines and for the establishment of regulatory policies to effect sound conservation of this important fishery.

TABLE II

LINEAR EQUATIONS SHOWING THE RELATIONS OF THE DIMENSIONS OF THE BLUE CRAB, *Callinectes sapidus.*

No.	*Sex*	*Group*	*Equation*
1	Male		L = 4.52 + 0.412 W
2	Female	Lower Group	L = 4.438 + 0.408 W
3	Female	Upper Group	L = 7.111 + 0.370 W
4	Male		E = –2.213 + 0.4176 W
5	Female		E = –3.836 + 0.4360 W
6	Male		C = –10.805 + 0.6246 W
7	Female		C = 1.982 + 0.4356 W

Table III

Showing Method of Estimating Average Number of Moults in *C. sapidus* by Reference to Figure 2.

Specimens

Males Initial Width 20 mm. Moults		Females Initial Width 20 mm. Moults		Males Initial Width 80 mm. Moults		Females Initial Width 80 mm. Moults	
From	To	From	To	From	To	From	To
20.0	22.0	20.0	22.9	80.0	106.0	80.0	108.2
22.0	24.8	22.9	26.9	106.0	135.2	108.2	148.8
24.8	28.5	26.9	32.6	135.2	164.2		
28.5	34.0	32.6	40.8	164.2	195.2		
34.0	41.6	40.8	48.4				
41.6	52.0	48.4	63.5				
52.0	66.8	63.5	84.2				
66.8	87.3	84.2	114.2				
87.3	126.5	114.1	156.9				
126.5	155.1						
155.1	184.0						
No. of moults, 11.		No. of moults, 9.		No. of moults, 4.		No. of moults, 2.	

Acknowledgement is made to the Chesapeake Biological Laboratory and the Department of Zoology of the University of Maryland for equipment and laboratory facilities used in the prosecution of this study during the period 1933-1938. Valuable help in the procuring of crabs was given willingly by Captains Harvey Mister, Henry Kopp, Arthur Phillips, while the firm of J. C. Lore and Sons cooperated in providing floats for observational purposes.

Thanks are also expressed to Commissioner G. Walter Mapp of the Virginia Commission of Fisheries through whose interest in the conservation of the Chesapeake crab fishery, these studies were continued in the lower waters of the Bay.

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Virginia Fisheries Laboratory and College of William and Mary.

Franklin High School, Reisterstown, Maryland.

A Thoracopagus Twin Chick Embryo

CHAUNCEY MCLEAN GILBERT AND MILTON SILVERMAN

During the spring term of 1937, the senior author's attention was called to a 72-hour Siamese twin chick embryo, which had been mounted *in toto*, by one of the members of his class in elementary embryology.

The twin was composed of two almost separate embryos, fused in the region of the thorax and part of the pharynx, which, for this reason, is referred to as a *thoracopagus twin*. For convenience, we shall designate the members of the twin as A and B (Fig 1 *A*, *B*).

While multiple chick embryos have been repeatedly reported—notably by O'Donoghue (1910) and Tanneuter (1919)—and similar multiple formation had been produced experimentally by Morita (1936) and others, no adequate description has been made of the morphological abnormalities consequent to the fusion of the individual embryos.

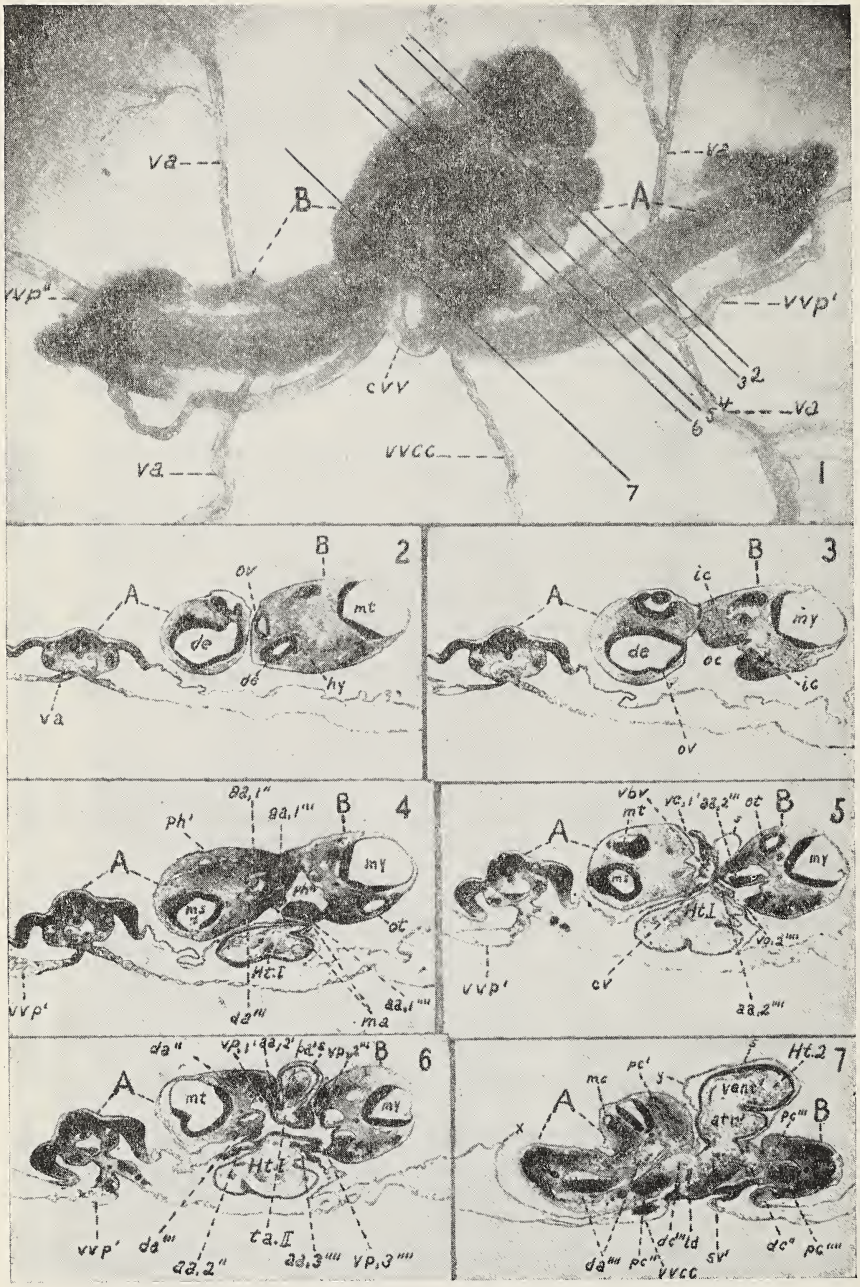
In order to make our study of the twin as thorough as possible, the preparation was removed from the slide, stained more deeply, embedded in paraffin and sectioned. Later, it was found necessary to make wax plate models of the pharyngeal regions and hearts, in order to properly interpret the morphology of these regions.

Very recently, Weiss (1939) said that "all deformities are amenable to a natural and consistent explanation on the basis of the dynamic view of development." This generalization is unquestionably true. However, many of the abnormalities present in the twin appear not to be amenable to any *known* dynamic views of development. The study of the morphology of this twin should be of interest to both the morphologist and the experimental embryologist, because of evident adaptations to certain embryonic requirements contingent on the fusion of the two embryos, and the absolute suppression of certain organ rudiments and the retardation of others.

The individual embryos were evidently developed from individual primitive streaks nearly opposite one another. The resulting embryos grew until they met at the center of the blastoderm. Subsequent growth resulted in distortions of a purely mechanical nature in both embryos—especially marked in A (Fig. 1)—and a fusion in the thoracic and posterior pharyngeal regions. The anterior end of B lies on its left side, while that of A lies on its right, in consequence of which the two head regions are brought face to face. Both embryos appear to have grown at a normal rate, as 35 pairs of somites were counted in B and a like number were probably present in A. Sections through the posterior regions of both embryos failed to show any abnormalities and the development appeared to be normal for that of 72-hour chicks.

THE EMBRYONIC MEMBRANES

The greatest length of the twin was 9:5 mm. If the individual embryos met when each was half that length (4.75 mm.), they should have been in about the 17-somite stage. At this stage the heart fold of the amnion should cover the entire region of the fore-brain (Lillie, 1930). As a matter of fact, however, amniotic folds are largely wanting. No head folds are present (Figs. 2, 3, 4, 5, and 6). There is, however, a lateral amniotic fold at the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B
A
Va
vvp''
vvp'
cvv
vvcc
Va
Va
2
3
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right side of B, which extends anteriorly from the region of the right vitelline artery. At the region of the bend of A (Fig. 7, *X*), this fold extends toward a fold (*V*), produced from the pericardium of Heart II and eventually fuses with it, so that the major portion of the region of the bend of A is completely covered by an amnion of restricted dimensions. Lateral and posterior tail folds are indicated but fail to meet dorsally to form an amnion.

The want of amniotic head folds may be due to the blastoderm having been so stretched by the formation of the cephalic pockets under the heads of the advancing embryos that it was impossible for the amniotic head folds to form.

The Central Nervous System and the Organs of Special Sense

The brain of B is quite normal. That of A, however, is decidedly distorted, probably due to the pressure exerted upon it by the anterior head region of B (Fig 1, *A*).

The development of the left eye of each embryo is normal (see Figs. 2 and 3 for left eye of A). The right eye of each embryo, on the contrary, is abnormally developed. In A, the optic vesicle is very small (Fig 3, *ov*), but nearly reaches the ectoderm in the third section posterior to that shown in Fig. 3. This is possible because of the extreme narrowness of the mesoderm in this region. The right wall of the diencephalon is very thin (Fig. 3), which is probably correlated with the failure of the right eye to develop, as Durken (1930) found the extirpation of optic vesicle of *Rana fuscua* resulted in abnormally thin wall of the brain on the side where the eye failed to develop, due to a great reduction in the number of neurones present. The right eye of B is represented by a large optic vesicle (Fig. 2, *ov*), which has failed to invaginate to form an optic cup. Although this vesicle touches the ectoderm, there is no thickening of the latter to form a lens rudiment, as might be expected, as Hoadley (1926) and others have shown that the optic vesicle of the chick is capable of inducing lens formation.

There must be a dynamic explanation for the abnormalities mentioned above, and for the fact that the right eye in each case was the abnormal one, but at the present time, none appears to be forthcoming.

Both olfactory and otic invaginations appear to be normal.

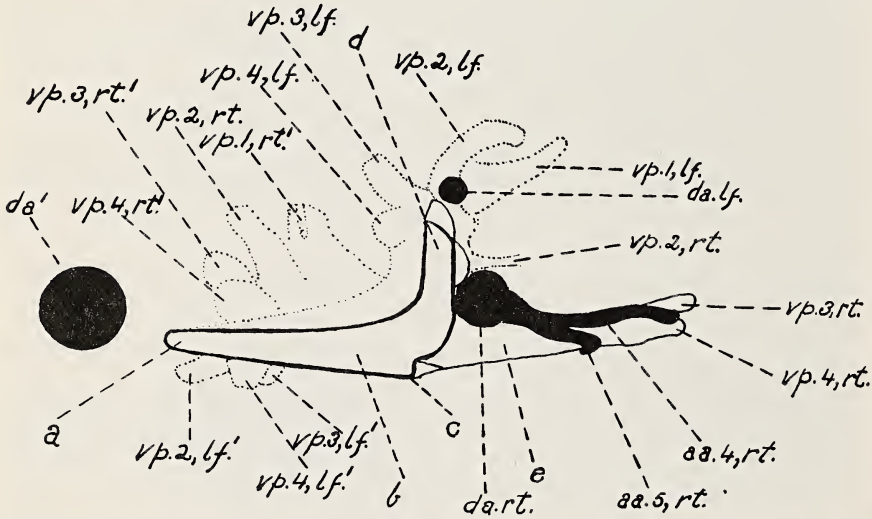
The Alimentary Tract and Its Derivatives

There is only a single oral invagination in the "twin" (Fig. 3, *oc*). The left mandibular arch of B is normal, while the right is a mere stump (Fig. 4, *ma*). The anterior pharynx of B is of normal size, while that of A is small (Figs. 4, 11, 13, *ph′*, *ph″*). There are no mandibular arches in A, and its greatly attenuated

anterior pharynx communicates with the hypophysial portion of Rathke's pocket by means of a small duct, which is the only direct means of communication between the pharynx of A and the exterior.

The anterior pharynges are independent of one another as far as the level of the first pair of visceral pouches (Figs. 11-13). The extent of the fusion can best be understood by referring to the text-figure, and Figs. 11-13. The posterior width of the fusion is indicated by the arrows in Fig. 13, but the outline of the common pharynx is L-shaped as shown in the text-figure.

The visceral pouches are peculiarly distorted, those on the right side of the pharynx of B and the left of A being larger and more pointed than those of the left side of B and the right of A (see text-figure and Figs. 5, 6, 11, 12, 13). This is due to a certain eccentricity in the position of the pharynges themselves. The configuration of the pharynges and their associated structures is so peculiar that it may be best understood by referring to text-figure and figures.



There is a common anterior intestinal portal into which the anterior intestinal portals of A and B open. Their arrangement is quite complicated and difficult to describe.

The above abnormalities of the alimentary tract can be explained as a direct result of the fusion of the embryos. The reason for the following anomalies are, however, not so clear.

There are no thyroid diverticula present in either A or B. Again, there are no signs of lung buds, although they should be quite evident in this stage of development, but a right accessory mesentery is present in B, the posterior end of which can be seen in Fig. 7. We cannot see that there was anything to prevent the

formation of these structures. Furthermore, we have been unable to find any references in the literature concerning the induction of either thyroid glands or lungs.

There are three liver diverticula, all of which belong to B: a small diverticulum given off midway down the left side of the anterior intestinal portal, the liver cords derived from it being infiltrated by a capillary network and mesenchyme—the latter a most unusual condition; a second, much larger than the first, given off the right side of the anterior intestinal portal (Fig. 7, *ld*); a third, posterior to the above and also given off the right side, encircles nearly half of the ductus venosus, giving off many cords of hepatic cells, which have, however, as yet, not infiltrated the lumen of the ductus.

Willier and Rawles (1931) believe that the liver is probably induced by the heart rudiments. We suspect, however, that it is induced by the ductus venosus, (fused omphalomesenteric veins), as no well-defined ductus is present in A, in which no liver diverticula are present.

The Circulatory System

The circulatory system exhibits many anomalies probably of more interest to a morphologist than to an experimental embryologist, as their induction was probably entirely mechanical and largely associated with the functional reduction of Heart I and the consequent functional increase of Heart II.

Heart II possesses an enormous sinus venosus (Figs. 7 and 8, *sv'*), into which open two common cardinal veins (*dc'''*, *dc''*). The first (labeled in Fig. 8, *cdc*) is a common duct, which receives both right and left posterior cardinal veins of A (*pc''*, *pc'*), as well as the anterior cardinal veins of the same embryo. The second receives only the right posterior (*pc'''*) and anterior cardinal veins of B. That is, the sinus venosus of Heart II receives all of the venous blood from A and half of that from B. Heart I, on the contrary, possesses no definite sinus venosus but only a slight prominence (Figs. 9, 10, *sv*) which receives the left common cardinal vein of B.

The vitelline circulation is very unusual and its configuration is closely correlated with the large amount of blood being used by Heart I. Suffice it to say, however, that the sinus venosus of Heart II receives not only an enormous ductus venosus (Fig. 8, 9, *dv*) but a common central vitelline vein (Figs. 1, 7, 8, 9, *vvcc*). This latter vein receives a commissural vein (Figs. 1, 8, 9, *cvv*) which form a large loop and connects with the ductus venosus. The commissural vein seems to be nothing more nor less than an extension of the posterior vitelline vein (*vvp'*), which enters the common central vitelline vein at a point opposite the junction of the commissural vein with it. The commissural vein also receives the posterior vitelline veins (*vvp''*) before it enters the ductus venosus. The latter is formed by the fusion of paired vitelline

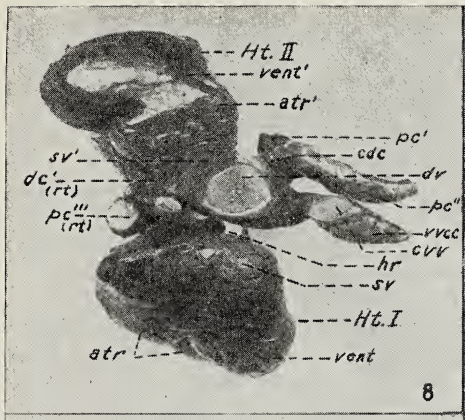
veins, which do not show distinctly in Fig. 1. Heart II, therefore, receives blood from the following vitelline veins: (1) paired vitelline veins of B; (2) posterior vitelline vein (*vvp''*); (3) commissural vein and by it most of the blood from posterior vitelline vein (*vvp'*); and (4) the common central vitelline vein (*vvcc*).

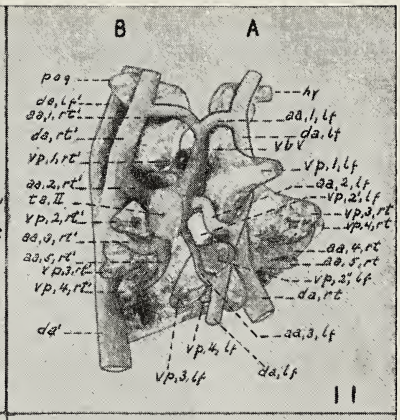
Heart I, on the contrary, receives only one vitelline vessel, the very much reduced vitelline vein of A, which enters the heart on a slight prominence ,situated alongside of and very close to the prominence into which the single common-cardinal enters (see below). It would appear, therefore, that the sinus venosus of Heart I has been reduced to these prominences.

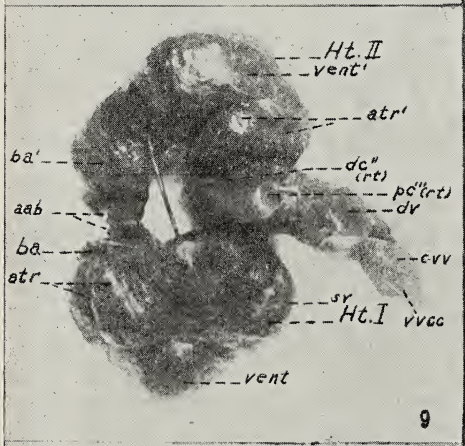
As the posterior vitelline vein (*vvp'*) passes by the region of the anterior intestinal portal, it forms a weak anastomosis with the right vitelline vein by means of a capillary plexus. This plexus is continuous with the capillary plexus mentioned as being associated with the first liver diverticulum. It is probable that through this plexus the posterior vitelline vein may contribute a very small amount of blood to Heart I.

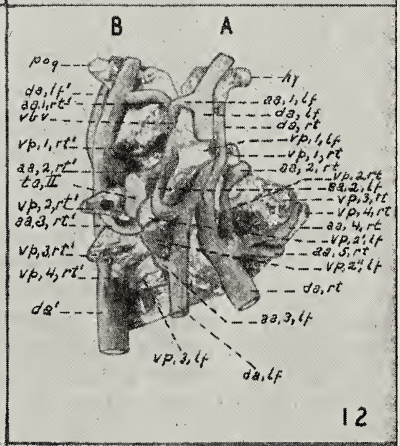
It will be seen from the above description that Heart II belongs to B, while Heart I belongs to A, as the paired vitelline veins of B enter the ductus venosus of Heart II, while the single vitelline vein of A enters the vestigial sinus of Heart I.

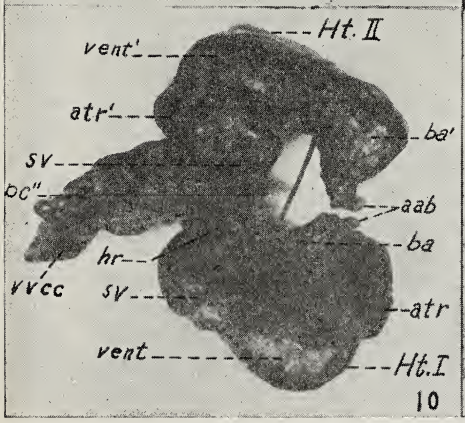
The configuration of the hearts and their relation to each other is shown in Figs. 8, 9, 10, which are photographs of wax models of these structures. Heart II bears some resemblance to a normal heart, in that it is clearly divided into a sinus venosus, atrium, ventricle, bulbus arteriosus, and truncus arteriosus. As has already been stated, the sinus is enormous, as it receives all the systemic veins of embryo A and half of those of embryo B, together with the greater part of the vitelline circulation. The atrium shows indications of becoming divided into right and left auricles, although there is very little difference in their size. The ventricular region is somewhat abnormal, in that the ventricular loop has not been drawn posteriorly as would normally be the case in a 72-hour embryo, and the distal portion of the ventricle and truncus lie in a straight line, the truncus being brought into the medial plane between the two individual embryos by means of a sharp right-angled bend, arising at the region of the left auricle. Heart I, on the contrary, is very abnormal. It is nearly shapeless (Figs. 8, 9, 10). The truncus arteriosus is telescoped on the bulbus, which is, in turn, telescoped on the rest of the heart (Figs. 9, 10). There are apparently external indications of the atria (*atr.*) and ventricle (*vent.*). However, internally the various chambers all open into a common central cavity. The sinus venosus (*sv*) is practically non-existant, as was explained before, being reduced to two prominences, one receiving the vitelline circulation and the other the left common cardinal of B.

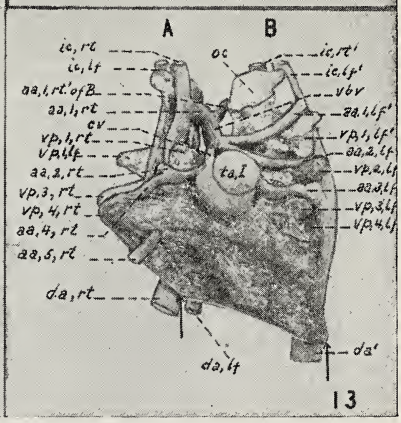

Ht. II
vent'
atr'
pc'
cdc
sv'
dc' (rt)
dv
pc'' (rt)
pc''' (rt)
vvcc
cvv
hr
sv
Ht. I
atr
vent
8


B
A
poq
hr
de, lf'
aa, 1, rt'
aa, 1, lf
da, rt'
da, lf
vbv
vp, 1, rt'
vp, 1, lf
aa, 2, rt'
aa, 2, lf
ta, II
vp, 2, lf
vp, 2, rt'
vp, 3, rt
aa, 3, rt'
vp, 4, rt
aa, 5, rt'
aa, 4, rt
vp, 3, rt'
aa, 5, rt
vp, 4, rt'
vp, 2', lf
da, rt
da'
aa, 3, lf
vp, 4, lf
vp, 3, lf
da, lf
11


Ht. II
vent'
atr'
ba'
dc'' (rt)
pc''' (rt)
aab
dv
ba
cvv
atr
sv
Ht. I
vvcc
vent
9


B
A
poq
hr
de, lf'
aa, 1, lf
aa, 1, rt'
vbv
da, lf
da, rt
vp, 1, rt'
vp, 1, lf
vp, 1, rt
aa, 2, rt'
aa, 2, rt
ta, II
vp, 2, rt
aa, 2, lf
vp, 2, rt'
vp, 3, rt
aa, 3, rt'
vp, 4, rt
aa, 4, rt
vp, 3, rt'
vp, 2', lf
aa, 5, rt
vp, 4, rt'
vp, 2'', lf
da, rt
da'
aa, 3, lf
vp, 3, lf
da, lf
12


Ht. II
vent'
atr'
ba'
sv
pc''
aab
ba
hr
vvcc
sv
atr
vent
Ht. I
10


A
B
ic, rt
oc
ic, rt'
ic, lf
ic, lf'
aa, 1, rt' of B
vbv
aa, 1, rt
aa, 1, lf'
cv
vp, 1, rt
vp, 1, lf'
vp, 1, lf
aa, 2, lf
aa, 2, rt
ta, I
vp, 2, lf
vp, 3, rt
aa, 3, lf
vp, 4, rt
vp, 3, lf
aa, 4, rt
vp, 4, lf
aa, 5, rt
da, rt
da'
da, lf
13

The truncus arteriosus of Heart II (Figs. 11, 12, *ta* II) gives off four arteries: (1) a large anteriorly-directed ventral blood vessel (Figs. 5, 11, 12, 13, *vbv*), which in turn gives off the first right (Figs. 13, A, *aa*, 1, *rt*) and left aortic arches of A (Figs. 11, 12, A, *aa*, 1, *lf*)—the right one being very much the larger of the two and appearing as a continuation of the ventral blood vessel itself—the first right aortic arch of B (Figs. 11, 12, B, *aa*, 1, *rt*) and the first (Fig. 13, B, *aa*, 1, *lf'*) and the second left (Figs. 13, B, *aa*, 2, *lf'*) aortic arches of B; (2) the second right aortic arch of B (Figs. 11, 12, B, *aa*, 2, *rt'*); (3) the second left aortic arch of A (Figs. 11, 12, A, *aa*, 2, *lf*); (4) the third left aortic arch of A (Figs. 11, 12, A, *aa*, 3, *lf*); and (5) the third right aortic arch of B (Figs. 11, 12, B, *aa*, 3, *rt'*) which gives off a fifth aortic arch of B (Figs. 11, B, *aa*, 5, *rt'*). No fourth or fifth left aortic arches are present in A and no fourth right aortic arch in B. We have designated the arteries which lie posterior to the fourth visceral pouches as the fifth aortic arches. This is an arbitrary designation, as these aortic arches might quite as properly be called the sixth aortic arches. However, inasmuch as the sixth, together with the transitory fifth aortic arches do not normally appear until the fourth day of incubation, it was thought advisable to designate these precociously developed arteries as the fifth aortic arches.

At this point it would be well to speak of the condition of the dorsal aortae in A and B. The radices aortae are quite different in the two embryos. In A, the right radix is large, while the left is very small (Fig. 6 *do'*, *da''*; Figs. 11, 12, 13, *da rt*, *da lf*; Text-Fig 1, *da rt*, *da lf*). Anteriorly, both of the radices are approximately of the same size, but the right one increases rapidly in size as it proceeds posteriorly, while the left remains approximately of the same diameter throughout. The two radices fuse to form the unpaired dorsal aorta in the region of the anterior intestinal portal. In B, the right and left radices are of the same size, and they fuse very close to the region where the third aortic arches enter them.

Truncus arteriosus I, gives off three blood vessels: (1) a commissural vessel (Figs. 5, 13, *cv*), which connects truncus arteriosus I with the aforementioned ventral blood vessel; (2) the 3rd, left aortic arch of B (Fig. 13, B, *aa3*, lf'); and (3) a third blood vessel which divides into two. The first (anterior) of these has been designated the 2nd right aortic arch of A (Figs. 12, 13, A, *aa2*, rt.), as it runs posterior to the first visceral pouch of A. It will be seen by examining Fig. 12, however, that this vessel runs parallel with the right dorsal aorta (*da*, *rt*) for some distance before entering the right dorsal aorta in common with two other vessels, which will be described below. There appears to be no 3rd right aortic arch present in A, because of the curious displacement of the second visceral pouch. The 2nd right aortic

arch, however, does pass through what appears to be the displaced 3rd visceral arch in the latter part of its course (see Text-figure and photographs of model of pharynges for these relationships), so that it functions as both 2nd and 3rd aortic arches. The second (posterior) branch is unquestionably the 4th right aortic arch (Figs. 11, 12, 13, A, *aa* 4 *rt*). This passes posteriorly to the 3rd visceral pouch and enters the dorsal aorta in common with the 2nd right aortic arch. There is also an incomplete 5th right aortic arch present (Figs. 11, 12, 13, A, *aa*, 5, *rt*) which also enters the right dorsal aorta in common with the second and fourth aortic pouches.

It will be seen from the above description that Heart II contributes blood to the 1st and 2nd pairs of aortic arches of B, together with the single 5th right aortic arch of B; also the 1st pair of aortic arches of A, and the 2nd right and 3rd aortic arches of A. Heart I, on the contrary, contributes blood directly only to the 3rd left aortic arch of B and the 2nd and 4th right aortic arches of A. Indirectly, however, it contributes blood to the ventral blood vessel of Heart II by means of its commissural vessel. Furthermore, the common connection of the 2nd and 4th right aortic arches of B with truncus arteriosus I is decidedly weak. It would appear, therefore, both by its reduced venous supply and arterial output, that Heart I was rapidly losing its function, which was being taken over by Heart II. It would be interesting to know what the final adjustment would have been.[1]

Another interesting point to consider is the curious arrangement of the first aortic arches of both embryos. It will be remembered that A did not possess any mandibular arches. The first aortic arches are, however, present and form a loop around its attenuated anterior pharynx. The left mandibular arch of B is, however, present and its 1st left aortic arch runs through it in a normal manner. The right mandibular arch is, on the contrary, nothing but a vestige, so that the 1st right aortic arch of B makes no attempt to run through it but connects with the aortic loop formed by the 1st aortic arches of A. Finally, all three of these vessels then connect with the anterior end of the ventral blood vessel, so that they appear to spring directly from it.

There seems to be little doubt that the strange configuration of the aortic arches had been determined hydrodynamically. However, Copenhaver (1939) made hetroplastic transplantations of heart rudiments of *Amblystoma tigrinum* to the side of *A. punctatum*. Out of 100 *tigrinum* to *punctatum* grafts, thirty-seven survived and developed a heart in the heterotopic position which established connections with the blood vessels of the host. Blood entered the venous end of the transplanted heart and was pumped out the arterial end. While Copenhaver did not comment on the phenomenon, it seems possible that chemodynamic as well as hydrodynamic factors may have entered into the establishment of the connection in this case. In the case of our twin, however, it seems safe to conclude that the configuration of the aortic arches arose from purely hydrodynamic causes, as the early connections of the heart with the blood vessels may be assumed to have been entirely normal, as they undoubtedly arose before the fusion of the component embryos.

By examining the photographs of the models of the hearts (Figs. 8, 9, 10), it will be noted that there is no evidence of atrophy of Heart I in correlation with its evident loss of function, or of hypertrophy of Heart II in correlation with its increased functional load. If anything, Heart I is the

[1]It is quite evident, however, that no long continued development of the "twin" could have taken place because of the want of amnion formation. Such a want of amnion formation may account for the fact that there is no record of any avian Siamese twins ever being hatched.

larger of the two. It appears possible that the relative size of Heart I is due to excessive work put upon it due to its malformed structure, irrespective of the fact that it was pumping a very small amount of blood. It is unfortunate that the student who discovered and fixed the monster did not make observations on the heart beats before killing it. He was, however, under the impression that the hearts beat at the same tempo, but alternately. On questioning, he appeared to have made no extended observations that could be relied upon.

Legend

A, embryo A.
aa (1-5), Aortic arches of A; *aa'* (1-5), aortic arches of B; *rt*, (right), *lf* (left), as case may be.
aa 1″, First left aortic arch of A in Fig. 4.
aa 1‴, First right aortic arch of B in Fig. 4.
aa 2′, Second left aortic arch of A in Fig. 6.
aa 2″, Second right aortic arch of A in Fig. 6.
aa 2‴, Second right aortic arch of B in Fig. 5.
aa 2⁗, Second left aortic arch of B in Fig. 6.
aab, Bases of aortic arches.
atr, Atrium of heart I.
atr', Atrium of heart II.
B, Embryo B.
ba, Bulbus arteriosus of heart I.
ba', Bulbus arteriosus of heart II.
cdc, *Common* common cardinal vein of A.
cv, Commissural vessel.
cvv, Commissural vitelline vein.
da, *rt*, Right radix aorta of A.
da, *lf*, Left radix aorta of A.
da', Dorsal aorta of B.
da″, Left radix aorta of A in Fig. 6.
da‴, Right radix aorta of A in Figs. 4, 6.
da⁗, Dorsal aorta of A in Fig. 7.
dc″, Right common cardinal vein of B.
dc‴, Right *common* common cardinal vein of A.
de, Diencephalon.
hr, Herniated region of heart I.
ht I and *ht* II, Heart I and heart II.
hy, Hypothysis.
ic, Internal carotid.
ld, Liver diverticulum.
ma, Mandibular arches.
mc, Myocoele.
ms, Mesencephalon.
mt, Metencephalon.
my, Myelencephalon.
oc, Oral cavity.
ot, Otic invagination.
ov, Optic vesicle.
pc', Left postcardinal vein of A.
pc″, Right postcardinal vein of A.
pc‴, Right postcardinal vein of B.
pc⁗, Left postcardinal vein of B.
ph', Pharynx of A.
ph″, Pharynx of B.
s, Somatopleure surrounding heart II.
sv, Sinus venosus of A.
sv', Sinus venosus of B.
ta I, Truncus arteriosus of heart I.

ta II, Truncus arteriosus of heart II.
va, Vitelline artery.
vbv, Ventral blood vessel.
vc 1′, First left visceral cleft of A in Fig. 5.
vc 2″″, Second left visceral cleft of B in Fig. 5.
vp, 1′, First left visceral pouch of A in Fig. 6.
vp, 2″″, Second right visceral pouch of B in Fig. 6.
vp, 3″″, Third left visceral pouch of B in Fig. 6.
vp (1-4), Visceral pouches of A; *vp*, (1-4)′, Visceral pouches of B; *rt* (right) or *lt* (left) as the case may be.
vp, 2′ *lf* and *vp* 2″ *lf*, Bifid third left visceral pouch of A in Figs. 11 & 12.
Vent, Ventricle of heart I.
Vent′, Ventricle of heart II.
vvcc, Common central vitelline vein.
vvp′, Posterior vitelline vein of A.
vvp″, Posterior vitelline vein of B.
x, Amniotic fold which finally fuses with a fold, somatopleure, (y) to form a restricted amnion over tip of bent portion of A.

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Text-Figure 1. Semi-diagramatic drawing of transverse section of pharynx immediately posterior to the last visceral pouches. Blood vessels shown in black. Structures which lie anterior to section are stippled. The outline of the cross-section of the combined pharynges is outlined by a heavy line. Structures belonging to B are indicated by a ′ following the lettering; the structures belong to A have no mark following the lettering.

Plate I

Fig. 1. Photograph of the entire mount before sectioning. The lines marked 2, 3, 4, 5, 6, 7 show the approximate regions of the photomicrographs of the sections shown below.

Figs. 2, 3, 4, 5, 6, 7. Photomicrographs of sections corresponding approximately to the regions indicated by the lines labeled 2-7 in the figures of the entire embryo.

Plate II

Figs. 8, 9, 10. Photographs of wax model of the hearts.

Figs. 11, 12, 13. Photographs of wax model of the pharyngeal regions of the "twin", showing region of fusion and arrangement of aortic arches.

Summary

1. The monster under investigation is a thoracopagus twin which had been incubated for a period of 72 hours. The region of fusion extended from the region approximately indicated by the first visceral pouches to the anterior intestinal portal. The individual embryos are designated A and B.
2. Amnion formation had largely been inhibited, the amnion covering only a small part of A. Amniotic head folds are entirely wanting.
3. There was considerable distortion of the vesicles of the brain, especially evident in A.
4. The right eye is defective in both A and B, insomuch that both optic cup and lens have failed to form. The left eyes, however, are normally developed for their age.
5. Both olfactory and otic invaginations appear to be normal.
6. The anterior regions of the alimentary tract as very abnormal. Their morphological relations can only be understood by referring to text and figures.
7. There is only one oral cavity—that of B. The fore-gut of A, however, communicates with the exterior by narrow passage connecting it with the hypophyseal portion of Rathke's pocket.
8. There is only one complete mandibular arch present—the left one of B.
9. There are no thyroid nor lung diverticula present in either A. or B.
10. There are three liver diverticlua present, all of which belong to B.
11. There are two hearts, Heart I and Heart II. The former is distorted, while the latter is much more normal and appears to have taken over the greater part of the functional activity of Heart I.
12. The sinus venosus of Heart II is enormous and receives all the systemic blood of A, the right common cardinal of B, and the greater part of the vitelline circulation. Heart I, on the contrary, receives only the left common cardinal of B and the right vitelline vein of A.
13. The arrangement of the aortic arches is most peculiar, and cannot be summarized.

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University of Virginia,

University, Va.

Chemistry at William and Mary, 1693-1860

Robert G. Robb

Through the years, William and Mary has been fortunate in securing able men on its faculties, men who have had a profound influence on American thought and education. We are concerned here, however, solely with those connected with the Department of Chemistry, or its ancient prototype natural philosophy.

For the first fifty years after the founding of the College in 1693, the campus atmosphere seems to have been decidedly monastic. There were two divinity schools—one professor taught the Hebrew tongue and expounded the Old and New Testaments, while the other "explained the commonplaces of divinity and the controversies with heretics." (Small wonder that the Brafferton Indian School of the College was never popular with the Indians!) The impediments of a wife and family were accorded to the president of the College only; any mere professor "entering into marriage or removing into town ipso facto vacated his office" by decree of the Board of Visitors.

In such a habitat the sciences were undoubtedly at a very low ebb. Natural philosophy was completely overshadowed by big brother, moral philosophy. This lack of interest in science prevailed until about the middle of the eighteenth century, when there seems to have been a great awakening of interest in natural phenomena throughout the English speaking world. William and Mary was fortunate to have just at this time of awakened interest in science, a remarkable teacher occupying the chair of natural philosophy. William Small, intimate friend of Samuel Watt, of steam engine fame, and of Erasmus Darwin, scientist and grandfather of Charles Darwin, came to Williamsburg in 1758, bringing with him a vital enthusiasm for science that infected all who sat under him. He made a lasting impress on education in the New World by introducing the lecture system and reinforcing these lectures by classroom demonstrations expertly performed with excellent apparatus. In the College library there is a sheet of paper in Dr. Small's handwriting which lists some fifty or more pieces of scientific apparatus purchased by him in London in 1764 under a commission from the College. The total cost of this scientific equipment was 332 pounds, 4 shillings —at least $30,000.00 in present day coin—and it doubtless gave to William and Mary the best scientific equipment of any college in America.

A seven word tribute from one of his students will indicate the caliber of William Small's work as teacher and leader: "He fixed the destinies of my life," wrote Thomas Jefferson.

Small returned to England in 1764, and the next man of note to take the chair of natural philosophy was James Madison, later president of the College and Episcopal Bishop of Virginia.

Madison took up his duties just before the outbreak of the American Revolution. He was an ardent republican and in his sermons always referred to Heaven as "that Great Republic," where presumably free and equal angels spent their days flitting through halos and clouds of glory. At one time or another he was in charge of the departments of moral philosophy, international law and political economy; but "in the department of Natural Philosophy he excelled, his enthusiasm throwing a peculiar charm over his labors."

If in the early days, science sometimes suffered under the ministrations of philosophers, who were educated and thought as clergymen of the Church of England, ample amends were made by the Rt. Rev. James Madison, a philosopher with a touch of reverence, who gloried in the marvels of science and knew no greater pleasure than the study of natural phenomena and their underlying laws. Among the inducements for the study of natural philosophy, he records the following: "The gratification which the mind feels in pursuit of it"; "The novelty and grandeur of the subject"; "It is the best field for exercising man's intellect"; "It is the source of the sublimest conception of the Author of the Universe"; "In our enquiries into the works of Nature every moment brings us something new, beautiful and instructive."

The following quotations taken almost at random from the lecture notes of Robert D. Murchie, student at William and Mary in 1809, do scant justice to the subject but will give some idea of Madison's course in natural philosophy. In these notes, the Caloric Theory is found in perfect flower, presented with convincing plausibility and a wealth of homely illustrations.

> "It is supposed that there exists a very subtile and elastic fluid dispersed through all the bodies of the Universe. . . . This heat or caloric is a distinct body, having a considerable part to act in all chemical operations and from the absorption or disengagement of this body arises a temperature. . . . The most obvious instance of a body parting with caloric is this: When a heated body is cooling in the air, the air surrounding it will exhibit an undulatory motion resembling the appearance produced by mixing two liquids (brandy and water for example) of unequal densities. This undulatory motion clearly results from the passage of some substance from the heated body to the air.
>
> "If a body has a greater affinity for another than for caloric then the heat is disengaged or precipitated. Water has a stronger attraction for vitriolic acid than for caloric—caloric is therefore disengaged. . . . Other methods of disengaging caloric are by friction, hammering, etc.
>
> "Caloric not only surrounds the particles of bodies on every side but it fills up every interval which the bodies leave between each other. It enters into the interstices of matter and separates its particles; when it departs the particles come closer together and the bulk of the body is contracted. . . . Every body which passes from the solid state to the liquid state absorbs a portion of heat which is no longer sensible to the thermometer but is in a true state of combination.

"Chemical affinity is the agent employed by Nature to maintain its equilibrium by forming a balance to the power of repulsion or that extremely subtile fluid called caloric which ever tends to disunite the particles of matter. . . . The power of affinity which ever tends to keep bodies united and the caloric which ever tends to disunite them are in perpetual warfare.

"In every combustion, oxygene combines with the body burning; it abandons its caloric. The caloric is disengaged and produces immediately sensible heat and light because it endeavors to combine with neighboring substances. . . . Oxygene is eminently possessed of caloric, the greater and more rapid the absorption of oxygene the greater the heat.

"God said, let there be light, and there was light, but it is still a question what is light. . . . We are ignorant in what manner the sun darts forth those rays that seem to animate all Nature. . . . Light is a material substance consisting of particles inconceivably small. A ray of light equal only to the 14 millionth part of a grain of sand would have the force of a cannon ball of 10 pounds flying with the usual velocity; yet the light of the sun instead of wounding, nourishes the most tender and delicate parts of flowers.

"Refraction arises entirely from this fact: that rays are more attracted by a denser than a rarer medium, hence it is that a straight stick immersed (partly) in water appears crooked."

The following is a rather remarkable observation for the year 1809: "Besides the power of reflection, *we may prove that rays of light passing near the edges of bodies are attracted by them and turned out of their straight course.*" (The italics are mine).

A hundred years later, when Einstein as a result of his calculations came to this identical conclusion, astronomers were sent scurrying to the far corners of the earth to test the truth of the statement by observations at the time of a total eclipse of the sun. Madison gives no hint of the source of his statement nor of any method for proving it. It is possible he picked up the idea from Newton's Principia.

"The manner in which the electric fluid is excited is a subject of curious speculation; as yet it rests on the uncertain foundation of conjecture."

"There is a battery at William and Mary sufficiently strong to take away life."

"During a thunder storm if you wish a place of perfect security place yourself in a feather bed suspended from the ceiling by silken cords: but this is a method which will be resorted to only by the guilty wretch who trembles at the thought of death and not by virtue's ardent votary whose soul disdains the slavish fear of launching into the boundless ocean of eternity and supports him tranquil and unappalled amid the crush of worlds."

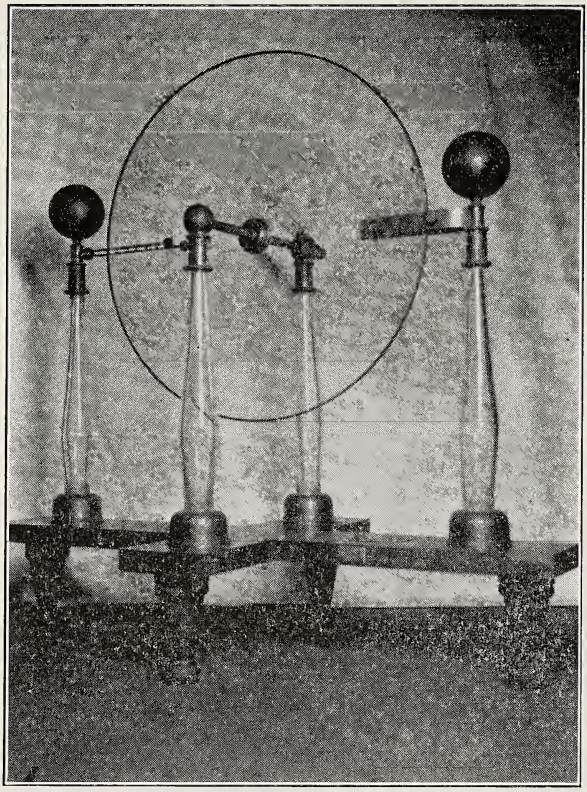
"The amusement which electricty affords us is alone a sufficient inducement to study it."

"The cultivation of the science cannot fail to be grateful to the inquisitive mind of man. I therefore advise every student to furnish himself with an electrical machine since the expense is small compared with the pleasure it will afford."

That the pleasure furnished by these ancient electrical machines really was worth the cost of the apparatus is indicated

by the following verses from Murchie's notes. Whether these lines were read to his class by the good Bishop, or whether they were inserted into the lecture notes at this point by the more romantic Mr. Murchie, the record saith not:

"If on wax some fearless beauty stand
And touch the sparkling rod with graceful hand
Through her fine limbs the mimic lightnings dart
And flames innocuous eddy round her heart.
On her fair brow the kindling lustres glare,
Blue rays diverging from her brilliant hair,
While some fond youth the kiss ethereal sips
And soft fires issue from their meeting lips."



An Old Machine in the Possession of the College of William and Mary Used to Generate Electricity By Friction. Made by E. S. Ritchie, Boston. Diameter of Wheel, About Three Feet.

When Jefferson was in Williamsburg in 1779, as Governor of Virginia, he found a congenial spirit in Madison; and together they reorganized the College curriculum. The classical department and the two divinity schools were abolished, and chairs of medicine, law, and modern languages introduced.

The department of natural science continued to attract able men; and after the death of Madison, in 1812, this chair was filled by some of the most eminent scientists of the country. Among these was Robert Hare, pioneer organic chemist of America, inventor of the oxy-hydrogen blow pipe, and discoverer of a cheap way to make acetylene. Brilliant in research, Hare seems to have been but a mediocre lecturer. He spent but one year at William and Mary and was succeeded by the first of a great family of teachers, Dr. P. K. Rogers, who in 1828 was succeeded by his still more able son, William Barton Rogers, later chairman of the University of Virginia faculty and founder, in 1859, of the Massachusetts Institute of Technology.

A newspaper advertisement dated August 10, 1829, gives some idea of the character of the science courses at that time:

> "Chemical and Philosophical Course: William B. Rogers, Professor—Chemistry, Mineralogy, Botany and Natural Philosophy with its application to the Mechanic Arts. Textbooks, Webster's Chemistry, Rogers' Introduction and Carvallo's Natural Philosophy."

This bald statement of the courses taught by William B. Rogers gives no conception of the extraordinary fascination of the lecturer. Like William Small, he changed the destinies of students who sat enthralled by his powers of exposition. Francis H. Smith, for fifty years the beloved professor of physics at the University of Virginia, records the impression made by Rogers' course:

> "It was a memorable epoch in my own intellectual life when I first listened to his presentation of Newton's argument for universal gravitation. . . . In power to make difficult things plain, he was unequalled by any teacher I have ever known. His capacity for luminous exposition was really extraordinary. At his touch complex things became simple and dark things bright."

He was intensely interested in all branches of science. His father, Patrick Kerr Rogers, wrote to Thomas Jefferson:

> "I take the liberty of sending you a copy of a little work prepared for the use of one of my classes at William and Mary. The demonstrations of the 14th, 35th, 68th and 93rd propositions are by my second son, who is now in his twentieth year and has a very extraordinary passion for physico-mathematical sciences."

The remarkable success of William Barton Rogers as a lecturer is in part explained by his own statement:

> "In my opinion a very important requisite in public speaking is zeal or perhaps I may even say enthusiasm. With respect to my own exertions, I have always observed that my success in exposition is proportional to the earnestness with which I engage in it."

What an incalculable boon it would be to the under-graduates of today if some of our learned doctors would put into their

chosen profession of teaching a small part of the zeal and enthusiasm which they lavish on research and publications!

On the resignation of William Barton Rogers, in 1836, to accept a professorship at the University of Virginia, Dr. John Millington was elected to the chair of natural philosophy at William and Mary. Dr. Millington was the author of many books and scientific papers published in London, Philadelphia, and Richmond. His academic record includes the following honors: Fellow of the Astronomical Society of London; Fellow of the Royal Society of Arts; Professor at the Royal Institution of London; Professor of Chemistry at Guy's Hospital; Vice President of the London Mechanics Institute. He filled the chair of natural philosophy at William and Mary very ably for thirteen years.

One may read on his very ornate tombstone in Bruton Parish churchyard that he died in 1868, after "ninety years of an honored and useful life on earth closing in eternal rest. . . . Science mourns the loss of a devoted and indefatigable disciple of most varied information and of marvelous industry: the worthy friend and associate of men like Sir H. Davy, Breedster, Faraday, Hershell and Lord Brougham." Evidently, this member of the Society (as the William and Mary faculty preferred to style themselves) was quite a personage.

Perhaps is was Dr. Millington's association with lords and ladies of London that in time made him dissatisfied with the society of Williamsburg. At any rate, a letter to his friend Bernard Peyton, of Richmond, January 4, 1848, shows him to be actively promoting a plan to start a new college in Richmond, because he had become "quite disgusted with my old favorite Williamsburg." In a second letter to Peyton, he writes: "My own chemical and philosophical apparatus and collection of mineralogical and geological specimens is very large and complete, and my library of 4,000 volumes on all subjects would be at the service of the Institution without expense." This statement reflects to some extent the changed financial status of the College since the days of affluence before the Revolution. Dr. Tyler states that in colonial times the salaries of William and Mary professors were probably larger than those paid at any other college in America. "A professor of divinity received annually 150 pounds sterling from the College and in addition to this 16,000 pounds of tobacco as incumbent of some neighboring church." However, when Dr. Millington assumed his duties at William and Mary, the College had lost most of its former sources of income, and appropriations for scientific equipment had been woefully cut. Millington stated that his ingenious predecessor (Rogers) had made much of the apparatus used in class demonstrations, but that he, Millington, was "resolved not to risk his reputation by proceeding with the course aided only by the scanty materials

at his command." He, therefore, in addition to the regular College appropriation, spent $3,600.00 of his own money in scientific apparatus, thus making his laboratory "replete with every modern improvement and convenience, and furnished with very extensive apparatus for illustrations."

Millington resigned from the College in 1849 to become head of the chemistry department at the University of Mississippi, and Benjamin S. Ewell took his place at William and Mary. By this date, the College had sold its twenty thousand acres of land and put the proceeds into an endowment fund of approximately one hundred and forty thousand dollars, which yielded an income in 1859 of about $8,000.00. In that year the main building of the College was gutted by fire and practically all scientific equipment destroyed. Ewell, now president of the College, succeeded in repairing most of this damage by the fall of 1860, mainly by individual subscriptions. In May, 1861, "war at its very threshold made it necessary for the College to suspend exercises. . . . The President and all the students and Professors hurried into the Confederate army."

PROFESSORS OF SCIENCE AND OF MATHEMATICS AT THE COLLEGE OF WILLIAM AND MARY IN VIRGINIA PRIOR TO THE CIVIL WAR

(Dates shown are the years when professors were appointed; dates of resignation or death are given only when a hiatus occurs in the series.)

Professors of Natural Philosophy and Mathematics

— Le Fevre	1712–1713
Rev. Hugh Jones	1717
Alexander Irvine	1729
Joshua Fry	1732
John Graeme	1737
Rev. Richard Graham	1749
William Small	1758–1764
Rev. John Camm	1766
Rev. Thomas Gwatkin	1770–1775
Rev. James Madison	1773

Professor of Anatomy, Medicine, and Chemistry

James McClurg	1779–

Professors of Natural Philosophy

Rt. Rev. James Madison	1784
Dr. John McLean	1812
Dr. Thomas L. Jones	1814
Dr. Robert Hare	1818

Professors of Natural Philosophy and Chemistry

Patrick Kerr Rogers, M.D.	1819
William Barton Rogers	1828
Dr. John Millington	1836
William F. Hopkins	1849
Benjamin S. Ewell	1848

Author's Acknowledgments

Material used in preparing this article include:

Various publications of Dr. Lyon G. Tyler.

Murchie's *Lecture Notes* on Madison's Course in Natural Philosophy.

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William Barton Rogers, Organizer and Educator, by John Stewart Bryan, Alumni Gazette of the College of William and Mary, March, 1939.

College of William and Mary,

Williamsburg, Virginia.

Notes on Copulation of Certain Nematodes

W. L. Threlkeld

In the process of collecting material for studies pertaining to the incidence and control of helminth parasites of sheep, routine examination of washings from the digestive organs indicated that copulation in several of the larger species could be readily discerned at a magnification of x 20.

As this phenomenon has received little attention pictorially some of these worms were successfully removed from the washings, immersed in Carnoy's fixative for twenty-four hours, washed in 70% alcohol, mounted in glycerine, and photographed. The routine preservative added to the washings was formaldehyde, resulting in an approximately 8% solution. Carnoy's fixative was not used on worms fished from these washings.

The material obtained yielded four pairs of *Haemonchus contortus* from the abomasum, fifteen pairs of *Bunostomum trigonocephalum* from the small intestine, and from the colon, five pairs each of *Oesophagostomum columbianum* and *O. columbianum-Chabertia ovina* unions.

Two whole mounts of *Haemonchus* worms were made. The photomicrograph Figure 1 of one of these is represented. An attempt was made to dehydrate and section the other two pairs of worms, but disjunction occurred when the specimens were transferred to paraffin. All of the *Bunostomum* worms were mounted and a photomicrograph of one pair is described, Figure 2. Attempts to mount *Oesophagostomum columbianum* were unsuccessful, and only one of *Oesophagostomum-Chabertia* unions was successfully mounted. One of these is pictured in Figure 3. Figures 4 and 5 show the anterior ends of the parasites pictured in Figure 3.

The reproductive system of male strongylid worms has been frequently described in numerous text books as consisting of a testis, seminal vesicle and vas deferens forming a single elongated, continuous structure. This sequence of organs almost entirely fills the body of the worm displacing the intestine from one side to the other.

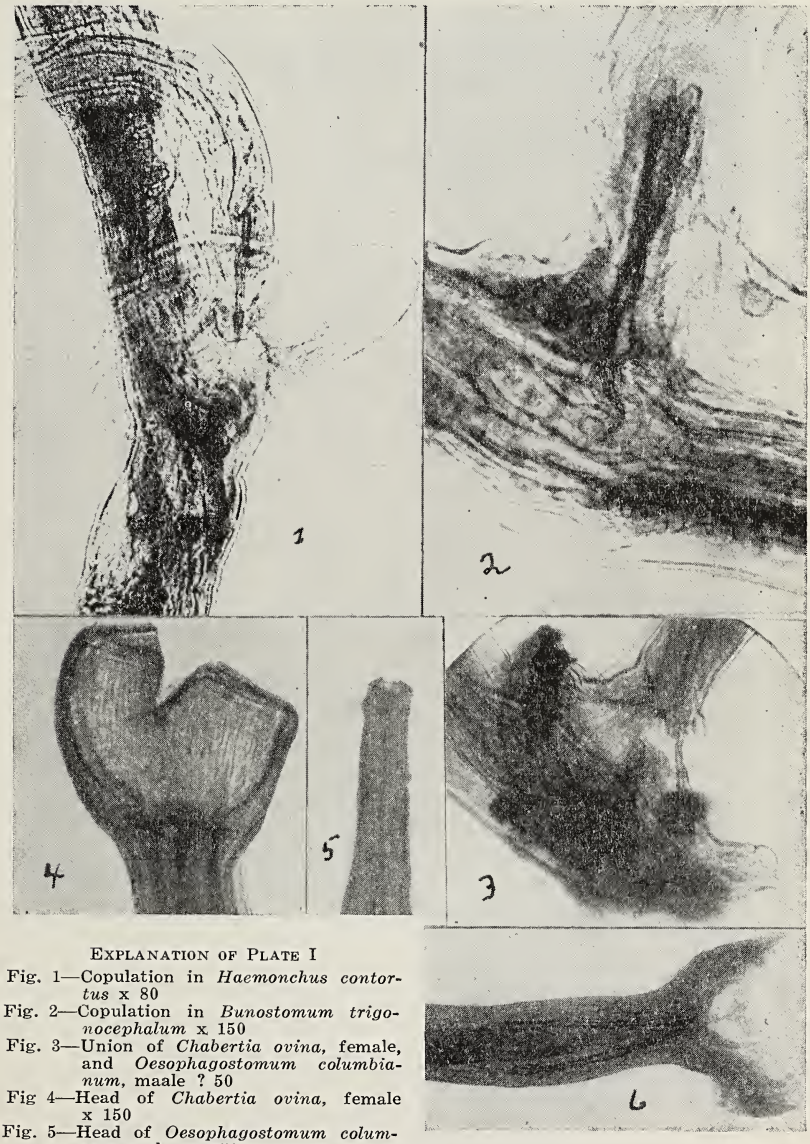
The proximal position of the testis is often twisted and its relative position varies throughout the length of the worm, becoming thicker and straighter at its distal position where, in many species, there is situated a cement gland. Conjointly with the intestine the genital tract empties into the cloaca which terminates in an anal opening. Figure 6, showing the posterior region of *Ostertagia circumcincta* illustrates the position of the accessory reproductive organs. The black "V" shaped structure, the chitinous spicules, lie adjacent to the terminus of the intestine with the caudal portion of the genital tract appearing within the "V". The spicules can be withdrawn or protruded by means of

muscular action. They have been described as holdfast organs, excitors, dilators of the vagina and directors of the spermatozoa during copulation. Cuticular thickenings intimately connected dorsally and ventrally may be present to serve to guide the spicules and are known respectively as the gubernaculum and telamon.

In the male stronglid worms there is a large terminal accessory structure called the "bursa" composed of lobes supported by tactile rays. This structure is well illustrated in (the photomicrograph), Figure 6. Figure 1 depicts one apparent function of the bursa and spicules during copulation. The latter structures identified in the photomicrograph as a black pencil-like object, are inserted well into the vagina while the bursa is pushed slightly cephalad with respect to the male and closely applied to the body of the female, almost as a human hand would grasp a bar with the thumb extended, representing the spicules. It seems that in this case the chief holdfast organ is the bursa and there is little evidence of cement being employed as a holdfast agent, certainly not to the extent to which it is employed by *Oesophagostomum* worms. In the latter species it is evidenced by a dark mass of the material deposited around the vulva. In *Bunostomum* species, Figure 2, the spicules are of an entirely different form from those of *Haemonchus*. These spicules are longer, more slender, and alate, and are characterized by a definite double twist before they become closely applied to each other at their ends which reach the muscular ovijector of the female. The bursa is too short to function as the main holdfast organ. The lobes of this organ are more or less flattened to the body of the female instead of grasping the female as in *Haemonchus* species. A great amount of cement is applied in the union to insure permanence of position. The bursa of the male is so firmly attached to the female that little difficulty was experienced in the transfers to slides. It is not known how long this species may remain in copulation. In one instance an embryonated egg was caught, apparently at the time of deposition, between the bursa of the male and the body of the female. This may be seen to the left of the vulva, faintly outlined in the photomicrograph. (Fig. 2). Ejection from the vulva probably occurred just before the spicules made entrance. Eggs of this species have been reported as hatching in twenty-four hours at 22° C. If the body temperature of the host animal played no part in accelerating the rate of development of the egg it is probable that copulation had been in process for at least twenty-four hours previous to slaughter of the sheep.

Figure 3 shows the union of an *Oesophagostomum* male and a *Chabertia ovina* female. These were one of five such pairs observed at a magnification x20. No claim is made that copulation was accomplished or that eggs were fertilized. On the other hand circumstantial evidence is not lacking in this case. It will be noticed that the tail of the female is characteristic of *Chabertia ovina*. In an attempt to clear away the dark ring of cement so characteristic of *Oesophagostomum* species, the spicules were

slightly displaced from the vulva and appear in the picture just posterior to the anus. The heads of these worms appear in Figures 4 and 5. Here again the parasites can be readily identified. The cleft in the mouth of the *Chabertia ovina* resulted from accidental pressure on the slide before it was ringed with balsam. Attempts to mount the other pairs of these species in union were unsuccessful.



EXPLANATION OF PLATE I

Fig. 1—Copulation in *Haemonchus contortus* x 80

Fig. 2—Copulation in *Bunostomum trigonocephalum* x 150

Fig. 3—Union of *Chabertia ovina*, female, and *Oesophagostomum columbianum*, maale ? 50

Fig 4—Head of *Chabertia ovina*, female x 150

Fig. 5—Head of *Oesophagostomum columnum*, male, x 150

Fig. 6—Posterior end of a male *Ostertagia circumcincta*, x 80

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A Simple, Sturdy, Precise Glass Thermoregulator with a Rapid Adjustment for Different Temperatures

H. N. Calderwood[1] and F. W. Koerker[2]

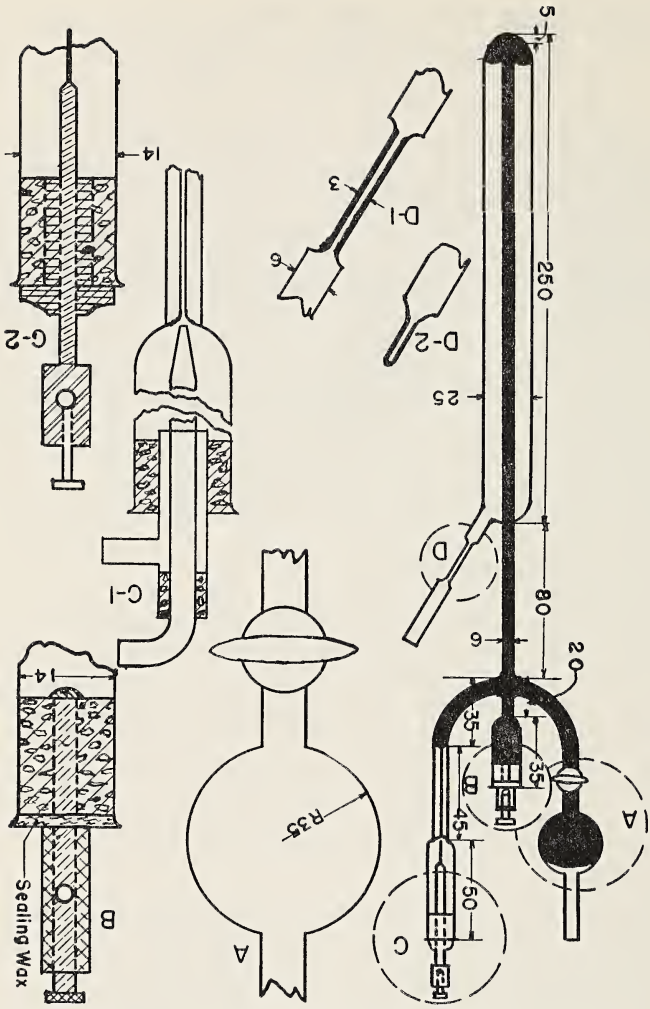
The thermoregulator shown in the accompanying drawing was designed to give an instrument with several advantages over the forms usually described.

The rugged form of construction presented by the concentric cylinders affords the expansive fluid a large surface in proportion to its volume, which surface, combined with the acceleration of the convection currents by the hollow cylindrical space, greatly reduces the time required for the fluid to attain the temperature of the bath. Filling operations are greatly simplified, and are made in such a manner as to eliminate entirely the entrapping of the expansive fluid, e.g., toluene, in the mercury column, with the accompanying breaking of the electrical circuit when the instrument is used in an electrically heated bath. Another very desirable feature, adding greatly to the ruggedness of the instrument when used in an electrical circuit, is the complete absence of metal through glass seals.

In some glass laboratory thermoregulators, particularly those designed for gas heating, the setting or adjustment is made by changing the position of a mercury surface with a piston actuated by a screw. A serious difficulty with this device is the leakage of the mercury past the piston, necessitating a resetting of the piston. In the instrument shown in this article the piston is replaced by a stopcock and a reservoir of mercury (part A), danger of leakage thus being prevented. Any properly made stopcock is satisfactory, but one with a small bore is preferable, since it gives closer control when the instrument is adjusted for different temperatures.

The central tube (part B) carries the fixed electrical connection which is not used when the instrument operates a gas heated bath, and the capillary equipped arm (Part C) is the usual circuit controlling device. For a gas heated bath the attachment (part C-1) is used, while for a bath heated electrically the fixed binding post (part B) and the attachment (part C-2) are used to control the electrical circuit. With an electrically heated bath greatly increased precision of the temperature regulation is obtained, since the platinum tip on the adjustable contact (part C-2) can be placed at the upper end of the capillary bore, thereby taking advantage of the region of maximum variation of the mercury thread for the minimum temperature change. Although the entire capillary bore constitutes a region of maximum sensitivity, the upper end was selected as the most desirable point at which to close and open the electrical circuit, since, should any

[1]Present address: 3814 Jocelyn Street, Washington, D. C.
[2]Present address: Dow Chemical Company, Midland, Michigan.



failure of or accident to the electrical circuit cause the bath to overheat, that quantity of mercury forced by the increased temperature to rise above the lower end of the platinum wire will return, when the proper temperature is restored, below the wire without entrapping any air and thus avoid breaking the electrical contacts within the thermoregulator.

After fabrication and cleaning of the instrument, the expansive fluid chamber is filled through tube B with purified mercury (1) to a depth of 2.5 cm. above the lower end of the tube. Purified toluene (2) is then distilled directly into the chamber by means of an adapter with a capillary tip to conduct the distillate past the construction shown in part D-1, until the expansion

chamber is filled to within 5-10mm. of the bottom of the constriction. The adapter is then drained and removed without wetting the constriction, the adjacent glass parts are protected by asbestos shields, and the expansion chamber is sealed, as shown in part D-2, by means of a fine blast flame. A funnel with a fine capillary tip of sufficient length to dip into the column of mercury in tube B is now fixed in the top of tube B by a closely fitted stopper, and the arms A and C are closed by means of the stopcock and a stopper respectively. Purified mercury is poured into the funnel and allowed to flow slowly into tube B by partially opening the stopcock in A, the entire instrument being tapped continually to dislodge any small bubbles of air entrapped by the rising mercury column. After the mercury column has reached the point of junction of arms A, B, and C, the funnel is moved up so that the tip is again only slightly submerged, and the filling continued until the column of mercury has entered the bore of the stopcock, which is then closed and the filling again continued until tube B is filled completely.

In the meantime the cork stopper (rubber should not be used because of contaminating the mercury) which is to carry the fixed binding post is prepared in the following manner. A cork stopper of the best quality is pressed thoroughly and bored for an iron screw of such a size and thread as to fit into a small electrical binding post. The bored stopper is steeped in a small bath of paraffin at the temperature of boiling water until all the air in its pores has been dislodged. It is then cooled in the bath, and after being reheated is removed and, while hot, wiped free from excess paraffin. The iron screw and binding post are now attached to the stopper and tightened firmly. This entire assembly is carefully lowered onto the column of mercury in tube B in such a manner as to entrap no air between the stopper and the mercury, and gently but firmly pressed into the tube until it reaches the position shown in part B. A small amount of melted sealing wax, preferably composed of equal parts of beeswax and rosin, is now poured into the tube so as to seal the stopper firmly into place, and the mercury reservoir above the stopcock in part A filled to any desired volume.

The thermoregulator is now placed in the bath whose temperature it is to control, and the bath brought approximately to the desired temperature. The excess mercury in part C is removed down to the top of the capillary and the temperature of the bath adjusted to the desired point. The gas or electrical regulating part is then inserted and the final adjustment made by manipulating the stopcock in arm A. With an electrically heated bath the final adjustment may be made very close by raising or lowering the platinum tip by means of the threaded portion of the regulating head (part C-2) in arm C.

At the time this instrument was developed, Dr. Walter H. Bauer of this laboratory developed one of the same form, but

without the arm A with its reservoir and stopcock for the rapid adjustment for different temperatures. The fixed binding post used here was installed at Dr. Bauer's suggestion. One of these instruments, of the dimensions shown, held the temperature of a covered and insulated bath operating below room temperature within a range of ± 0.005° C. of the desired point for six months without any difficulty.

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A Simple Aerator

Herbert William Jackson

A constant source of clean air for aeration of aquaria or other low pressure uses may be obtained by the following apparatus (Fig. 1). The salient features are an aspirator or vacuum pump which works on water pressure (A), and a chamber for the separation of air and water (E). Tubes conducting water (C, D, F) should be large (8 to 10 mm.) to reduce friction. Water and air from the discharge of the aspirator (C, D) are led into the separation chamber through one hole of a three-hole rubber stopper. Through a second hole, a small glass tube (H) leads air from the

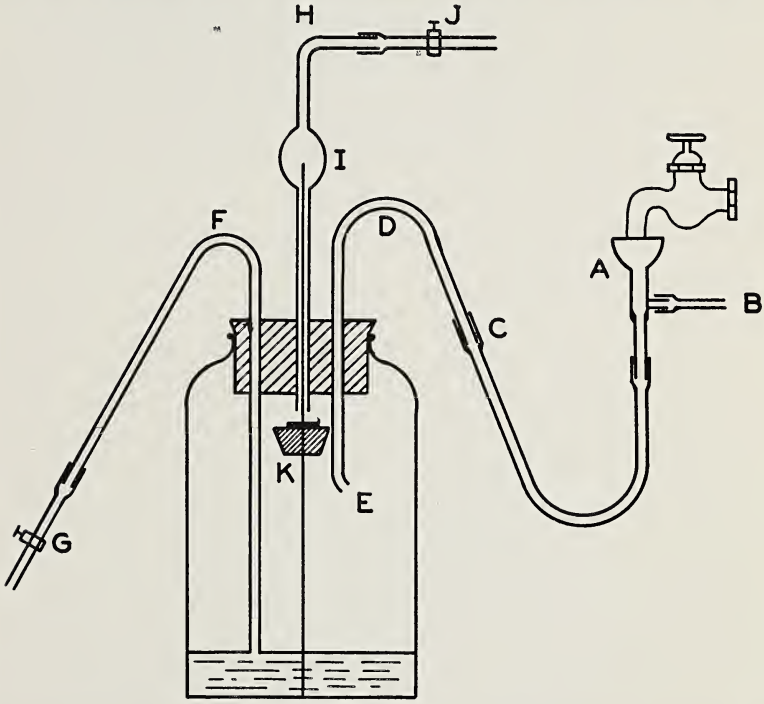

Fig. 1.

A—Aspirator or vacuum pump on faucet.
B—Air intake (a few feet of rubber tubing reduces noise).
C—Large bore rubber tube.
D—Air and water intake (8 mm. glass tubing).
E—Separation chamber (1-2 liter capacity).
F—Water and excess air discharge (8 mm. glass tubing).
G, J—Adjustable pinch cocks.
H—Air discharge (3-5 mm. glass tubing, bulb (I) prevents condensed moisture being carried along in air tube).
K—Automatic float valve.

top of the chamber (the bulb I is highly desirable), while through the third hole a tube (F) leads water from the bottom. Both air and water outlets should be controlled by valves (G, J). When the air valve (J) is closed, pressure in the chamber will force

both air and water out through the water outlet (F). The air valve (J) may now be opened slightly, permitting just enough air to escape so that a slight excess continues to flow out with the water. This excess is necessary as a safety factor, as should the air outlet be too free, the reduced pressure will allow the chamber, and consequently the air tube, to fill with water.

An automatic float valve (K) may be readily constructed of a large paraffined cork with a soft rubber disc on top. The upper end of a length of stiff wire thrust through the cork and rubber disc slides up the air outlet, while the lower portion extends down to the bottom of the chamber as a support to prevent the guide wire from falling out of the air tube.

When the air pressure falls too low to force the water out through the normal passage (F), the water will rise in the separation chamber and float the cork up against the end of the air tube, thus effectively closing it until the water level drops somewhat. This automatic valve may be relied on entirely in place of the air valve (J) if desired. Pressure up to the limit of the strength of the apparatus may be obtained by adjusting water outlet valve (G).

Cornell University.

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Biology at William and Mary Before the War Between the States

DONALD W. DAVIS

Like nearly all of the current subjects of instruction at the College of William and Mary, Biology naturally traces back into departments under other names. Meager as must have been the teaching during the early years in any of the fields specifically mentioned in the Charter granted in 1693 by the British sovereigns, certainly some matter within our present field was contemplated in the listing of objects mentioned in the preamble of the Charter: " . . . to the end . . . that the youth may be piously educated in good letters and manners . . . to make, found and establish a certain place of universal study, or perpetual College of Divinity, Philosophy, Languages and other good Arts and Sciences . . ." It is safe to say that none of those subjects in the conception of Commissary Blair, who doubtless prescribed them, would have been defined in terms that would at all fit with the boundaries of present departments. For any fair view of the teachings of those days, one must go back of the titles of the chairs established and of the courses that may be listed, remembering that the terms, Natural Philosophy, Natural Science, and Chemistry were by no means so restricted in meaning as they have since become, and that Science signified knowledge or learning rather than the particular body of knowledge that the word means today. A letter, illuminating on the point, was written in 1802 by "an inhabitant of Williamsburg" to the Editor of the *New York Evening Post* to protest errors contained in "two short paragraphs (of that paper) respecting the College of William and Mary." One item of the correspondent's indictment is as follows: "9. Instead of the desertion of science, in the College of William and Mary, it is submitted, whether mathematics, natural philosophy, astronomy, ethics, law of nations, politics, civil law, deserve to be ranked, in the estimation of the learned editor, among the sciences." We must not allow unaccustomed terms to lead us to neglect any indications of biological elements in the courses of study of the early days.

In the Philosophical School, which with the Grammar School and the Divinity School made up the early College, the first chair was that of Natural Philosophy and Mathematics. Established in 1712, it is from this chair that any instruction in sciences should be expected. Its first six occupants have left little record of the

scope of their teachings or of the fields of their activity. It should be remembered, however, that the half century covered by their service immediately followed a period of brilliant progress in biology marked by the work in microscopy of the Englishmen, Hooke and Grew, of the Italian Malpighi, and of the Dutchmen, Swammerdam and Leeuwenhoek. The English preceptors and former associates of our academic predecessors were quite familiar with the work of these men. Of those named, not themselves English, Malpighi had many brief papers published by the Royal Society of London which honored him with election to membership and preserved the portrait he presented; and the letters in which Leeuwenhoek recorded his observations were largely addressed to the Royal Society which, also, received from him a gift of twenty-six microscopes each fitted to an object for examination. The years preceding the opening of our Philosophical School also saw important work on classification of plants and animals by the founder of modern natural history, John Ray, whose "The Wisdom of God manifested in the Works of Creation" could scarcely have been unknown to the philosophical and reverend occupants of William and Mary's Chair of Natural Philosophy and Mathematics. Thus, it is reasonable to suppose that some of the biological science of their day was included in the teaching of these men.

The seventh occupant of our chair, 1758-64, was William Small, the first notable scientist of the faculty, of whom his pupil Thomas Jefferson wrote " . . . he fixed the destinies of my life." Small came at the time of the rise of the great Swedish naturalist, Linnaeus, who already had achieved wide recognition. Twenty years earlier, Linnaeus, arriving in Paris and going unannounced to the Garden of Plants, attended a demonstration by Bernard de Jussieu. Observing the demonstrator to be puzzled over a particular plant, the stranger remarked, "It has the appearance of an American Plant." Whereupon de Jussieu exclaimed, "You are Linnaeus." Fifteen years later, Linnaeus published his "Species Plantarum" and, in the very year of Small's appointment, his "Systema Naturae." Contacts between Virginia's naturalists and Linnaeus or his associates had been established even before the publication of these notable landmarks in the orderly classification of plants and animals. It may well be, therefore, that Small influenced the young Jefferson specifically toward the botanical studies which constituted no small part of his repertoire of intellectual and practical interests.

We have the testimony referred to above as to the greatness of Small's teaching and we have reason to believe that he introduced the lecture system into American education, but as to the subject matter with which he dealt we know little. Isaac A. Coles, writing in 1779 to Henry St. George Tucker, says: "The study of

the natural sciences and experimental philosophy was introduced at William and Mary by Dr. Small of Birmingham, England. Gov. Fauquier was an ardent devotee and in his will left his body for scientific purposes. Jefferson was brought up under his influence, and even James Madison, the Bishop, imbibed the spirit. Natural Philosophy was his favorite study." Notable in the record of Small's service is the list of apparatus purchased for the College after his return to England in 1764. The day was not one of extensive equipment for biological studies but this list includes at least one item whose chief service, then as now, has been biological, "a best double microscope etc." Indicative of such use is one of its earliest names, "vitrum pulicare" or "flea-glass." Similar instruments are still used in a demonstration which doubtless has had a very long, if devious, history, the flea circus of our fairs. Coles' reference to Dr. Small of Birmingham, Eng., calls attention to the fact that in his later years our erstwhile professor was a famous Birmingham physician and close friend of the physician and philosophical naturalist, Erasmus Darwin, and of the inventor of the steam engine, James Watt.

In the absence of definite records of the subjects taught at the College under Small and his immediate successors, we must fall back on the interest of the times which, indeed, were not sterile. Dr. John Mitchell, physician and naturalist, living at Urbanna, Middlesex Co., was a fellow of the Royal Society of London and a contributor to its Transactions. He sent data on the American Flora to Linnaeus. He wrote various papers on natural history, an "Essay on the Causes of Different Colors of People in Different Climates" (1744) and "Yellow Fever in Virginia in 1737-42." John Clayton, for over fifty years Clerk of Gloucester County, called by the English botanist, Peter Collinson, "My friend the great botanist of America," corresponded with Linnaeus, Gronovius and other naturalists of Europe and America. Gronovius' "Flora Virginica" which was based largely on specimens sent him by Clayton was printed, in parts, in 1739 and 1743 and in a revised edition in 1762. Two volumes of an illustrated natural history of Virginia, painstakingly accumulated by Clayton and ready for printing, were lost by fire during the Revolution. While we know of no direct associations of Clayton with the College, the John Clayton listed among the Visitors of 1723 being more probably his father, the Attorney-General, a strong suggestion of indirect contacts is found in the fact that, in May, 1773, when the Virginia Society for the Promotion of Useful Knowledge was organized in Williamsburg, John Clayton, then about eighty-eight years old, was elected president. The atmosphere surrounding the College in the last half of the eighteenth Century was not heedless of the scientific, and more specifically of the biological, knowledge of the time.

We have more definite indications that, after Dr. Small, the next Professor of Natural Philosophy of whom we have a noteworthy record introduced some biological subjects in his academic instruction. This was the Reverend James Madison, a graduate of the College, who was appointed in 1773, made President in 1777 and who was also, after 1790, first Episcopal Bishop of Virginia. A sample of his sermons reveals Madison as a broad minded cleric which is, perhaps, another way of saying what one of his pupils wrote of him: "The priest is buried in the philosopher." On June 15, 1774, at the first meeting of the VSPUK (the modern alphabetical type of designation is convenient, if not elegant) following Madison's appointment to the faculty, John Clayton having died, John Page, the vice-president, was made president, George Wythe vice-president and Madison secretary and curator. Madison's interests, largely scientific according to our present classification, certainly did not exclude biological topics.

In 1780 President Madison wrote to President Ezra Stiles of Yale College in response to the latter's request for "any of yr own compositions and printed Theses or Academic Exercises":

> "I have nothing that I think worthy of your Attention by me at present. We have as yet published no Exercises under the new Establishment, tho' we have some young men of real Genius, who promise to become Ornaments of their country. Whenever we do, I will take the Liberty of transmitting them to you.
>
> "As to myself, I have some thoughts of publishing a Course of Lectures upon that Part of Natural History wc relates to Quadrupeds, some Time the ensuing Winter or Spring.—If I shd, I will send them to you, tho' I fear they will be far from deserving your Esteem.
>
> "Shd you think it worth while to continue a Correspondence, which you have so obligingly commenced,—I shd be glad to have some Acct of the Cold the last Winter at your Residence. As it was probably the severest ever experienced, since the settlement of America—and also your usual Summer Heat, together with the Quantity of Rain that falls annually and the most prevailing Winds. Also your Latitude and Longitude—together with the Variation of the Needle.—Facts of this kind will serve to throw great Light upon the Natural History of America."
>
> I am Sir with great Respect,
> Your Most Obedt Servt
> J. Madison.

A number of items in Madison's letters to Thomas Jefferson testify to interest in varied current problems. In 1785 "We have rec'd a Present of some valuable Books from the King of France. Among others Buffon in duo complete." On March 27, 1786, "In the continuance of the meridan line wch bounds the western extremity of Pennsylvania, marine shells were found on the highest ground between the Ohio and Lake Erie. I have written to Mr. Ellicott, who was concerned in running the line, in order to procure some of them, which I mean to forward to you. I

shall be happy to send them to you, as they will afford you some useful Data, & wd. no doubt be a particular gratification to those who are capable like Buffon of penetrating into ages past." On December 28, 1786, "Having just heard of Mons. Quesnay's Departure for France I have requested the Favr. of him to take charge of the Shells mentioned in a former letter, I thought they wd probably be acceptable to you, especially whilst in Paris where the science of Natural History has so many able Votaries. Mons. Buffon in his celebrated Epoques speaks of shells found in the highest parts of this country, & so do you in your Notes. I will not pretend to controvert the Method you suggest of accounting for their existence, but I have designedly sent a small collection of similar shells, taken from the immense bed wh. you know lies within the vicinity of this place, and indeed traverses the whole country. You will then be enabled to compare them together and see whether their Similarity, or other Properties do not point out an identity of cause in their formation. At all Events you will probably consider them of some Importance in the History of the Earth." In 1789, "I sh'd be much obliged, if in your next letter wch. you may favour me with, you wd. be so good as to inform me, of the best Treatise on Conchology. I wish to see the Nat. Histy of this lower country somewhat inquired into." In connection with certain bones found in North Carolina he proposes (1800) that "the Philos. Society depute one of its members sufficiently interested in Natural History and Chemistry to examine the [Wall?] in North Carolina, of which no doubt, you have often heard." In 1805 he reports the finding of bones and stomach of a "Mammoth" and the conclusion that these animals were vegetable feeders.

A further token of President Madison's respect for natural history in education is given in his letter written in 1811 to C. S. Todd, a former student at William and Mary then attending a famous law school in Litchfield, Connecticut, and later (1841) Minister to Russia: "I hope you do not confine yourself to law, but take a wide range in belles lettres, history, and the best writers in natural law. There are some excellent natural philosophers, most probably, in your vicinity. Chemistry and natural history should form a principal portion of the study of young men of capacity."

In view of the relations between the two men it was natural that, in 1777, Madison, newly made president, should have entered sympathetically into the plans of Jefferson, then Governor of the State and a member of the Board of Visitors, to transform the College into a university. The story of the reordering of the academic functions has often been told. Jefferson contemplated considerable expansion. Relative to scientific fields he explains, "In natural philosophy I mean to include chemistry and agri-

culture, and in natural history to include Botany, as well as other branches of those Departments." The chief changes actually instituted in these fields seem to have been the formal addition of Natural History to the scope of the chair of Natural Philosophy, occupied by the President, and the institution of a chair of Anatomy, Medicine and Chemistry. To the latter chair was appointed a physician then practicing in Williamsburg, Dr. James McClurg.

Son of a wealthy physician of Elizabeth County who served as surgeon in the Virginia State Navy in the Revolution, McClurg had studied at William and Mary, had gone to the University of Edinburgh where he studied medicine and had returned to settle down in the capital of Virginia. His name was carried on the Masonic Roll in Williamsburg beginning in 1774. In 1776 he had sought Jefferson's influence to secure an "appointment as Physician to Continental Troops in this colony." He occupied his chair, the second chair of medicine in the United States, from 1779 to 1784, but of his teaching and of his pupils we have little definite knowledge. Though Jefferson recognized Botany as a division of Natural History, certain phases of it, generally associated with Materia Medica in the medical studies, were doubtless included in the scope of the chair of medicine. Leaving the college in 1784 to take up medical practice at the new seat of government in the growing city of Richmond, McClurg was an outstanding physician there for forty years. He was sent as a delegate to the Constitutional Convention in 1787 but did not sign the document the Convention adopted. In that same year, when John Page wrote to Jefferson urging him to accept the presidency of the VSPUK, the latter replied that he "should feel himself out of his true place to stand before McClurg." Several papers, including an "Essay on the Human Bile," said to be "so original and instructive that it was translated into the language of every European nation," were published by McClurg. The 1820 volume of the Philadelphia Journal of Medical and Physical Sciences was dedicated to "The Elegant Scholar and Accomplished Physician, Dr. McClurg." The inscription on his tombstone in St. John's Churchyard, Richmond, accords him the highest rank in his profession.

In the earliest years of the nineteenth century the biological teachings of President Madison were, very appropriately, extended by an amateur naturalist, Dr. Louis Hue Girardin, who occupied the Chair of Modern Languages but who conducted a class in Natural History. *The Richmond Enquirer* of October 24, 1806, under the date at Williamsburg, October 21, carried this notice: "During the present term at Wm. and Mary College, Professor Girardin will continue to lecture on Natural history. . . . The want of a museum naturae, Botanic garden, etc. has been ob-

jected to by some. Unquestionably such splendid institutions are in a high degree subservient to the diffusion and progress of natural knowledge. . . . A succedaneum not entirely inadequate may be found in plates, herbals, etc. and, (which is better than artificial assistance of description), the immense book of nature is everywhere, and at all times, open before the eyes of the inquisitive. For the study of animal and vegetable anatomy and physiology, and, in general, of what is termed "the Philosophy of Natural History," indigenous specimens are fully sufficient. Within a few miles, plants may be found to illustrate not only all Classes of the Linnaean system, and most of the orders, but also many interesting, elegant, and useful genera, with some of their most valuable species. In the number, beauty, and usefulness of her vegetable productions, Virginia yields to few tracts of country of the same extent. Of this a single glance over the joint labors of Clayton and Gronovius, the pages of Michaux, Barton, etc., or a few rambles through our woods, fields and meadows, may convince any person in the least degree acquainted with the subject." Michaux, a pupil of Bernard de Jussieu, had been sent by the French Government to study the forest trees of North America, to report on their utility in naval construction and their suitability for introduction into France. He arrived in New York in 1785, was in Charleston, S. C., in 1787 and in 1796 and, meanwhile, had explored widely. He is said to have shipped 60,000 trees to France. His son, born in 1770, was also a traveller and silviculturist but it is probably the father to whom Girardin refers. Benjamin Smith Barton was a physician and naturalist of Pennsylvania who studied medicine in Philadelphia, London and Goettingen and later practiced and taught medicine in Philadelphia. The references to these naturalists and to Clayton and Gronovius testify to Girardin's familiarity with botanical work both here and abroad, and his interest in the local flora is apparent from his advertisement. Contemporary recognition of Girardin's concern with Natural History is given by Joseph C. Cabell, a graduate of the College who had spent the years 1803-6 in Europe and, in the course of his stay, had attended lectures by noted men in the Natural Sciences and had made some collections of objects of scientific interest. He wrote to Thomas Jefferson under the date of July 23, 1810, as follows: "Since my return, I have become involved in the usual pursuits of Virginians, and my mind has been totally abstracted from Natural History . . . not wishing to act the part of the dog in the manger, I lent my cabinet of minerals to William and Mary College, and my herbarium to Mr. Girardin, not long after I got back to Virginia." A copy in oils made by a graduate of the College from a portrait of Girardin is now a prized possession of the Department of Biology.

The next teacher, notable in our records for his teaching in the sciences, was Patrick Kerr Rogers who occupied the chair of Natural Philosophy and Chemistry from 1819 to 1828. A graduate of medicine from the University of Pennsylvania in 1802, an accomplished scholar, author during his service at the College of "An Introduction to the Mathematical Principles of Natural Philosophy" and a popular and impressive teacher, his greatest success was in the raising of four illustrious sons all of whom became eminent college and university teachers, and all except William Barton served at one time or another at the University of Pennsylvania as their father had done before coming to William and Mary. One, Henry Darwin Rogers, was finally called from a professorship at the University of Pennsylvania to a similar post at the University of Glasgow. There is abundant evidence that it was not solely by inheritance that the father influenced his sons and that his other pupils shared in the profit of his instruction. Of the topics covered in the teachings of Dr. Patrick Kerr Rogers rather little is known, but one may assume that he would not have neglected entirely those phases of science with which, as a medical man of the day, he must have been familiar. His academic successor was his son and pupil, William Barton Rogers, whose sole experience as a college or university student appears to have been at William and Mary during his father's professorship. William Barton Rogers was of the type of individual that, once initiated into the scholarly life, finds its own means of developing that life to its utmost. Patrick Kerr Rogers and his associates at William and Mary surely provided for him that initiation. Unseeking of personal renown, academic advancement or honors, William Barton Rogers had conferred upon him the degree of LL.D. by Hampden-Sydney College in 1848, by his Alma Mater in 1857 and by Harvard in 1866. As Professor of Natural Philosophy, the younger Rogers included in the junior chemical course (catalog of 1829-30) the "Elements of Botany." With his intense and abiding interest in Physical Geography and Geology, he surely must have interested himself and his pupils in the abundant fossils of the Peninsula and in their interpretation.

A letter written by Rogers at Boston, April 4, 1859, is of such historical significance from both a sentimental and biological point of view that extracts may fittingly be cited: " . . . With him [Littleton Waller] and his lady friends I made a good collection at his fine marl bank the next (Sunday) morning, and after dinner was driven in a buggy to dear old Williamsburg. To my great delight I found all along the road proofs of prosperous and improved agriculture. The old "Burnt-ornery", as the negroes used to call the ruinous charred inn, is now replaced by a hamlet of neat white houses, and on all sides I saw evidences of

neatness and thrift. But sad was the sight when about sundown I came in view of the college, as I approached by the road leading past the president's house. Many of the old trees on the roadside greeted me as familiar friends, but I missed the sharp, many windowed roof of the college, and found as I drew near, that although the solid walls had for the most part, defied the assault of the fire, the whole interior of the wings, as well as main structure, had been turned to ashes.

"I drove past, with a tearful eye, noting that the mossy coat of old Botetourt was unscathed, that the dial kept its place, that the president's house and our home, the Brafferton, had not been injured, and that one of those noble live-oaks at the gate was dead."

The reference by Rogers to improved agriculture on the Peninsula reflects the work of Edmund Ruffin who was educated at the College within the first two decades of the century and who was, at least between 1833 and 1845, a member of the Board of Visitors. He is recorded as Rector of the Board in 1836-37. By his study of scientific farming and his stirring editorship of the *Farmer's Register,* Ruffin so encouraged extensive use of marl in counteracting soil acidity, drainage of excessively moist lands, rotation of crops and the introduction of legumes into the crop cycle that from a period of decline of agriculture and depopulation on the Peninsula in the first third of the century there resulted in the years from 1835 to the War Between the States the marked improvement that Rogers joyously recognized. The alert scientists and engineers of the college faculty in these years could not have been oblivious to such changes or unconcerned with them in their teaching of chemistry or natural history.

Nor could such change have gone unrecognized by the man who followed in 1836, after Rogers had accepted the directorship of the incipient Geological Survey of Virginia and the Professorship of Natural Philosophy and Geology at the University of Virginia. This was John Millington, M.D., who had lectured for many years at the Royal Institution and, as professor of chemistry, at Guy's Hospital in London. He had served as superintendent of some British mines and of a mint in Mexico. Before coming to William and Mary he conducted an instrument shop in Philadelphia, an early example of the great American supply houses which now offer scientific equipment in such abundant variety to those who may be able to buy. This last experience must have contributed to his dissatisfaction with the remnants of the ancient equipment purchased in 1764 by William Small and of the improvisations of William Barton Rogers, which he found upon his arrival at Williamsburg; and the same experience; it is to be hoped, made it possible for him to indulge a very general inclination among teachers of sciences in adding $36,000 of

his own to the meager appropriations of the College for scientific apparatus. Millington made for the College a collection including geological specimens (fossils?) and materia medica.

According to the College Catalogs, Millington offered extended instruction in medical sciences at least from 1840 to 1846. As specifically laid out in the catalogs of the early 1840's the subjects treated were "anatomy, physiology, materia medica, anatomy of the nerves and organs of sense, pathology, and therapeutics, operations of surgery." The announcement of the courses makes clear that this was not planned as the equivalent of a course in a school of medicine but rather a substitute for the period of apprenticeship that commonly occupied a portion of the period of medical training. Tyler, in his study of "The Medical Men of Virginia," points out that, from a state of dependence in early colonial times upon apprenticeship as the sole form of medical training, "The number of University graduates increased till, by the time the American Revolution was fairly under way, the tone of the profession was largely dominated by them." Still, in a Virginia statue of 1736, it was enacted that no surgeon or apothecary who had served an apprenticeship to those trades should charge more than certain prescribed rates whereas those who had taken a medical degree at a university might collect double the aforesaid charges.

In the Catalog of 1845-6 private instruction only was offered in the medical subjects previously described without that limitation. It is difficult to judge whether this signifies a change in policy or a mere clarification as to a practice already in vogue. The registers of students in 1843-4 and 1844-5 specify the courses of the registrants as "Junior," "Senior," "Junior & Senior," "Senior, Med.," "Chem.," "Math," "Private Law," "Law & Gov. History," "Entire Junior," "Chemical and Medical," "Senior & Law," "all the Classics," "Regular Senior," "Prep L. & Gr. & S. P." Five men are thus listed as being under medical instruction in 1843-4 and four in 1844-5. In any case the boundary between private and official instruction was far less precise than one might suppose. Indeed the fee paid to an instructor by each regular scholar was two-thirds of that paid by a private student. The limitation of medical instruction to private arrangement does not denote any antagonism to the subject. Law was also offered privately and advertised in the Catalog to the extent of five hours a day five days a week! It is difficult to imagine how, with any such program, Millington could carry on classes in chemistry, natural philosophy and engineering; but perhaps his text book of seven hundred pages in the last-named subject, published in 1839, may have relieved somewhat the burden of preparing lectures and freed some time for a return to topics of his early studies.

In 1849 Dr. Millington declined the customary annual reelection to accept an appointment as professor of chemistry in the University of Mississippi. In the previous year Benjamin Stoddert Ewell had been appointed to the Professorship of Natural Philosophy and Mathematics and now William F. Hopkins was chosen to succeed Millington as Professor of Natural Philosophy and Chemistry.

It seems that during Hopkins' short stay he taught chemistry and divided Natural Philosophy with Ewell who probably continued the instruction in engineering introduced by Millington. Ewell was a graduate of the United States Military Academy and had been an instructor there, had seen service as a railroad engineer and had been professor of mathematics at Hampden-Sydney College and professor of mathematics and military science at Washington College (Washington and Lee University). From 1849 to 1861, except for the brief period of Hopkins' occupancy of the Chair of Chemistry, he was the only embodiment on the faculty of any interest in scientific matters. In 1848 and from 1854 until the outbreak of the War Between the States, he was not only professor but president as well. Under these circumstances it is not to be supposed that he would foster any of the biological interest that may have been stirred by Millington, Rogers and their predecessors, but the scanty records of the College in these years give little basis for a judgment. The burning of the Wren Building in 1859, already alluded to, may have destroyed some evidence of activities that would interest us in this connection as well as much that would have thrown light on earlier periods. Recorded recollections of the students of that day have dealt more with personalities and places than with the subjects of study. The events of the strenuous following years left in the minds of the pupils little specific impression of the studies they pursued.

It would probably be a mistake to conclude from this history either that there had been little of biological matter presented to the students at William and Mary in its first one hundred and fifty years or that the instruction offered was pedantic and ineffectual. Our records are pitifully meager. Of only a few of the men known to have taught scientific subjects have we any dependable information. We find these to be observant and thoughtful men in touch with the past and with their own times. That little is known of the others may not be due to any deficiency in their knowledge of the biology current in their day or to any lack of vitality in their teaching. To them may be fittingly applicable the famous peroration of Henry Van Dyke at the dedication of the Phi Beta Kappa Memorial Building at the College on November 27, 1926:

"I Sing the Praise of the Unknown Teacher."

"Great generals win campaigns, but it is the Unknown Soldier who wins the war.

"Famous educators plan new systems of pedagogy, but it is the Unknown Teacher who delivers and guides the young. He lives in obscurity and contends with hardship. For him no trumpets blare, no chariots wait, no golden decorations are decreed. He keeps the watch along the borders of darkness and leads the attack on the trenches of ignorance and folly. Patient in his daily duty, he strives to conquer the evil powers which are the enemies of youth. He awakens sleeping spirits. He quickens the indolent, encourages the eager, and steadies the unstable. He communicates his own joy in learning and shares with boys and girls the best treasures of his mind. He lights many candles which in later years will shine back to cheer him. This is his reward.

"Knowledge may be gained from books; but the love of knowledge is transmitted only by personal contact. No one has deserved better of the Republic than the Unknown Teacher. No one is more worth to be enrolled in a democratic aristocracy—

"King of himself and servant of mankind."

Note:—Material for this article has been secured almost entirely from the rich archives of the Library of the College of William and Mary. The labor of becoming acquainted with much of this material has been greatly lightened by the indices prepared by the Librarian of the College, Earl G. Swem. These include the *Virginia Historical Index* and *An Analysis of Ruffin's Farmers' Register* (Bull. of the Virginia State Library XI 3,4; July, October, 1918). Galen W. Ewing's *Early Science Teaching at William and Mary* (Journal of Chemical Education XV 1, January, 1938) has provided a most helpful outline.

College of William and Mary,

Williamsburg, Va.

Solidago bicolor A Rather Puzzling Assemblage in Northern Virginia

H. A. Allard

Introduction

Owing to its distinctive flower color, the rays being white or cream-colored rather than the usual yellow color of other goldenrods, *Solidago bicolor* L. should be a fairly distinctive assemblage, and this seems to be the case, at least in the New England area of its range.

In various localities of northern Virginia, however, its status is not so clearly defined, and in some localities the population may embrace yellow-rayed as well as white-rayed forms which show no other distinguishing characters.

Hybrid Population On Big Cobbler

In 1939, the writer reported a yellow-rayed form of *bicolor* on Big Cobbler Mountain in Fauquier County, Virginia.[1]

In a continuation of length-of-day studies with our native goldenrods, seeds of two white-rayed plants typical of *Solidago bicolor*, selected from the Big Cobbler assemblage of this species were planted. The progenies of these two plants revealed both white-rayed and yellow-rayed forms, but there were no other obvious differences to be seen among these, the bicolor type of leaf, roughness and pubescence appearing in all.

Since it was evident that we were dealing with a genetic heterozygous condition for ray color in these lines, a large number of plants were grown in the field at Arlington Farm, Va., in 1940 from seed of both white-rayed and yellow-rayed parents which had appeared in these progenies.

An analysis of these progenies with respect to ray color is presented in Table 1.

It is obvious from the behavior of this progeny that white ray color is dominant over yellow ray color; several of the white-rayed plants breeding true to white ray color, appear to represent the homozygous dominant condition, while others, more especially the progeny represented by 72 plants, were heterozygous. The rather close approach to a 50 per cent occurrence of each ray color here may indicate a chance back cross of the hybrid involving two simple contrasting unit characters, white and yellow ray, with the recessive yellow.

The yellow-rayed parent gave a practically pure progeny for yellow ray, indicating a homozygous recessive condition for yel-

[1] "A Yellow-rayed Form of *Solidago bicolor* on Big Cobbler Mountain, Fauquier County, Virginia." Claytonia V, No. 3, pp. 28-30.

TABLE 1.

OCCURRENCE OF WHITE-RAYED AND YELLOW-RAYED PLANTS IN PROGENIES OF *Solidago bicolor*.

Ray color of parent, number of plants in progeny, and occurrence of white- and yellow-rayed plants.

Ray color of—			
Parent	Progeny		Number
	White	Yellow	
White	39	33	72
White	35	0	35
White	45	0	45
White	20	1	21
White	23	0	23
White	34	0	34
White	67	9	76
White	87	7	94
Yellow	1	35	36

low in this instance. The single white plant found in this progeny may indicate a chance cross by bees or other insects, since the goldenrod is a insect-pollinated plant.

This data is sufficient to indicate that the Big Cobbler assemblage is complicated with a hybrid constitution, which renders difficult its delimitations as a solely white-rayed species here. Subsequent examination of the wild population on Big Cobbler, revealed both yellow- and white-rayed forms in abundance which were separable only on the basis of ray-color.

GLABROUS AND GLABRATE FORMS OF *S. bicolor*

Solidago bicolor, together with several other species is abundant on the shale barrens of the Massanutten ridges. It would appear that the open forest growth and the lack of ground litter and a closed herbaceous cover, make these barrens a favorable habitat for many goldenrods and asters that can withstand the thin, dry shale soils.

On the extensive barrens east of Mr. Burner's home at the terminus of the public highway at Pugh's Run, Shenandoah County, Virginia, both *Solidago erecta* Pursh and *Solidago bicolor* are very abundant.

The *Solidago bicolor* assemblage here as well as elsewhere on the many barrens of the Massanutten reveals great variation in the condition of hairiness which is characteristic of the more

typical plant. Some forms are extremely hairy throughout as is characteristic of the typical representatives of the species, while others show a greatly reduced pubescence, or become entirely glabrous or glabrate, the latter condition being regarded as rarely occurring in *bicolor*.

In other respects than ray color these glabrous or glabrate forms are not distinguishable from yellow-rayed *erecta* plants everywhere intermingled with the *bicolor* assemblage on the barrens. For this reason one might be led to regard these as white-rayed form of *erecta*, on the one hand, or as extremely glabrous variants of *bicolor* on the other. These resemblances between *erecta* and *bicolor*, aside from ray color may indicate close affinities in these two species.

Solidago bicolor does not seem to be a very distinctive species aside from its white rays.

Conclusions

Deam[2] is of the opinion that *Solidago bicolor* is not worthy of specific rank and chooses to regard it as an albino form of *hispida*, although for the present he follows other authors in maintaining its status as a species. He has not been able to separate *bicolor* from *hispida* on the basis of any characters used by other authors.

It is obvious that the *bicolor* assemblage is not clearly defined in its morphological characters and may approach both *erecta* and *hispida* Muhl. in its resemblances. It approaches the former in the absence of the pubescence in glabrous or glabrate forms, and is not distinguishable from *hispida*, according to Deam, by any specific characters, other than ray color.

It is obvious also, that a heterozygous condition may arise involving both white and yellow rays, as the Big Cobbler assemblage has shown.

This brings us to the question of the origin of the white-rayed *bicolor* form. Since the fundamental color of all our goldenrods is yellow, white ray probably represents some mutational genetic change which, from its rare occurrence in the goldenrod assemblage, generally, does not often occur or persist. Strangely enough the *bicolor* from has persisted to become a permanent and widespread plant in our flora.

A second question arises relative to the yellow-rayed forms found on Big Cobbler. Does this material which has shown a hybrid behavior represent an actual cross with some yellow-flowered species occurring here, or has some recombination or mutation of genes taken place which has given a reversion to an original yellow condition of the rays in this population?

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[2]"Flora of Indiana", by Charles C. Deam, 1940.

This cannot be definitely answered. *Solidago hispida* does not appear on Big Cobbler, but *S. erecta* may, although it is not abundant. Hybrids with this species might well give a wide range of variability in such morphological characters as leaf-shape, pubescence, etc., and by continued intercrossing would completely confuse the typical features of both species ultimately.

That yellow-rayed forms typical of *bicolor* in all other respects, occur more or less frequently in Virginia, and perhaps elsewhere, cannot be doubted. In the collections of the U. S. National Herbarium, two yellow-rayed plants have been deposited by Mr. E. S. Steele, both collected on shales in the Alleghenies, one near Millboro, Bath County, in 1906, the other near Augusta Springs, Augusta County, in 1908. These in all other respects are typical of *bicolor*. Unfortunately ray color in the fresh material has been indicated on practically none of the herbarium sheets, with the exception of this material collected by Mr. Steele.

It is evident then, from these considerations, that the *bicolor* assemblage in some localities of northern Virginia, at least, is not always clearly defined in its morphological characters, nor even in its genetic condition with respect to ray color.

U. S. Department of Agriculture,

Washington, D. C.

The Junior Academy Movement

HUBERT J. DAVIS, *Chairman*

VIRGINIA JUNIOR ACADEMY OF SCIENCE COMMITTEE

The science youth movement in America has begun. There is nothing parallel to this movement in the history of science. It is unique in its sponsorship, rapidity of growth, and opportunities for creative expression. Through the Junior Academy organizations youth offers a united effort to wrest from nature the solutions to problems which have puzzled mature scientists of our past and present generations.

The Junior Academy movement, though slow in getting started, is the logical development growing out of the change in our school system. The shift from literary societies, spelling matches, and other school-imposed, teacher-dominated activities in our schools to the free creative activities of the clubs, home-rooms and socialized assemblies have given incentive for the Junior Academy organizations. State and national organizations for the high school journalistic, literary, honor, and athletic meets provided patterns for the Junior Academies.

Before reviewing this movement in the nation as a whole let us turn briefly to the rapid development within our own state.

In 1939 the Virginia Academy of Science appointed a science club committee with the authority to inquire into the status of science clubs. This committee conducted a survey of the state just before the annual meeting of the Virginia Education Association in November. Sixty clubs scattered throughout the state answered the questionnaire.

Dr. H. H. Sheldon, a nationally known authority on science clubs, was secured as principal speaker for the Virginia Education Association meeting. Dr. Sheldon's speech, along with a radio address by Dr. G. W. Jeffers during the Christmas week over WRVA, aroused interest in science clubs throughout the state. This enthusiasm was revealed by the responses to a more thorough survey of the clubs conducted in January 1940.

The Science Club Committee sponsored the publication and distribution of a pamphlet on science clubs in March. The sponsors and delegates of fifty-five clubs were invited to attend the meeting of the Virginia Academy of Science in Lexington. Fifty delegates and eleven sponsors representing fifteen clubs attended this meeting.

Dr. Otis W. Caldwell, general secretary of the American Association for the Advancement of Science attended this meeting and presented the request of the science club delegation for the authority to organize a Junior Academy of Science. This authority was granted.

In June the executive council selected the personnel of the two committees necessary for the functioning of the Junior Academy of Science as authorized by the Academy at the Lexington meeting. The council selected a committee of ten science club sponsors and a committee of ten from the senior Academy.

The Junior Academy committee selected was Miss J. Frances Allen, Radford; J. T. Christopher, Danville; C. G. Gibbs, Floyd; Miss Elizabeth Gillespie, Norfolk; Wm. T. Hall, Clarksville, Mr. H. S. Holmes, Petersburg; Miss Martha Lipscomb, Richmond; W. I. Nickels, Jr., Charlottesville; W. W. Noffsinger, Roanoke, vice-chairman, and Hubert J. Davis, Williamsburg, chairman.

The sponsoring committee selected was L. F. Addington, Wise; L. C. Bird, Richmond; Francis S. Chase, Richmond; Dr. I. A. Updike, Ashland; William M. McGill, Charlottesville; George W. Jeffers, Farmville, vice-chairman, and J. A. Rorer, Charlottesville, chairman.

At the close of the school year available information revealed ninety-two science clubs in Virginia. These clubs represented fifty-seven counties and seven cities, and embraced all the educational districts. Their interests represent research, photography, exhibits, collections, museums, hydroponics, nature study, modeling, taxidermy, etc. Assuming that each club has an average membership of twenty, these clubs represent nearly two thousand of the best future scientists from all parts of the state.

The present national status of the academies with twenty-three active organizations composed of from fifteen to twenty thousand members is far removed in size from the Danville, Illinois club which has the distinction of being the first to affiliate with the Illinois Junior Academy in 1919. The real movement began, however, more than a decade later. At the St. Louis meeting of the American Association for the Advancement of Science Mr. Louis Astell presented a paper entitled[1] "How State Academies of Science May Encourage Scientific Endeavor Among High School Pupils".

At the Cleveland meeting in 1930 a Junior Academy Committee was appointed. It was composed of Dr. Otis W. Caldwell, chairman, Mr. Louis Astell and Carl Oesterlin. This committee adopted a plan to sponsor the Junior Academies on a national scale. It prepared and distributed a paper containing suggestions for the organization of Junior Academies along with other helpful data. This committee has vigorously promoted this work up to the present time.

The promotion work of the A. A. A. S.. has been ably supplemented by the American Institute of Science and Engineering Clubs. This organization was established in 1928 for the encouragement of all phases of science and industry. In 1928 it initiated

[1]*Science* 1930, Vol. XXXI, p. 445-449.

the Children's Science Fair, an annual exhibit of scientific work among high school pupils of the science clubs in New York City and environs. It broadened its activities in 1938 to national scope, and provided field workers for organization and consultation service to member clubs.

A third factor in the rapid development of this movement was the sponsorship provided by the state Academies of Science. A survey conducted by Dr. Otis W. Caldwell[2] in 1938 showed that fifteen junior academies had been organized under the sponsorship of the senior academies. More recent data indicated that there are between twenty and twenty-five Junior Academies. The following data from Dr. Caldwell's survey along with other data reveal the rapidity of this development.

Year of Organization	*States*
1919-1928	Illinois
1930	Indiana, Kansas
1931	Iowa
1933	Kentucky, Pennsylvania
1934	Alabama, West Virginia
1935	Oklahoma, Texas
1936	Missouri, St. Louis
1937	Minnesota
1939	Florida
1940	Virginia, Ohio

Other academies on which information is lacking are Nebraska, Michigan, New Jersey, Maryland, and Oregon. Most of these have been organized within the past two or three years.

A factor which is lending much encouragement to this movement is the large number of radio programs which are now being devoted entirely to science. Along with this we have had the increased circulation of periodicals such as *Current Science, Popular Science Monthly, Popular Mechanics,* and *Hobbies.* These publications either have a section devoted to science clubs or provide useful materials for such work.

Progressive high school administrators are now making a determined effort to forestall the high school fraternities and sororities. The science club with its state and national affiliations offer an excellent substitute with worthwhile activities. Clubs have displaced the literary societies in many schools. The state organization provides the incentive and competition similar to that heretofore given by the state literary meet.

The problems to be solved in the promotion of the Junior Academies are so great that the movement could not be kept alive even by the stimulation of the sponsoring organizations were it not for the nature of the work done by these clubs and the normal interests of the participants.

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[2]Caldwell, Otis W. Supplement to Dr. Oerlin's paper *American Science Teachers Association,* Jan. 1940, p. 54-56.

Youth is imitative, egoistic, and keenly alert to the possibilities of the Junior Academy work. The quest for solutions to their scientific problems, the keen competition with other clubs in science congresses, exhibits, etc., and the associations with real scientists is fascinating. They fire the entire spirit with an indomitable urge to discover and to create.

The annual meetings are held jointly with the senior academies. This permits the high school pupils to associate with real scientists in bone and flesh. The shaggy-haired, absent-minded recluse of the boy's imagination becomes a real individual, a hero to the boy.

Dr. Oerlin[3] tells of an incident which illustrates this hero worship.

> ". . . Because of injury in transit, the project which one of my boys was to present on the Junior program failed to work. Frantically he worked on it. After all, bringing a gadget a hundred miles and then not being able to show it is a tragedy. One of the senior scientists from the host institution offered assistance.
>
> ". . . By using several parts borrowed from the laboratory of the institution and the help of this senior scientist the project was ready when called. That scientist doesn't know what a hero he is in the eyes of that boy. For there is no end to the admiration my boy expressed for him. . . ."

The Junior Academy is composed largely of those representing the upper bracket of intelligence. It provides a natural outlet for adolescent enthusiasm and gang spirit. Properly directed it gives these adolescents experiences which may stimulate them to serious thinking and planning for their future leisure hours and profitable, wholesome vocational activities.

Youth believes in itself, and seeks opportunities to display its abilities. Much of the work of the academy members is worthy of serious consideration. Dr. Otis W. Caldwell[4] says, "It is astonishing to see the quality and seriousness of some of the work that is done by the younger scientists." *Science News Letter*[5] reports school science club members experimenting with the effect of alcohol, strichnine, and aspirin on the action of a frog's muscle; a girl who requested samples of blood from her parents at intervals so that she might experiment with the effect of fatigue, food, and excitement on the blood; another boy who made a stroboscope from scraps of wood, metal and glass.

A club in Texas[6] completed a check list of two hundred fifteen birds as to the dates of their arrival, summer or winter residents, etc., and sold enough copies to finance the club activi-

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[3]Oerlein, Karl F. Junior Academies of Science. *American Science Teachers Association.* Jan., 1940, p. 52.

[4]Deffenbaugh, W. S. Junior Academies. *U. S. School Life.* June, 1937, p. 47.

[5]*Science News Letter.* Aug. 7, 1937.

[6]Tarter, D. G., Walker, E. B. Texas Ornithology Club. *Texas Outlook.* July, 1939.

ties throughout the year. In another project they invented a new bird trap. With this they caught and banded ninety birds.

Other activities include research, publications, and exhibits. The Kentucky Junior Academy offers an annual award of ten dollars for research. The West Virginia Academy publishes six issues of the *Junior Academy Science News Letter* annually. Each issue is prepared and edited by a different staff composed entirely of high school pupils. Highlights of the A. A. A. S. meetings in Richmond in 1938, and Columbus in 1939 were the exhibits of the Junior Academies. At the annual meeting of the Missouri Academy of Science in March, 1940, several sections of the Senior Academy gave place on their programs to meritorious papers by the members of the Junior Academies. Such worthwhile activities could be enumerated almost ad infinitum.

These young scientists actually perform research, construct practical machines, realize the application of scientific principles to everyday events, and come to understand the social significance of the implications of science in the development of modern society.

The Junior Academy is governed by the student officers and sponsored by the Senior Academies. The work is carried on by enthusiastic club sponsors in cooperation with the members of the Senior Academies. Their annual meetings consist of talks, prepared papers, movies, demonstrations, exhibits, and reports on research activities.

These activities carry the pupils beyond the classroom routine into educational activities which are of great value to them, because they are tinted by their own enthusiasm and experience. They afford training in leadership. The outcomes of such cooperative participation in scientific pursuits are discovery of special talents; opportunity for recreation and fun; aid to the pupil in finding himself, and in the discovery of a hobby which helps him to enjoy profitably his leisure hours; increased self-reliance; guidance in making vocational decisions; activities in the interpretation of scientific principles; practice of cooperation in the execution of the programs; and widening the scope and multiplicity of youthful interests. They provide an esprit de corps by participation in the program and seeing the Senior Academy members in action.

Along with these desirable outcomes, we may well formulate the main objectives of the Junior Academy of Science.

1. To train in citizenship and cooperative enterprises.
2. To spread ideas, promote friendships between club members and schools, and to distribute helpful project materials.
3. To provide a real incentive for creative work in science through keen competition afforded by exhibits, congresses, research, and reports.
4. To stimulate the discovery of human talent and to begin its development at an early age.

5. To provide opportunities for friendships and associations with the leaders in the field of science.
6. To provide training in planning, and executing their own annual programs and meetings.
7. To provide fun and recreation through the development of scientific hobbies.
8. To provide the sponsors of the clubs with worthy motivation for sponsoring their clubs.
9. To familiarize the future scientists with the organization and work of the scientific societies and thereby boost future adult membership.
10. To acquaint senior scientists with the work of the junior scientists, and enlist their support for worthy scientific pursuits.

The course of this movement is not easy, nor is its progress assured. The high school extra-curricular programs are crowded. Continuity of membership is difficult because of the constant changes in sponsorship. Source materials for scientific projects on the junior level are scarce. There is a dearth of teacher-sponsors who have been trained for leadership. Most clubs are sponsored by teachers who already are burdened by heavy teaching loads. Many of the science teachers have more training in methods than in content. Possibly the most serious handicap which faces the Junior Academy movement is the failure of school administrators to realize that these activities are as important as competitive athletics, bands, etc. The movement is too young to have established its worth to those less acquainted with the nature of its work. There is some evidence, however, that the enthusiasm of the few qualified teacher-sponsors, along with the equally enthusiastic academy members may eventually solve most of the difficulties.

The future of our present civilization depends not on regimented labor, nor conscripted military training, but upon the discovery and development of our science reserves which constitutes our greatest national resource. Youth calls for help. If this call is properly heeded, youth of today who are leaders of tomorrow may be guided to achieve a merited place for America as the true world leader in science. Will the scientists of tomorrow be destroyers or creators through science? It is the creative power that reveals the human race at its best, and gives the greatest satisfaction to life. The Junior Academies of Science may hold the answer to this question.

WILLIAMSBURG, VA.

Colonel William Fleming's Scientific Observations in Western Virginia

William D. Hoyt, Jr.

Observations made by early travellers along the seacoast and in the river valleys to the west of the mountains have been printed, but nowhere is there an account of things seen and recorded by an intelligent observer in the middle region which was once all part of Virginia. Such a man was Colonel William Fleming (1729-1795), Scots physician, who landed in Norfolk in 1755, immediately went to the frontier to fight Indians, and after the campaigns were over settled first at Staunton and then in Botetourt County. He became an important figure in the Valley, led one division of the colonial forces at the Battle of Point Pleasant in 1774, and during the Revolution had charge of an entire section of the western defense. In 1779 he was the head of the Commission to Settle Land Titles in the Kentucky district, and three years later, after service in the Council and as acting Governor of Virginia, he returned there as chairman of the Commission to Examine and Settle the Public Accounts in the Western Country.

The trips to and from the settlements in the backwoods provided many opportunities for observation, and Fleming often jotted down in his journal comments on the nature of the land he traversed, the kinds of trees he saw, and the details of activities which were new to him. Ordinarily, one would not expect to find an Indian fighter and frontier leader interested in science, unless some matter connected with his crops, his livestock, or the weather attracted his attention momentarily. Fleming's deeper concern was explained by his background and training, which was distinctly above the average for the time and the place. He was a graduate of the University of Edinburgh, he had served as a surgeon's mate in the British navy, and he had practiced professionally while living in Staunton. His home, "Belmont," located at the Fording of Tinker's Creek in Botetourt County, contained a library which was of sufficient size and quality to be regarded as one of the finest in Virginia. Among the many volumes were works on medicine, surgery, chemistry, astronomy, mathematics, philosophy, and agriculture, besides many others of a literary nature. A man who would take the trouble to gather such a collection in that distant place must have read the books and known their contents from cover to cover. With this knowledge gained from the printed word there doubtless was mixed a genuine curiosity concerning the region to the westward. A proclamation in 1763 promised grants of land to soldiers who had served in the French and Indian War, and

since Fleming was eligible, he probably looked around for likely locations as he rode through the unsettled countryside.

Fleming's first observations were made during Dunmore's War, 1774, while the army was marching from the place of assembly, Camp Union, now the location of Lewisburg, West Virginia, to Point Pleasant on the Ohio River, where was fought the important battle with the Indians. The entries in the Orderly Book gave an excellent idea of the type of country, including numerous items about the soil, the trees, and the water. Fleming was particular, too, to note the distances covered each day, and it has been remarked (by Virgil A. Lewis) that he was surprisingly accurate in his computations. The first few days the army passed through meadow lands, then it marched "over two smart hills to a Savannah, or Meaddow ground," and after that the way seemed to be mostly "steep little ridges," "broken ridges, chiefly Chestnut," and sharp declivities. As the Alleghany Mountains were approached and crossed, there were "sudden & frequent Showers of Rain as is usual near these Mountains." The Gauley River was one which could not be avoided, though it had "a stony ugly foarding," and "the Banks that have been washed by the floods discover not above a foot [of] soil, & then a white or reddish sand & Clay or grity earth." As the progress continued, "the mountains begun then to fall away, and the bottom to Open. these Creeks in the bottom [are] stock[ed] with Sugar, Papa [pawpaw] trees, & beech, flowing Poplar, & leather wood. some peavine & buffaloe grass." Fleming found pieces of coal which had been washed out of the ground and which burned very well; and there were "two curious Springs, the Vapour of which kindles quick as Gunpowder & burns with a surprising force," though the water "tasted unctious."

Fleming was severely wounded in the encounter with the redmen and for a while it was thought he would not survive. Two balls struck his left arm below the elbow and broke both bones, and a third ball entered his chest and pierced the lungs. His description of the treatment was graphic: "when I came to be drest, I found my Lungs forced through the wound in my breast, as long as one of my fingars.. Watkins Attempted to reduce them ineffectually. he got some part returned but not the whole. being in considerable pain, some time afterwards, I got the whole Returned by the Assistance of one of my Own Attendants. since which I thank the Almighty I have been in a surprizing state of ease. Nor did I ever know such daingerous wounds, Attended with so little inconvenience."

The damage was sufficient, however, to keep Fleming from active service in the Revolutionary army, and he spent three years as County Lieutenant of Botetourt, entrusted with the defense of his part of the frontier. His next trip west took place

when he went out to direct the settlement of the disputes over land titles. No longer was the country a complete wilderness, but there were large areas which were unoccupied and uncultivated, and the Indians still hovered on the outskirts ready to strike whenever and wherever an opening appeared. As in the campaign of Dunmore's War, Fleming took time to notice the terrain, its products and natural phenomena, the people, the towns, and the conditions of health.

The entire journey was featured by the extraordinarily bad weather. Snow fell on November 28, and then came several days of "excessive cold." A "storm of snow" fell on December 5 and the rivers rose so that the Kentucky was impassable. Variety was provided on the 12th by lightning and thunder during the evening, and after that the frost became so severe that everybody suffered greatly. Fleming heard of a family named Davis whose camp fire was put out by the rising waters of a creek, the father drowned attempting to swim across for more fire, and those left behind perished from the cold. On January 3 there was a twelve inch snow, and for the next several weeks the temperature was so low that the Kentucky was frozen two feet thick. Even after the worst was past in February, the alternate thawing created untold difficulties. By March 20

> "the effects of the severe winter was now sensible felt, the earth for so long a time being covered with snow and the water entirely froze, the Cane almost kiled, the Hogs that were in the Country suffered greatly, being frozen to death, in their beds, the deer likewise not being able to get either water or food, were found dead in great numbers, tirkies dropt dead of[f] their roosts and even the Buffaloes died starved to death"

Fleming tried to explain such unusual weather by the movements of winds and clouds in relation to the parallel ranges of mountains. He was told by hunters that the storms and foul weather came from the north and the clear dry weather from the east, which was contrary to the situation in the region east of the Alleghanies.

The land through which Fleming passed on his way to and from sessions of the Commission was varied. Nowhere was this better seen than between Harrodsburg and the Falls of the Ohio, a route taken twice within a month in November and December, 1779. Near Harrodsburg there were short broken hills, and then came a path along a ridge dividing two streams, the banks of which consisted of very good upland. The country became rougher again, with rich bottoms and level flats set between high steep rocks and connected by "a sidling pass." This changed to a wide plain with ponds here and there, until the Falls itself provided a series of perpendicular drops which could not be passed in boats unless the river was full. The return journey was made over the same ground, the elevations near Harrodsburg attracting attention as "steep short brushy hills and short knobs and

very brushy." Fleming commented on the structure of the country, "as to its risings, sinkings, and levels [which] is entirely formed by the rock below the Surface which every where extends through this Country at the depth of from one to twelve or more feet and never above 18 or 20 but in general to the surface 3 or 4 feet deep frequently the rock appears above the Surface." The soil was rich on top with a greasy clay of different colors beneath, often surprisingly shallow where shaly rocks split off in flags of various sizes. Everywhere there were creeks, islands, and ridges, with rough trails or roads connecting the settlements and the isolated cabins.

Fleming noted in the ground the presence of minerals, including coal, iron, and flint. He was observant enough to see the effect of such natural products on the foliage of the trees. In one place on the way out in the autumn he saw the leaves turned yellow while those around retained their verdure, and on the way home in the spring the same trees were in full foliage while those nearby had only small leaves. Different sorts of trees were present in Kentucky, too. Those which caused remark were the pines on the tops of the hills, a larch sixty or seventy feet high with bark like cherry, grain like mahogany, and leaves containing pods of "a sweet acrimonious visid Juice," and the sugar trees. The latter reacted according to the weather and were tapped for sap, and when in blossom had a yellow cup-like flower.

Animals were plentiful, and on many occasions buffalo were killed. Fleming was interested in the hump, "that remarkable rising on the shoulders" which was formed by spines of different sizes. Once an elk was shot, but it was so poor it could not be used for food. There were numbers of "Paroquitos" flying around Boonesborough, and near St. Asaph's Fleming saw what he called a peacock woodpecker.

The towns of Kentucky came in for only passing comment by Fleming. Boonesborough he said had thirty houses which stood in a bottom surrounded by hills so that enemies might do execution from all sides. Bryant's Station, on the other hand, was "an exceeding fine tract of land and a happy situation," with fifty families, all except four newly arrived. The water supply at Harrodsburg came in for the most picturesque description in all of Fleming's account of his trip.

> "The Spring at this place," he wrote, "is below the Fort and fed by ponds above the Fort so that the whole dirt and filth of the Fort, putrified flesh, dead dogs, horse, cow, hog excrements and human odour all wash into the spring with the Ashes and sweepings of filthy Cabbins, the dirtiness of the people, steeping skins to dress and washing every sort of filthy rags and cloths in the spring perfectly poisons the water and makes the most filthy nauseous potation of the water imaginable and will certainly contribute to render the inhabitants of this place sickly."

Indeed the health of the people was not so good. Fleming blamed the water at the Falls for the general sickliness there, with

fever, ague, and biliousness causing several deaths while he was there. There were many ill with colds at Bryant's Station in January, but the severe weather was said to be the cause since the settlers were accustomed to warmer climates.

Fleming was much interested in the industries of Kentucky. He spent some time watching the making of salt at Bullitt's Lick in November, and he described the process by which 3,000 gallons of water was boiled down to three or four bushels of salt every twenty-four hours. Again, in March, he visited Colonel Bowman's place near Harrodsburg and saw the people employed making sugar and molasses. He thought they produced sugar equal to Muscovedo, and from the juice they made beer and vinegar and might with careful management make spirits. On another occasion Fleming inquired about the cane itself, whose roots would continue in the earth for years if the soil was neither too wet nor too dry.

Fleming's third opportunity for remarking on aspects of the western country came while he was with the group which examined and adjusted the accounts of the officials there. The journey out was uneventful except that several times the party stopped in places where the water was "excessive bad" because it was "tinclusd" with coal. The business of the commission went slowly and during the intervals between sessions Fleming rode from station to station viewing the country he had not seen before. On one occasion he noted that the hills of the Kentucky district were "vastly steep, Rocky & bad beyond conception." As the winter advanced, bad weather made travel on horseback difficult, and more than once Fleming was forced to swim his animals through the swift currents of the rivers. On December 29, he was unable to cross at all and so "lodged at the foot of a rock cold & rainy." A week later he found no place to stay the night, and "encampd in an old field, the day & night very cold." But in spite of these hardships, and indeed at the very times when it was snowing worst, Fleming stopped to gather some petrified cockle shells in a spring. He remarked that what he found were "sea cockles, some wholly petrified, others half petrified some single shells, others the whole cockles, some few of the Clam kind, some shoels seemed broke and dented in by the pressure of foreign bodies from above, and cemented by the petrifying matter, they seemed either to be real Antedeluvians, or to have lain there since that part of the country was possessed by the sea, as these was real marine shells." This is, perhaps, the most complete case of scientific observation in Fleming's journals, and one needs only to remember the time, the place, and the occasion to realize that under other conditions William Fleming might have played an important role in early American scientific history.

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Distribution of Galax aphylla in Virginia

J. T. Baldwin, Jr.

Galax aphylla L. (Fig. 1) is the only species of the genus. It consists of two chromosome races: $2n = 12$ (Fig. 2) and $2n = 24$ (Fig. 3). Comparative occurrence of the two races throughout their ranges has been mapped (Baldwin, 1941). Distribution in Virginia of the species and of its races is given in Fig. 4.

The cytogeographic evidence lends weight to the opinion of Fernald (1937) that *G. aphylla* has moved from the upland into the coastal plain. That the migrational history of the plant may be more fully analyzed, it is important that additional collections of the species be made.

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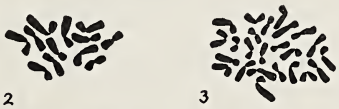
FIGURE 1.
Galax as photographed, June 23, 1934, in the Great Smoky Mountains National Park, by Carlos C. Campbell.



Metaphase chromosomes of *Galax:* Fig. 2, $2n = 12$ and Fig. 3, $2n = 24$. Drawn *ca.* 2000 X from leaf smears, and reduced one-half.

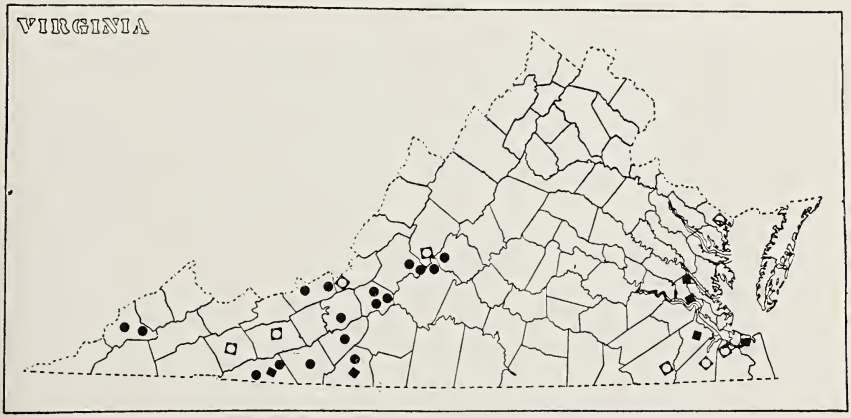


FIGURE 4.

Stations for *Galax* in Virginia: circles for diploid plants, solid squares for tetraploid, and perforated squares for stations known only by herbarium record.

GENERAL NOTES

VIRGINIA JUNIOR ACADEMY OF SCIENCE ORGANIZED—The Virginia Junior Academy of Science was organized during the meeting of the Virginia Education Association in Richmond during Thanksgiving week. A joint meeting of the Virginia Academy of Science sponsoring committee and the Junior Academy committee was held in the John Marshall High School. John Alex Rorer, Chairman of the sponsoring committee presided.

The committee worked out a temporary constitution for the Junior Academy, set up membership requirements for science clubs, appointed committees, and established other necessary machinery for the proper functioning of the organization. The work of these committees is subject to the approval of the executive committee of the Virginia Academy of Science and the student representatives from the science clubs which will consider these matters at their first annual meeting.

Hubert J. Davis, Matthew Whaley High School, Williamsburg was selected temporary chairman, Miss J. Francis Allen, Pulaski High School, secretary, and Dr. E. C. L. Miller, Secretary and treasurer of the Virginia Academy of Science was selected as treasurer of the Junior Academy.

The first annual meeting of the delegates of the science clubs will be held in Richmond May 1, 2, 3, along with the Virginia Academy of Science's annual meeting. At this time student officers will be chosen, the constitution ratified, and plans for establishing a monthly publication considered. The Junior Academy will also attempt to sponsor a science congress, a science exhibit, and a program similar to the one held by the senior Academy.

A special feature of the Virginia Academy of Science annual meeting will be the exhibit of the General Electric HOUSE OF MAGIC. The senior Academy is cooperating in working out a tour of the places of scientific interest in Richmond for the delegates. It is also expected that some of the papers prepared by the Senior Academy members will be worked out especially for the junior members. An outstanding speaker for the meeting will be selected partly on his ability to interest the junior members, and will probably be a scientist who has won the Nobel prize.

The Junior Academy is now a reality. More than twenty clubs have filed application for membership, and are being admitted as rapidly as it is possible to review their qualifications. The charters are being printed and will be ready for distribution soon. A sixty-page project kit has been prepared for distribution which will supply materials for club activities and for the selection of moving picture films for club use.—HUBERT J. DAVIS, Matthew Whaley High School, Williamsburg, Virginia.

CHROMOSOMES OF CRUCIFERAE: A PROJECT AND A REQUEST—The chromosome numbers of some species of plants vary, and intraspecific chromosome races may, thereby, become established. How often this has happened, and whether or not certain regions more than others harbor such chromosome-differing races, will be revealed by routine cytological surveys of many species throughout their geographic and ecologic ranges. The same broad comparative cytological approach will give an insight into the dispersal paths of certain species and into the significance of polyploidy, and, likewise, will allow the recognition of trends in the evolution of floras, and will, to some extent, clarify systematic and phyletic relationships. Adequate prosecution of this project can only result from the work and cooperation of many individuals over a long period of years.

The writer has initiated such a study of the Cruciferae and, accordingly, would greatly appreciate, at any time, the receipt of seed and herbarium specimens of any crucifer collected from any place by any person, amateur or professional. It is not necessary that the specimens be named: critical identification will come later. But it is important that the date and place of collection and name of collector be recorded with the seeds and herbarium materials. For this investigation all crucifers from all places are of interest: the common and the rare, the introduced and the native; for example: the plan is to examine cytologically several hundred collections of *Capsella Bursa-pastoris*.—J. T. BALDWIN, JR., Department of Botany, University of Michigan.

A CORRECTION—The cut on page 36 of the last issue (Vol. 2, No. 1, January, 1941) was inadvertently placed upside down by the printer. It appeared in the paper, "A Simple, Sturdy, Precise Glass Thermoregulator with a Rapid Adjustment for Different Temperatures," by H. N. Calderwood and F. W. Koerker, to whom we apologize.—ED.

The Virginia Journal of Science

Vol. II APRIL, 1941 No. 4

Virginia Academy of Science

PROGRAM

Nineteenth Annual Meeting

Medical College of Virginia
Richmond, Virginia

Thursday, Friday and Saturday
May 1st, 2nd and 3rd, 1941

The Virginia Journal of Science

Official journal
of the
VIRGINIA ACADEMY OF SCIENCE

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Virginia Academy of Science

OFFICERS

WORTLEY F. RUDD, *President*
Medical College of Virginia

E. C. L. MILLER, *Secretary-Treasurer*
Medical College of Virginia

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Medical College of Virginia

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D. MAURICE ALLAN
EARLE B. NORRIS
RUSKIN S. FREER
GEORGE W. JEFFERS

PERSONNEL OF LOCAL COMMITTEE ON ARRANGEMENTS

Richmond Meeting, Virginia Academy of Science, 1941

1. Chairman.....H. B. HAAG
Medical College of Virginia
Sub-Chairman.....FOLEY SMITH
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2. Committee on Exhibits.....RODNEY C. BERRY, *Chairman*
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3. Committee on Publicity.....W. R. GALVIN, *Chairman*
Thomas Jefferson High School
4. Committee on Friday Night Dinner.....
L. E. JARRETT, *Chairman*
Medical College of Virginia
5. Committee on Registration and Information.....
F. J. WAMPLER, *Chairman*
Medical College of Virginia
6. Committee on Meeting Rooms, Lanterns and Operators..
R. F. MCCRACKAN, *Chairman*
Medical College of Virginia
7. Committee on Housing.....F. L. APPERLY, *Chairman*
Medical College of Virginia

8. Committee on Finance.....CATESBY JONES, *Chairman*
1123 State Office Building

9. Ladies Committee.....MISS GERTRUDE DRINKER, *Chairman*
Dairy Council

10. Committee on Radio.....GEORGE W. JEFFERS, *Chairman*
State Teachers College, Farmville, Virginia

11. Section Hosts:

Astronomy, Mathematics and Physics.....C. H. WHEELER
University of Richmond

Biology.....
- J. M. BAILEY, *University of Richmond*
- ROSCOE HUGHES, *Medical College of Virginia*
- R. M. SMART, *University of Richmond*

Chemistry.....
- J. C. FORBES, *Medical College of Virginia*
- W. R. HARLAN, *Research Dept., Am. Tob. Co.*
- BRAXTON VALENTINE, *Valentine's Meat Juice Co.*

Education.....C. E. MEYERS
State Office Building

Engineering.....R. B. DAVENPORT
Larus Brothers

Geology.....JOHN E. ELDER
State Department of Agriculture

Medicine.....
- JAMES H. SMITH, *1000 West Grace Street*
- HARRY BEAR, *Medical College of Virginia*

Psychology.....ROBERT C. ASTROP
University of Richmond

NOTICES AND INFORMATION

Please have all calls made through 7-1800, extension 368.

Because our meetings take place at a time when Garden Week will be in progress, it is suggested that all members who have not reserved rooms directly, communicate with Dr. F. L. Apperly, chairman, Committee on Housing, Medical College of Virginia, Richmond, who will be glad to make room reservations.

Displays and demonstrations will be located in the physiology and pharmacology laboratory on the fourth floor of McGuire Hall.

Botanical forays will be held Saturday afternoon and Sunday, May 3 and 4, visiting the bogs near Petersburg under the leadership of Dr. Robert F. Smart and Seward Forest, Brunswick County, under the leadership of Mr. J. B. Lewis. Registration should be made as early as possible with Prof. A. B. Massey, Blacksburg.

A one-day trip to the Dismal Swamp, entering it from the Suffolk side is being planned. For details write Dr. John W. Bailey, of the University of Richmond.

General Program of the Nineteenth Annual Meeting

RICHMOND, VIRGINIA

1941

MEDICAL COLLEGE OF VIRGINIA—HEADQUARTERS

Thursday, May 1

7:30 P. M. Academy Conference. Simon Baruch Auditorium (Egyptian Building).

Friday, May 2

8:30 A. M. Registration. Library Building.

9:30 A. M. Section Meetings.

12:30 P. M. Lunch.

2:00 P. M. Section Meetings.

5:00 P. M. Tea.

7:15 P. M. Banquet. Hotel John Marshall.

Address of Welcome. Dr. William T. Sanger.

Response by President Wortley F. Rudd.

Presentation of Annual Research Prize of the Academy, the Jefferson Prize and the Inter-Academy Award, by Dr. Frank A. Geldard.

Address—Austin H. Clark, *Curator, Division of Echinoderms, U. S. National Museum,* and *President of the Washington Academy of Sciences.*

8:30 P. M. House of Magic. Hotel John Marshall Auditorium. (Virginia Room).

Saturday, May 3

9:00 A. M. Section Meetings.

12:00 Noon. General Business Meeting in Simon Baruch Auditorium.

Section of Astronomy, Mathematics, and Physics

F. B. Haynes, *Chairman*

Isabel Boggs, *Secretary*

FRIDAY, MAY 2—10:00 A. M.

Room 602, Old Virginia Hospital

1. A Study of the Internal Resistance of Dry Cells.
   W. R. Greer and J. F. Ryman; *Virginia Polytechnic Institute.*

2. A Semi-automatic Spectrographic Exposure Control.
   J. R. Cosby, F. B. Haynes, and H. D. Ussery; *Virginia Polytechnic Institute.*

3. Orbital Motion of Wolf 424.
   Dirk Reuyl; *Leander McCormick Observatory, University of Virginia.*

4. Two Recent Naked-eye Comets.
   Claude M. Anderson, Jr.; *Leander McCormick Observatory, University of Virginia.*

5. Spectral Classification of Reference Stars used in the Derivation of Cepheid Motions.
   C. A. Wirtanen; *Leander McCormick Observatory, University of Virginia.*

6. Intercomparison of Various Spectral Classifications of Faint Stars.
   A. N. Vyssotsky; *Leander McCormick Observatory, University of Virginia.*

7. Quantity or Quality in School Science.
   Preston H. Edwards; *Sweet Briar College.*

FRIDAY, MAY 2—2:00 P. M.

Room 602, Old Virginia Hospital

8. Business Meeting.

9. A Back Reflection X-Ray Camera of Simple Design.
   W. Richardson; *Virginia Polytechnic Institute.*

10. Vector Operations in Plane Geometry.
    B. Z. Linfield; *University of Virginia.*

11. Rotational Analysis of the (O, 4) Angstrom Band of CO for High Rotational Energies.
    Myron S. McCay; *Virginia Polytechnic Institute.*

12. The Use Made of Scientific Films in the General Course in Physics at the Virginia Military Institute.
    S. M. Heflin; *Virginia Military Institute.*

13. Demonstration of Equipment for Projecting Sound Motion Pictures.
    R. C. Weaver; *Virginia Military Institute.*

SATURDAY, MAY 3—9:00 A. M.

Room 602 Old Virginia Hospital

14. The Solution of Differential Equations by Operational Calculus, Part II.
    A. Lee Smith; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.*

15. Some Simple Lecture Demonstrations from the A. A. P. T. Manual.
    Joseph D. Elder; *Lynchburg College.*

16. Trip to the X-ray Department, Medical College of Virginia.

Section of Biology

E. DeWitt Miller, *Chairman*

Lena Artz, *Vice-Chairman*

R. F. Smart, *Secretary*

FRIDAY, MAY 2—9:30 A. M.

Simon Baruch Auditorium, Egyptian Building

1. Spermatogenesis and oogenesis in *Haemonchus contortus,* a Nematode Worm Parasitic in the Fourth Stomach of Ruminant Animals.
   William Logan Threlkeld and Myron Eugene Henderson; *Virginia Polytechnic Institute* and *Roanoke College.* (Lantern, 10 min.)

2. Helminth Parasites of Sheep.
   William L. Threlkeld; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

3. Chromosome Number and Winter Hardiness Relationships in the Higher Plants.
   Wray M. Bowden; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

4. Genetic Studies on Wild and Cultivated Watermelons *(Citrullus).*
   Orlando E. White; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

5. Time and Rate of Nutrient Absorption by Bright Tobacco.
   L. R. Kangas and A. L. Grizzard; *Virginia Polytechnic Institute.* (15 min.)

6. Time and Rate of Nutrient Absorption by Peanuts.
   John Strauss and A. L. Grizzard; *Virginia Polytechnic Institute.* (15 min.)

7. Results of a Three Year Study on the Control of *Cercospora* Leaf Spot of Peanuts.
   Lawrence I. Miller; *Virginia Agricultural Experiment Station, Holland, Va.* (Lantern, 15 min.)

8. Feeding a Perfect Human Diet to Rats.
   Joseph Z. Schneider; *Madison College.*

9. Schools of Training for National Park Service Work.
   Dr. Carl P. Russell; Supervisor of Research and Interpretation, *United States Department of the Interior National Park Service, Washington, D. C.* (Colored slides and motion pictures.) By Invitation. Introduced by Robert F. Smart.

FRIDAY, MAY 2—2:00 P. M.

Simon Baruch Auditorium, Egyptian Building

10. Further Observations on a Perennial Woody Gall on Hickory.
    Alphonse F. Chestnut; *College of William and Mary.* (Lantern, 15 min.)

11. Observations on the Spectroscopic Properties of Leaf Green Solutions.
    Lewis W. Webb, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division* and *U. S. P. H. S., Craney Island.* (Lantern, 10 min.)

12. Response of Aquatic Micro-organisms to Sulfanilamide, Sulfathiazole, and Sulfapyridine.
    Jane R. Holmes and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division* and *U. S. P. H. S., Craney Island.* (10 min.)

13. A Preliminary Survey of the Flora and Fauna of the Polluted Waters of the Norfolk Area.
    E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division* and *U. S. P. H. S., Craney Island.* (To be read by title.)

14. Notes on the Anatomy of a Rare Archiannelid *Dinophilus* sp. from the Norfolk Area.
    E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division* and *U. S. P. H. S., Craney Island.* (To be read by title.)

15. The Biological Control of the Mealy-Bug.
    J. G. Harrar and J. J. McKelvey, Jr.; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

16. Physiologic Studies of Some Entomogenous Fungi.
    J. G. Harrar and J. W. Showalter; *Virginia Polytechnic Institute.* (Lantern, 12 min.)

17. Some Effects of Theelin on the Mucus in the Genital Tract of the Guinea Pig.
    Roy Talmage; *University of Richmond.* (Lantern, 15 min.) (Introduced by H. I. Myers.)

18. Notes on the Sclerotium of *Fuligo septica.*
    W. T. Allman; *University of Richmond.* (Lantern, 10 min.) (Introduced by Robert F. Smart.)

19. Research in Progress at the Virginia Fisheries Laboratory.
    Curtis L. Newcombe; *Virginia Fisheries Laboratory* and *College of William and Mary.* (Lantern, 15 min.)

20. Growing Oysters in the York River.
    J. W. Bailey; *University of Richmond.* (Motion pictures, 20 min.)

21. Utilization of Apple Products in Lowering the Curd Tension of Milk for Infant Feeding.
    C. C. Flora and C. W. Holdaway; *Virginia Polytechnic Institute.* (15 min.)

Botany Division

SATURDAY, MAY 3—9:00 A. M.

Room 304, Egyptian Building

1. Native Grapes of Virginia.
   A. B. Massey; *Virginia Polytechnic Institute.* (Lantern, 12 min.)
2. Some Notes on *Buckleya distichophylla.*
   J. R. Mundie; *King College.* (Lantern, 5 min.)
3. Moisture Content of Bryophytes at Different Levels of Humidity.
   Paul M. Patterson; *Hollins College.* (Lantern, 10 min.)
4. A Preliminary List of the Mosses at Mountain Lake, Virginia.
   Paul M. Patterson; *Hollins College.* (10 min.)
5. Further Genetical and Cytological Studies on a Sea-side Ecotype of *Aster multiflorus* Ait.
   A. L. Delisle and Mary R. Old; *College of William and Mary.* (Lantern, 10 min.)
6. The Genes for Floral Colors in *Impatiens balsamina* and a Correlation with those Reported by other Investigators.
   Lucy Ann Taylor and Donald W. Davis; *J. A. C. Chandler High School* and *College of William and Mary.* (Lantern, 15 min.)
7. Seven-Year Experiment in Cotton Breeding at Hampton Institute.
   Thomas W. Turner; *Hampton Institute.* (Lantern 8 min.)
8. Further Work on the Effect of Indole-acetic Acid on the Vegetative Propagation of *Castanea, Albizzia* and some Ornamental Gymnosperms.
   Albert L. Delisle; *College of William and Mary.* (Lantern, 10 min.)
9. Books on Botany, Gardening, and Agriculture in the Library of Thomas Jefferson.
   Edwin M. Betts; *University of Virginia.* (10 min.)
10. Developing a Wilt Resistant Spinach Variety for Virginia.
    T. J. Nugent and Harold T. Cook; *Virginia Truck Experiment Station.* (Lantern, 10 min.)
11. Developing Wilt Resistant Watermelons for Virginia.
    Harold T. Cook and T. J. Nugent; *Virginia Truck Experiment Station.* (Lantern, 10 min.)
12. Cytology and Genetics in the flax genus, *Linum.*
    Charles Ray, Jr.; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

Zoology Division

SATURDAY, MAY 3—9:00 A. M.

Simon Baruch Auditorium, Egyptian Building

1. Further Notes on the Control of the Pea Aphid.
   Harry G. Walker and L. D. Anderson; *Virginia Truck Experiment Station.* (Lantern, 15 min.)

2. Coloration Studies on *Melanoplus bivittatus* Say.
   James McDonald Grayson; *Virginia Polytechnic Institute.* (Lantern, 20 min.)

3. Ecological Observations on the Ribbed Mussel, *Volsella demissus.*
   J. H. Lochhead; *Virginia Fisheries Laboratory* and *College of William and Mary.* (Lantern, 15 min.)

4. Recent Fossil Discoveries in Burkes Garde, Virginia.
   George Gose Peery; *Roanoke College.* (Lantern, 5 min.)

5. A Study of the Brown Thrasher, *Torostoma rufum.*
   Edna E. Becker; *Hollins College.* (Lantern, 15 min.)

6. On the Biology of Male Mosquitoes.
   Kenneth B. M. Crooks; *Hampton Institute.* (Lantern, 10 min.)

7. A New Hymenolepid Cestode from the Shrew.
   Arthur W. Jones; *University of Virginia.* (Lantern, 10 min.)

8. Preliminary Cytological Observation in Trematodes.
   H. Grady Britt; *University of Virginia.* (Introduced by B. D. Reynolds.) (10 min.)

9. A Study of Abdominal Hernia in the Frog, *Rana catesbeiana.*
   Thomas G. Hurdle; *Roanoke College.* (Introduced by Myron E. Henderson.) (Lantern, 5 min.)

10. A Transitory Membrane in the Formation of Midgut in the Cockroach, *Blattella germanica.*
    Lincoln C. Pettit; *Washington and Lee University.* (Lantern, 15 min.)

11. *Haptophyra plethodonis*, a New Species of Astomous Ciliate Found in the Intestinal Tract and Gall Bladder of *Plethodon cinereus* Green and *Pletodon glutinosus* Green.
    Martha H. Lipscomb; *Thomas Jefferson High School* and *The Mountain Lake Biological Station.* (Lantern, 10 min.)

12. *Plagiostomum dahlgreni* n. sp.
    William A. Kepner, M. A. Stirewalt, and F. F. Ferguson; *University of Virginia* and *Flora McDonald Norfolk Branch of the College of William and Mary.* (Lantern, 10 min.)

13. The Butterflies of Roanoke and Montgomery Counties.
    Carroll E. Wood, Jr. and Carl W. Gottschalk; *Roanoke College.* (Introduced by Myron E. Henderson.) (Lantern, 10 min.)

14. The Embryology of *Crepis capillaris.*
    Ladley Husted; *Miller School of Biology* and *Blandy Experimental Farm, University of Virginia.* (Lantern, 10 min.)

Section of Chemistry

W. G. Guy, *Chairman*

F. H. Fish, *Secretary*

FRIDAY, MAY 2—9:30 A. M.

Room 209, McGuire Hall

1. The Chemist in War.
   Leonidas R. Littleton; *Emory and Henry College.* (15 min.)
2. Vapor Phase Catalytic Hydrolysis of Halogenated Hydrocarbons.
   James W. Cole and Lester Van Middlesworth; *University of Virginia.* (10 min.)
3. The Straus Reaction on Hydroxycodeinone.
   Harris W. Bradley and Robert E. Lutz; *University of Virginia.* (10 min.)
4. Lantern Slides of Crystals.
   Warren W. Williamson and Harriett H. Fillinger; *Hollins College.* (15 min.)
5. Application of Physico-chemical Methods of Analysis to the Chesapeake Bay Waters.
   A. R. Armstrong; *College of William and Mary* and *Virginia Fisheries Laboratory.* (20 min.)
6. The Determination of Glycogen in Oysters.
   A. R. Armstrong; *College of William and Mary* and *Virginia Fisheries Laboratory.* (10 min.)
7. New Quinoline Derivatives in Chemotherapy.
   Alfred Burger, Luther R. Modlin, Jr., Stanley E. Krahler and Kenneth Bass, Jr.; *University of Virginia.* (15 min.)
8. The Synthesis of Some Iodinated Aromatic Compounds.
   Louis Long, Jr. and Alfred Burger; *University of Virginia.* (10 min.)
9. The Effect of Cold Rolling on the Acid Corrosion of Certain Alloys.
   J. A. Addlestone and M. W. Duke; *Virginia Polytechnic Institute.* (10 min.)
10. Mono and Dienol Acetates of 1,2,4 Trimesitylbutanedione—1,4.
    Vernon R. Mattox and Robert E. Lutz; *University of Virginia.* (15 min.)
11. Applied Science, the Financial System, and Democracy.
    Allan T. Gwathmey; *University of Virginia.* (20 min.)

Third Symposium on Organic Analytical Reagents

FRIDAY, MAY 2—2:00 P. M.

Room 209, McGuire Hall

12. Introduction.
    John H. Yoe; *University of Virginia.* (10 min.)

13. A Summary Report on 250 Organic Compounds.
    W. J. Frierson and P. M. Simpson; *Hampden-Sydney College.* (5 min.)

14. A Report.
    W. H. Wrenn and F. H. Fish; *Virginia Polytechnic Institute.* (10 min.)

15. A Progress Report.
    Jean L. Larner and Wm. E. Trout, Jr.; *Mary Baldwin College.* (5 min.)

16. A Progress Report.
    Edwin C. Markham; *University of North Carolina.* (5 min.)

17. The Salogenic Organic Compounds.
    L. A. Sarver; *American Viscose Corporation.* (20 min.)

18. A Progress Report.
    O. W. Clark, Jr., R. M. Irby, Jr. and Ira A. Updike; *Randolph-Macon College.* (5 min.)

19. A Progress Report.
    J. R. Taylor; *Washington and Lee University.* (5 min.)

20. Some Complex Compounds of Copper, Silver and Mercury with Ethanolamines.
    J. W. Cole and M. Brook Shreaves; *University of Virginia.* (15 min.)

21. A Progress Report.
    E. Louise Wallace and A. R. Armstrong; *College of William and Mary.* (5 min.)

22. A Progress Report.
    Thomas B. Crumpler and Earl B. Claiborne; *Tulane University.* (15 min.)

23. A Progress Report.
    W. E. Clark and L. R. Stallings; *Virginia Military Institute.* (5 min.)

SATURDAY, MAY 2—9:00 A. M.

Room 209, McGuire Hall

24. β-Monoalkylaminoethyl Alkoxybenzoates as Local Anesthetics.
    J. Stanton Pierce, J. M. Salsbury, and J. M. Fredericksen; *University of Richmond.* (15 min.)

25. The Electrolytic Preparation of Bromoform and Iodoform.
    J. B. Lucas and Irving Gray; *Virginia Polytechnic Institute.* (10 min.)

26. Structural Models of Cortin Compounds. I. 1,6-Disubstituted Hydronaphthalenes.
    Louis Long, Jr. and Alfred Burger; *University of Virginia.* (10 min.)

27. The Effect of PH on the Drying of a Sulfonated Product.
    R. A. Fisher and N. H. Nix; *Virginia Polytechnic Institute.* (10 min.)

28. Factors Influencing the Composition of Cigaret Smoke.
    O. L. Hillsman; *American Tobacco Company.* (20 min.)

29. Cis-β-Aroyl Acrylic Acids and Related Compounds.
    G. W. Scott and Robert E. Lutz; *University of Virginia.* (10 min.)

30. The Ring-Chain Tautomerism of Hydroxyfuranones Contain Alkyl Groups.
    Ralph C. Downing and Robert E. Lutz; *University of Virginia.* (10 min.)

31. The β-Hydroxyfurans and Hydroxyfuranones with Particular Reference to the 2,5-Dimesityl Derivatives.
    C. Edward McGinn and Robert E. Lutz; *University of Virginia.* (10 min.)

32. Business Meeting and Election of Officers.

Section of Education

PAUL G. HOOK, *Chairman*

E. B. BROADWATER, *Secretary*

FRIDAY, MAY 2—10:00 A. M.

Room 600, Old Virginia Hospital

1. The Life and Work of Joseph Dupuy Eggleston.
   E. F. Overton; *University of Virginia.*
2. Higher Education for Women in Virginia.
   W. Hall Cato; *University of Virginia.*
3. A History of the Constitutional Provisions for Education in Virginia.
   R. A. Meade; *University of Virginia.*

FRIDAY, MAY 2—2:00 P. M.

Room 600, Old Virginia Hospital

4. Negro Education in Virginia.
   Fred M. Alexander; *State Board of Education.*
5. Ability of Virginia Counties to Support Schools.
   R. F. Williams; *Supt. of Smythe County Public Schools, Marion, Va.*
6. The Content for a Course in Social Mathematics for the Senior High School.
   Francis G. Lankford; *University of Virginia.*
7. Vocational and Educational Counseling with Adults.
   John A. Mapp; State Board of Education.

Section of Engineering

D. H. PLETTA, *Chairman*

P. S. DEAR, *Secretary*

FRIDAY, MAY 2—9:30 A. M.

Room 304, Egyptian Building

1. Factors Controlling Commercial Utilization of Industrial Casein from Soybean Meal.
   Leland M. Reed and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

2. Preliminary Studies in the Design of a Commercial Plant for the Purification of Tall Oil.
   Jerome M. Crockin and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

3. Esterification for Development of Drying Characteristics of Tall Oil.
   Charles F. Eck and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

4. Factors Affecting the Corrosion Rates of Metals in Tallol.
   I. M. Markwood and R. A. Fisher; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

5. Cross-connection Pollution Hazards, and Method of Detection.
   Alvin F. Meyer, Jr.; *Virginia Military Institute.* (Lantern, 10 min.)

6. Roanoke River Stream Pollution Survey.
   H. F. Eich and P. H. McGaughey; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

7. Utilization of Rosin and Waste Fatty Acids for the Production of Adipic and Sebacic Acids.
   William R. Keller and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

8. The Industrial Utilization of Carbide Generator Lime Wastes.
   Robert L. Teeter and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 10 min.)

9. Industrial Waste Survey in Virginia.
   Dudley Thompson and Robert A. Fisher; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

10. The Utilization of Paper Mill Wastes in the Flotation of Manganese Ores.
    Hugh F. Smith and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 10 min.)

11. A New Extensometer.
    H. R. Puckett and D. H. Pletta; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

12. Business Meeting, Appointment of Nominating Committee.

FRIDAY, MAY 2—2:00 P. M.

Room 304, Egyptian Building

13. Continuation of Business Meeting.

14. Barium Carbonate as a Material for Adjusting "Glaze-Fit" on Talc Bodies.
    Fred W. Bull; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

15. Problems Encountered in Utilization of Red Cedar.
    E. H. Lane, Jr.; *The Lane Co., Altavista, Va.* (Lantern, 30 min.)

16. Clarification of Wool Scouring Liquors Containing Sulfated Higher Alcohols.
    Louis J. Sitomer and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

17. The Relationships Between Nozzles and Solvent-Solute Characteristics in Solvent Extraction.
    Edward L. Bragg and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

18. The Effect of Hot Plate Surfaces on Thermal Conductivities.
    R. M. Johnston and C. B. Ruehr; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

19. Design of Non-Diaphragm Calcium Chlorate Cell.
    Frank W. Tober and Frank C. Vilbrandt; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

20. The Torsional Properties of Round Edged Flat Bars.
    D. H. Pletta and F. J. Maher; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

Section of Foresty

JOHN *W.* MCNAIR, *Presiding*

FRIDAY, MAY 2—10:00 A. M.

Room 301, McGuire Hall

1. The State Forestry Department.
   F. C. Pederson; *State Forester.* (20 min.)
2. The Work of the Assistant State Forester.
   George W. Dean; *Assistant State Forester.* (10 min.)
3. District State Forestry Work in Southwestern Virginia.
   G. H. Hodge; *District Forester.* (5 min.)
4. District State Forestry Work in the Piedmont Area.
   Berlin Eye; *District Forester.* (5 min.)
5. District State Forestry Work in the Tidewater Area.
   Brantley Henderson, Jr.; *District Forester.* (5 min.)
6. Work of the Extension Service in Forestry.
   Wilbur O'Byrne; *Extension Forester.* (10 min.)
7. Work of the Extension Service in Forestry (Cont.)
   Conner; *Assistant Extension Forester.* (5 min.)
8. Work of the Forestry Department at V. P. I.
   J. B. Grantham; *Professor of Forestry.* (10 min.)
9. The Forestry Department at the U. of Va.
   Chapin Jones; *Professor of Forestry.* (10 min.)
10. Forest Entomology Work of the Virginia Agricultural Experiment Station.
    L. A. Hetrick.

FRIDAY, MAY 2—2:00 P. M.

Room 301, McGuire Hall

CHAPIN JONES, *Presiding*

11. Federal Viewpoint on Private Forestry.
    E. I. Kotok; *Assistant Chief, U. S. Forest Service.*
12. The Jefferson National Forest.
    John W. McNair; *Forest Supervisor, Jefferson National Forest.* (15 min.)

13. Forestry Work in the Northern Va. Area of the S. C. S.
    Lawrence T. Small; *Area Forester.* (10 min.)

14. The Virginia Farm Forestry Project.
    A. B. Lyon; *Project Forester.* (10 min.)

15. Forestry Work in the Rockbridge County Conservation District.
    Carl B. Liveley. (5 min.)

16. S. C. S. Forestry Work in the Tidewater District.
    W. A. Phillips; *Soil Conservation Service.* (5 min.)

17. The Work of the Forestry Department of Johns-Manville, Jarrat, Va.
    Ray F. Bower. (10 min.)

18. Education Work in Forestry of the Chesapeake Corporation.
    J. H. Johnson; *Assistant Forester.* (5 min.)

19. Work of the Forestry Department of the Chesapeake Corporation.
    W. L. Gooch; *Forester.* (With Slides.) (15 min.)

20. Work of the Forestry Department of the Chesapeake-Camp Corporation.
    T. N. Barron; *Forester.* (10 min.)

21. Discussion.

There will be a field trip into the surrounding area Saturday, the details of which will be announced at the Friday Meeting.

Section of Geology

E. C. H. LAMMERS, *Chairman*

R. S. EDMUNDSON, *Vice-Chairman*

WM. M. MCGILL, *Secretary*

FRIDAY, MAY 2—9:45 A. M.

Auditorium, Hunton Hall

1. Some Stratigraphic Variations in Northern Virginia.
   R. S. Edmundson; *Virginia Geological Survey.* (Slides, charts, 10 min.)

2. Mineralogy of Some Atlantic Coast Beach Sands.
   R. O. Wilbur and J. B. Snobble; *Washington and Lee University.* (Slides, 10 min.)

3. Mineralogy of Sands from Tributaries of South Fork of Shenandoah River, Virginia.
   C. L. Sartor and R. W. Root; *Washington and Lee University.* (Slides, 10 min.)

4. Source of Sediment of Tuscarora Sandstone in Massanutten Mountain, Virginia.
   H. W. Woods, Jr., and Egmont Horn; *Washington and Lee University.* (Slides, 10 min.)

5. A Method of Tracing the Flow of Underground Streams.
   M. H. Stow; *Washington and Lee University.* (5 min.)

6. Outlines of the Geology of Smyth County, Virginia.
   J. K. Roberts; *University of Virginia.* (Slides, 15 min.)

7. Virginia's Stone Industry.
   Arthur Bevan; *Virginia Geological Survey.* (Slides, 15 min.)

8. Gemology—the Infant Branch of Science.
   G. C. Barclay; *Certified Gemologist, Newport News, Va.* Introduced by Wm. M. McGill.) (15 min.)

9. A Chemical Study of the Profile of Certain Limestone Valley Soils in Virginia.
   C. G. Morgan and S. S. Obenshain; *Virginia Agricultural Experiment Station.* (Slides, charts, 15 min.)

10. Three Items of Virginia Geology.
    R. J. Holden; *Virginia Polytechnic Institute.* (10 min.)

FRIDAY, MAY 2—2:00 P. M.

Auditorium, Hunton Hall

11. Geophysical Investigations in Virginia.
    George Woolard; *Princeton, New Jersey.* (Introduced by E. C. H. Lammers.) (Maps, slides, 20 min.)

12. Mineral Composition of Rocks in the Hudson Highlands of Southeastern New York.
    J. D. Bates; *University of Virginia.* (Introduced by J. K. Roberts.) (Slides, 10 min.)

13. Age Relationships of Certain Metamorphic Rocks in the Vicinity of Lynchburg, Virginia.
    Wm. R. Brown, *Cornell University.* (Slides, 10 min.)

14. An Occurrence of Amethyst in Prince Edward County, Virginia.
    E. W. Sniffen; *Hampton, Va.* (Slides, specimens, 10 min.)

15. Diabase Minerals of the Virginia Triassic, Illustrated by Kodachrome.
    W. C. Overstreet; *University of Virginia.* (Introduced by A. A. Pegau.) (Slides, 10 min.)

16. Possible Unicoi Tuffs in the Central Blue Ridge of Virginia.
    R. R. Bloomer; *University of Virginia.* (Slides, 10 min.)

17. Progressive Down Dip Changes in Quality of Ground Water in the Virginia Coastal Plain.
    D. J. Cederstrom; *U. S. Geological Survey.* (Slides, charts, 15 min.)

18. The Occurrence of Ground Water along the Fall Zone in Virginia.
    Wm. M. McGill; *Virginia Geological Survey.* (Maps, charts, 10 min.)

19. Granite Contacts in Southeastern Piedmont Virginia.
    A. A. Pegau; *University of Virginia.* (Slides 10 min.)

BUSINESS MEETING

Reports of Committees.

Election of Officers.

SATURDAY, MAY 3—8:00 A. M.

Field Trip—Place of assembly and details of trip to be announced at the meeting Friday.

Section of Medical Sciences

ROLLAND J. MAIN, *Chairman*

GUY W. HORSLEY, *Secretary*

FRIDAY, MAY 2—9:30 A. M.

Room 423, Clinic Building

1. Studies on Fat Metabolism and Susceptibility to Carbon Tetrachloride.
   J. C. Forbes, B. E. Leach, and E. L. Outhouse; *Department of Biochemistry, Medical College of Virginia.* (15 min.)

2. The Synchronization of Cerebro-Cortical Potentials.
   C. G. Holland; *Departments of Physiology and Neuropsychiatry, University of Virginia.* (Lantern, 15 min.)

3. Study of a Case of Osteosclerosis with Myeloid Leukemia, with Special Reference to the Extensive Extramedullary Blood Formation.
   H. E. Jordan and J. K. Scott; *Department of Anatomy, University of Virginia.* (Lantern, 15 min.)

4. Structure and Function of the Brain of the New-born Bear.
   Walther Riese; *Department of Neuropsychiatry, Medical College of Virginia.* (Lantern, 15 min.)

5. The Efficacy of Bacteriophage and Other Bacterial Preparations in the Control of Experimental Friedlander B Infection in Mice.
   Leslie A. Sandholzer; *U. S. Public Health Service, Craney Island Laboratory, Norfolk, Virginia.* (Lantern, 10 min.)

6. A Study of the Antagonistic and Synergistic Relationships Between Members of the Pseudomonas and Escherichia Genera.
   Mary V. Ferguson and Leslie A. Sandholzer; *U. S. Public Health Service, Craney Island Laboratory, Norfolk, Virginia.* (Lantern, 10 min.)

7. Autopassive Local Sensitization and Desensitization.
   Oscar Swineford, Jr., and W. Roy Mason, Jr.; *Department of Internal Medicine, University of Virginia.* (Lantern, 20 min.)

8. The Methylene Blue Lactose Broth Test for Sterility of Glasses and Eating Utensils.
   A. F. Meyer, Jr.; *Sanitary Laboratory, Virginia Military Institute.* (10 min.)

FRIDAY, MAY 2—2:00 P. M.

Room 423, Clinic Building

9. Business Session:
   a. Discussion of advisability of combining Section of Zoology and Section of Medical Sciences.
   b. Election of Officers.
10. Preliminary Studies: Effect of X-ray on Normal and Injured Liver Cells in Rats.
   G. Z. Williams; *Department of Pathology, Medical College of Virginia.* (Lantern, 10 min.)

Symposium of Sulfonamide Drugs

11. Chemistry of Sulfonamide Drugs.
    Alfred Chanutin; *Department of Biochemistry, University of Virginia.*

12. Pharmacology of Sulfonamide Drugs.
    Harvey B. Haag; *Department of Pharmacology, Medical College of Virginia.*

13. Sulfanilamide and its Derivatives in Medical Practice.
    Ernest G. Scott; *Lynchburg, Virginia.*

14. Sulfanilamide and its Derivatives in Surgery.
    I. A. Bigger; *Medical College of Virginia.*

SATURDAY, MAY 3—9:30 A. M.

Room 423, Clinic Building

15. The Relation of Solar Radiation to Cancer Mortality in North America.
    Frank L. Apperly; *Department of Pathology, Medical College of Virginia.* (Lantern, 10 min.)

16. The Relation of Arterial Pulse-Pressure to the Arterio-Venous Oxygen Difference in the Blood.
    M. Katharine Cary and Frank L. Apperly; *Department of Pathology, Medical College of Virginia.* (Lantern, 10 min.)

17. Heparin and Peritoneal Adhesions.
    Floyd Boys; *Department of Surgery, University of Virginia.* (20 min.)

18. The Mechanism of Shock in Intestinal Strangulation.
    Everett I. Evans; *Department of Surgery, Medical College of Virginia.* (15 min.)

19. Alcohol Absorption from the Skin.
    R. V. Bowers and J. F. Blades; *Departments of Chemistry and Surgery, Medical College of Virginia.* (10 min.)

20. High Altitude Exposure and Drug Susceptibility (Morphine and Sulfanilamide).
    Ernst Fischer; *Department of Physiology and Pharmacology, Medical College of Virginia.* (Lantern, 15 min.)

21. An Analysis of Hormonal Influences on Fliud Balance.
    S. W. Britton and E. L. Corey; *Physiological Laboratory, University of Virginia.* (Lantern, 20 min.

22. Alcaptonuria in a Negro Family.
    Lynn D. Abbott; *Department of Biochemistry, Medical College of Virginia.* (15 min.)

SCIENTIFIC EXHIBIT

Third Floor, Egyptian Building

Pathogenic Fungi Demonstration. Open for the duration of the meeting.
Department of Bacteriology, Medical College of Virginia.

Section of Psychology

FRIDAY, MAY 2—9:30 A. M.

Room 500, Old Virginia Hospital

1. Intensity as a Determinant of the Simple Visual Reaction.
   V. Coucheron Jarl; *University of Virginia.* (Slides, 15 min.)
2. The Attentional Range as a Function of After-Stimulation.
   Frank Mas; *University of Virginia.* (15 min.)
3. Individual Differences in Visual Fusion Frequencies.
   F. Gordon Tice; *University of Virginia.* (15 min.)
4. The Duration of Sleep Movements.
   M. Morgan Jackson; *University of Virginia.* (Slides, 15 min.)
5. A Projection Technique for the Laboratory Demonstration of Color Mixing.
   Huntington W. Curtis; *College of William and Mary.* (10 min.)
6. Anesthetization of Albino Rats during the Delay Interval of a Delayed Alternation Habit.
   Gloria Ladieu; *University of Virginia.* (15 min.)
7. An Attempt to Condition the Galvanic Skin Response to a Subvocal Stimulus.
   Elliot Mitchell; *College of William and Mary.* (10 min.)
8. Some Factors Determining Acquisition of Verbal Expectations.
   Jeannette Hughes and Nancy Phillips; *Randolph-Macon Woman's College.* (15 min.)
9. Dominance Behavior in Monkeys.
   James H. Elder; *University of Virginia.* (10 min.)

FRIDAY, MAY 2—2:00 P. M.

Room 500, Old Virginia Hospital

10. Round Table Discussion.
    Speaker: Professor Clark L. Hull; *Yale University.*
    "The Problem of Primary and Secondary Motivation."
11. Business Meeting.

SATURDAY, MAY 3—9:00 A. M.

Room 500, Old Virginia Hospital

12. Behavior of Children in Puberty Praecox.
    Martin R. D. Singer; *University of Virginia.* (15 min.)

13. The Rôle of Hysterical Fugues in Systematized Amnesia.
    D. Maurice Allan; *Hampden-Sydney College.* (15 min.)

14. A Critical Analysis of Sub-Tests in the Terman-Merrill Revised Stanford-Binet Intelligence Scale.
    Cora L. Friedline; *Randolph-Macon Woman's College.* (15 min.)

15. An Experimental Evaluation of Two Non-Cultural Intelligence Tests.
    R. H. Henneman; *College of William and Mary.* (Slides, 10 min.)

16. An Investigation of the Relation between "Verbal Facility" and "Success" in College.
    D. D. McKinney; *College of William and Mary.* (10 min.)

17. A Study of Sisters in College.
    M. B. Coyner; *Farmville State Teachers College.* (15 min.)

18. A Comparison of Freshmen and Seniors in a Liberal Arts College in Respect to Their Understanding of Social Issues.
    Helen K. Mull and Evelyn Cantey; *Sweet Briar College.* (10 min.)

19. Student Belief on Certain Selected Social Issues.
    William M. Hinton and John G. Martire; *Washington and Lee University.* (15 min.)

20. The Development of Stereotypes Concerning Negro-White Differences.
    Robert Blake; *University of Virginia.* (15 min.)

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CONTENTS

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The Virginia Journal of Science

VOL. II MAY, 1941 No. 5

As It Appears to The Cavalier[1]

THOMAS LOMAX HUNTER

Science is man's latest brain-child. It is by far the most liberal and enlightened of all those children. It is the only one with a true international outlook. It has no political interests or obligations. Its devotees are the cream of our intellectual product.

Science is not geocentric. This little speck of star-dust is just its listening post. Its field is the infinite without, the infinite within, to use Shelley's striking phrase.

The vanguard of human progress had to reach the light and actually emerge from the jungle before science could be born. The great mass of humanity is still in that jungle.

Science being entirely non-political has no interest in the political quarrels which plague the less enlightened humans. It has no geographical boundaries. It knows neither race nor color nor creed. It looks at man through the calm eyes of biology, just as it looks at the earth as a geological specimen, and sees the skies with the eyes of the astronomer and astro-physicists.

All the arts man has made into the servants of the sword. The muses have been the mistresses of the state and the Church, painting, singing, dancing and making graven images as those powers have directed.

During the ages when politicians have quarreled and led men to war, the arts have divided politically and become partisans in those quarrels. As late as a quarter of a century ago, we banned the music of our enemies and spoke disparagingly of their poetry.

The priests of science have no part in such squabbles. They resolutely turn their backs on such silly business. War makes use of the creations of science and prostitutes them to its brutal

[1]Reprinted by permission from *The Richmond Times-Dispatch,* March 25, 1941.

ends, but the true scientist looks down on all that from an immensely superior height as an unfortunate necessary part of man's struggle in the jungle.

Oratory and poetry have always been the handmaidens of Mars. They proclaim the wisdom of our king, the valor of his soldiers and the cunning of his captains. The makers of graven images are drafted to make proper effigies of the valiant slayers of man and set them up as brazen statues in the public square. Walk through your city today and observe who it is that strides the brazen stallions in the parks. Almost wholly it is men who have commanded the slaughter

> *When the order shakes the line,*
> *And the lean-locked ranks go roaring down to die.*

Politics made Napoleon. Science gave us Pasteur. There are a thousand graven images of Napoleon to every one for Pasteur. The reason for this is that Napoleon was the darling of the mob, and Pasteur can be understood only by a few. Science is never concerned with majorities. Is not interested in Gallup polls. Pasteur has saved more people than Napoleon caused to be murdered.

When war comes it is easy to make our musicians assure us that Irving Berlin is a greater musician than Beethoven or that the man who sculptured Lincoln out of a mountain side is a grander sculptor than Michael Angelo. Before this current quarrel is over Irving Berlin will probably change his name to Irving Washington. Patriotism is wonderful when it reaches the proper temperature.

Scientists never ask the political or geographical origin of any scientific discovery. They are universal. They all belong to all humanity. No scientist turns up a patriotic nose at sulfanilamide and its variants. It has therapeutic value and that is all the scientist asks.

Science is not disdainful of wireless because it was invented by Marconi, nor of the flying machine because it was given us by a Yankee. When and if ever, a large part of humanity has reached the point in human progress which the scientists have attained, war will be as unthinkable as cannibalism or witch-burnings.

These few men of scientific enlightenment are out of the jungle, and are no longer under the jungle law. The great mass of humanity is still in the jungle and its law is the *lex talionis*.

Its kings are bloody-handed. Its politicians teach war as a useful art and hold armies as beneficent instruments of political idealism. Its priests find moral support for the acts of the politicians and supplicate the gods for victory and booty. Not so very long ago, the gods had a share of this booty, even a share of the captive women.

The hope of humanity for better things is in the hands of this noble army of science, not in the men of blood, their captains and their priests. In the hands of this vanguard of the light is our hope and our salvation.

Observations On Virginia Plants, Part I

F. R. Fosberg

I. Critical and Distributional Notes

In the course of casual collecting of Virginia plants and while preparing a check list of the plants of Shenandoah National Park certain critical and distributional notes have accumulated which seem worth recording in published form. Herbarium material has been consulted in the herbaria of the University of Pennsylvania (UP), Academy of Natural Sciences of Philadelphia, New York Botanical Garden (NY), U. S. National Arboretum (USNA), and the U. S. National Herbarium (US). The species discussed are either found in Virginia or are discussed in connection with related ones in the Virginia flora.

Abies balsamea L. var. **phanerolepis** Fern. Rhod. 11: 203. 1909.

A. intermedia Fulling, Jour. So. App. Bot. Cl. 1:91-94, 1936.

I have examined the original material of *Abies intermedia* in the herbarium of the New York Botanical Garden, as well as numerous other specimens from the type locality and its vicinity. The two characters upon which the species chiefly depends are the recurved exserted bracts and auriculate scales. The exserted condition of the bracts, characteristic of *A. balsamea* L. var. *phanerolepis* Fern., is a highly variable character in degree, but present in most individuals examined along the trail up Hawksbill Mountain, in Hawksbill Gap, and at Crescent Rocks, in the Blue Ridge. With the other character the story is different. Many scales from various specimens were examined before any trace of this condition was found. It was finally ascertained that occasional slightly auriculate scales may be found in most cones in this population, and that they are more numerous in some examples than others. One sheet of Fulling's type has few auriculate scales and these are not extremely developed. The other sheet has most scales auriculate, and some of them extremely so, as shown in Fulling's figure (l. c., p. 94, fig. 1). However, a character that can be found well developed only once in a population is, I think, best regarded as a mutation, or a casual variation.

Examination of several cones of *A. balsamea* and *A. balsamea* var. *phanerolepis* from farther north shows that occasional scales are somewhat auriculate in them also.

The exserted bracts associate this population with Fernald's var. *phanerolepis*, as suggested by Wherry (Ecol. 15:442. 1934, Jour. So. App. Bot. Cl. 2:28. 1937) and Freer (Claytonia 2:5. 1935). This form seems to be of sporadic occurrence over a large part of the range of the species. Perhaps it merits only the category of *forma*, but until its distribution has been more carefully plotted it seems best to defer any change.

Carex L. The following new records for Virginia are contributed by F. J. Hermann.

Carex aestivaliformis Mack.

Appalachian Trail near Skyland, Blue Ridge, Page Co., *Hermann 10752* (USNA). Previously not known south of Pennsylvania and Delaware.

Carex aggregata Mack.

Dry grassy slope bordering woods on right bank of New River, Carter's Ferry, Wythe Co., *Hermann 10627* (USNA). Known previously from New Jersey to District of Columbia, westward to Saskatchewan.

Carex angustior Mack.

Boggy ground at spring, alt. 4,100 ft., summit of Elliott Knob, Augusta Co., *Allard 145* (US). Known previously from the northern part of the country, southward in the mountains to North Carolina.

Carex baileyi Britton.

Sphagnum bog near Big Stoney Creek, Kelly Flats west of Kare, Giles Co., *Hermann 10690* (USNA). Known from farther north, and westward as far south as Tennessee.

Carex bushii Mack.

Slope of Mt. Pony, 1½ mi. south of Culpeper, Culpeper Co., *Allard 1451* (US); pasture at foot of Buck Mt., Fauquier Co., *Allard 3063* (US). Known previously from Massachusetts southward to District of Columbia, westward to Mississippi and Texas.

Carex cephalantha (Bailey) Bickn.

Sphagnum bog between Stuart's Draft and Sherando, Augusta Co., *Killip 32576* (US). Previously known from farther north and west.

Carex communis Bailey var. **wheeleri** Bailey.

From Fisher's Gap, Page Co., *Walker 2795* (US). Not previously known south of Connecticut and Michigan.

Carex kobomugi Owhi.

Foredunes west of Cape Henry, east of Ocean View, Princess Anne Co., *Walker 1208* (US). Previously known in North America only from a single station on the New Jersey coast (reported as *C. macrocephala* Willd.) Native of eastern Asia.

Carex molesta Mack.

Gap south of Hawksbill Mt., Blue Ridge Mts., Madison Co., alt. 1,000 m., *Fosberg 15313* (UP, USNA). Known previously from New York westward to Kansas and Nebraska.

Carex pedunculata Muhl.

Hemlock-arbor-vitae woods on bluff above Tom's Creek, Sunnyside Church, 4 mi. N. W. of Price's Forks, Montgomery Co.

Hermann 10661 (USNA). Known previously from farther north and west, and southward in the mountains to Georgia.

Carex rugosperma Mack.

Western slope of Bull Run Mts., Fauquier Co., *Allard 1157* (US); eastern slope of Bull Run Mts.; Loudoun Co. *Allard 2508* (US); gravelly roadside embankment 11½ mi. S. E. of Warsaw, Richmond Co., *Hermann 10596* (USNA). Previously not known south of Indiana and Maryland.

Anemone quinquefolium L. var. **lancifolium** (Pursh) Fosberg, n. comb.

A. lancifolium Pursh, Fl. Am. Sept. 386. 1814.

In his key (Rhod. 30:182. 1928) Fernald distinguishes *A. lancifolia* from *A. quinquefolia* only by the latter having the veins of the sepals not or only slightly anastomosing contrasted to the former with strongly anastomosing veins. Comparison of the descriptions adds minor differences in leaf shape and cutting, also the length of the petiole "long" vs. "short". These foliar characters are extremely variable, although the majority of specimens can be distinguished by them. The venation of the sepals is similarly variable, though generally the two can be distinguished on this basis. The existence of some specimens that cannot, with any certainty, be placed in one or the other, as well as the trivial nature of the differences and the superposition of their geographic ranges leads me to think that they are merely varieties of one species, rather than separate species.

Intermediate specimens are the following. Virginia: Madison Co., Blue Ridge, Big Meadows, *Fosberg 17026* (USNA); Smythe Co., White Top Mt., *Small* in 1892 (US), *Cathcart* in 1892 (US).

Saxifraga michauxii Britton, Mem. Torr. Cl. 4: 113. 1894.

Saxifraga leucanthemifolia of Michaux and other American authors, not Lapeyr. Jour. Phys. Chim. d'Hist. Nat. 48:266. 1799.

This species has been commonly called *S. leucanthemifolia* Michx., although Michaux made a definite reference to "La Peyr. Monog." and did not call his plant a new species. It is a true southern Appalachian endemic and its range is extended to the Blue Ridge of central Virginia by the following collections. Virginia: Madison Co., Old Rag Mt., *Fosberg 16919* (USNA); Page Co.-Madison Co. boundary, summit of Hawksbill, *Fosberg 17250* (USNA); Page Co., Stony Man Mt., *Hotchkiss 1601* (US), *Palmer & King 234* (US), *Steele & Steele 76* (US).

It is rather common on these high summits where it grows in company with such northern species as *Potentilla tridentata, Abies balsamea* and *Lycopodium selago*. It may be easily recognized by its flat rosettes of spatulate, prominently serrate leaves and its slender diffusely branched panicles of small whitish flowers, with the petals larger on one side than the other.

Spiraea betulifolia Pallas var. **corymbosa** (Raf.) Wenzig, Flora 71: 276. 1888.

Spiraea corymbosa Raf. Prec. Decouv. 36. 1814.

The differences between the eastern plant, commonly called *Spiraea corymbosa* Raf. (1814), and the northwestern one commonly called *S.lucida* Dougl. (1892), mainly the presence or absence of hairs on the inflorescence branches, seem too slight to maintain the plants as distinct species. As Hulten has pointed out (Kungl. Sv. Vet. Akad. Handl. 8: 40. 1929) that the type of *S. betulifolia* Pallas (1784) is still extant and is identical with *S. lucida* Dougl., the former name is the earliest for the complex. Therefore the combination given above must be used for the eastern plant if it is to be regarded as only varietally distinct from the northwestern one.

Spiraea betulifolia Pallas var. **corymbosa** (Raf.) Wenzig f. **campii** Fosberg, n. f.

Folia magna apice truncata, flores punicei.

Leaves larger than the common form, and truncate or subtruncate at apex, flowers pink.

Virginia: Rappahannock Co., Blue Ridge Mts., below Mary's Rock, Shenandoah National Park, alt. 700 m., June 19, 1938, *Fosberg 15302* type (UP); Page Co., along Little Hawksbill Creek, *Camp 1455* (NY).

By the standards accepted in recent treatments of *Spiraea* in North America this would be a distinct species. I consider it merely a form because of the trivial nature of the differences between it and typical pointed-leaved white-flowered var. *corymbosa,* and especially since the latter occurs in the same general region.

Veronica beccabunga L. var. **americana** Raf.

Veronica americana Schwein.

Although this widespread American plant has been considered a distinct species by almost every writer, the differences between it and its European relative *V. beccabunga* L. are slight indeed. They are as follows: *V. americana* is supposed to be somewhat less prostrate, ascending at tips, with leaves lanceolate to ovate, acute or acutish, serrate, fruiting pedicels 6-11 mm. long, while *V. beccabunga* is more prostrate, with shorter, obtuse or rounded leaves which are crenate, fruiting pedicels 4-5 mm. long.

I have examined considerable series of material from both America and Eurasia in the U. S. National Herbarium and the Academy of Natural Sciences at Philadelphia. These alleged differences turn out to be scarcely more than average differences, when a number of specimens are compared. *V. beccabunga* seems to me to be a species of the greater part of the North Temperate Zone, which has differentiated into rather poorly marked varieties, one in Eurasia and one in America. Dr. Pennell says (con-

versation 1940) that the plants from extreme eastern Asia are of the American form.

Mimulus moschatus Dougl.

This species is common in the Western States and in Canada east to Newfoundland. In the eastern United States it is found in Michigan, New York, and sporadically from New England as far south as West Virginia and North Carolina. Pennell considers all except the most northern of these eastern occurrences as introductions. *Fosberg 15289* (UP) from Lee Highway north of Pine Mountain, 5 miles east of Luray, Page County, adds this species to the flora of Virginia. Nothing in its occurrence at this locality would suggest its being introduced, but that is entirely possible, since there were houses not far away.

Hedyotis L.

In a later paper I shall discuss at some length the question of the status of *Houstonia* L. and show that it is morphologically insufficiently distinct from *Hedyotis* L. (sens. lat.) of the Old World. The only distinctive characters are the elevated disk in the fruit (the so-called semi-superior ovary), which is found in somewhat different form in several Old World species, and the form of the seeds which are usually more or less concavo-convex. The herbaceous habit, characteristic of the eastern United States species, is an extreme development, by no means characteristic of the group farther south in Mexico. This habit is found also in some Asiatic species and in most of subgenus *Oldenlandia.*

A new specific combination and a new name are necessary to enable me to refer to and annotate certain Virginia specimens under the genus *Hedyotis.* The other Virginia species have all been correctly placed in *Hedyotis* by earlier authors. Disposition of varieties (some of which have been called species) must await completion of my study of the *H. purpurea* assemblage (cf. Fernald, Rhodora, 42:362. 1940; Standley, Field Mus. Pub. Bot. 11:216. 1936). At present, my opinion is that the three extremes of this complex, which have been called in the past *Houstonia purpurea, H. longifolia,* and *H. tenuifolia* may better retain specific rank; the first characterized by its broad, cordate 3-nerved leaves and large fruits, the second by narrow oblong or lanceolate leaves with only one prominent nerve, the third by its elongate, very slender habit and narrowly linear leaves, long pedicels and small fruits. Their names in *Hedyotis* will be as follows:

Hedyotis purpurea T. & G. Fl. N. Am. 2: 40. 1841.

Houstonia purpurea L. Sp. Pl. 105. 1753.

Hedyotis canadensis (Willd.) Fosberg, n. comb.

Houstonia longifolia Gaertn. *Fruct.* 1:226. 1788. (not *Hedyotis longifolia* Schum. & Thonn. 1828).

Houstonia canadensis Willd. Roem. & Schult. Syst. 3:527. 1818.

Houstonia ciliolata Torr. Fl. U. S. 1:173. 1824.

Hedyotis nuttalliana Fosberg, n. name.

Houstonia tenuifolia Nutt. Gen. 1:95. 1818. (not *Hedyotis tenuifolia* Sm. 1811, Spreng. 1815, or Steud. 1840).

(Concluded in later issue.)

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

Industrial Waste Survey in Virginia

Dudley Thompson and Robert A. Fisher

The Department of Chemical Engineering at the Virginia Polytechnic Institute for many years has been conducting studies on the treatment and utilization of specific industrial wastes. As a result of difficulty experienced in obtaining information on the general status of waste disposal in the state, a more general investigation was started about two years ago for the purpose of collecting and correlating data on industrial wastes, the disposal of which might in one way or another affect public interests. Since dumping into a sewer or stream is the simplest way of disposing of industrial wastes and since considerable publicity was given to the subject of stream pollution during the last meeting of the State Legislature, the first emphasis in this investigation has been placed on those wastes which are likely to find their way into the streams of the State. Such wastes in the past have been the subject of widespread controversy, which has tended to give an exaggerated conception of their importance in the pollution of streams. Engineers now recognize that in the general problem of stream pollution, untreated municipal sewage is by far the most important factor.

Industrial wastes affect the public welfare esthetically and economically. Responsible agencies in all parts of the country in recent years have recognized the desirability and value of maintaining the streams in such condition that they may be a source of pleasure and recreation to the public. The disposal of many industrial wastes by means of the streams has been reduced or eliminated for this reason.

Economically, industrial wastes are of more fundamental importance in that they may affect the livelihood of thousands of people both directly and indirectly. Many industries exist today chiefly because they have been successful in recovering and utilizing their wastes. On the other hand, there are many industries, which if they were compelled by too stringent legislation to refrain from disposing of their wastes into the streams, would be placed in an extremely awkward position, if not forced to cease operations. In many cases technology, methods, and equipment have not been developed sufficiently to warrant their use without considerable economic handicap to the user. And there are cases where equipment, technology, and methods are inadequate regardless of costs. It must also be kept in mind that due to the diverse nature of the various industries, equipment and methods adequate in one are entirely unsuited in another.

Industrial wastes are usually disposed of in one of the following ways: 1. re-use, 2. recovery of by-products, 3. destruction, such as by burning, 4. impounding and treatment, 5. discharge to sewers, 6. discharge to streams. While it is fully realized that

all of the above methods are interrelated and cannot be entirely divorced one from another, this investigation is concerned chiefly with the industrial wastes that are disposed of by dumping into sewers or streams with or without treatment. In general, the extent and manner of application of these methods in Virginia industries are being studied in this survey, with particular attention being paid to those phases indicated above.

In this study the sources of information have been the published literature, public agencies, the industries of Virginia, and chemical tests made on the streams and waste effluents.

As indicated previously, very little information is available in the published literature. About ten years ago a study was made by the Virginia Cooperative Committee on Stream Pollution. Apparently what results were obtained were not sufficient to warrant a published report of the work. The Spratley Report of 1927, the Report of the Commission of Fisheries on the Subject of Pollution of the Tidal Waters of the Commonwealth of 1932, the Calrow Report of 1934, the Bacteriological Study and Report of the U. S. Public Health Service of 1934, the Reports of the Hampton Roads Sewage Disposal Commission of 1936 and 1938, Galtsoff's Preliminary Report on the Cause of the Decline of the Oyster Industry of the York River of 1938, form the principal published works. The Virginia State Department of Health feels that what information it has in its files is not sufficiently complete or extensive to merit its release to anyone outside of its own department.

Legislation dealing with stream pollution is not of great consequence in Virginia. Practically all of the stipulations that have been enacted into state laws have passed through the legislature during rather recent years and have dealt entirely with municipal and local rather than general or state problems. During recent sessions of the legislature bills have been introduced that dealt with the disposal of industrial wastes in Virginia. These bills did not pass.

Contacts have been made with federal, state, and municipal agencies in various parts of Virginia. These agencies have been very courteous and in most cases have been able to contribute considerable information. These contacts have included the Virginia State Chamber of Commerce, the Virginia State Planning Board, the Virginia Manufacturers Association, the Virginia Conservation Commission, the State Department of Public Health, the Norfolk Department of Public Works, the Hampton Roads Sewage Disposal Commission, the Bureau of Industrial Research, and the Potomac River Flood Control Survey.

A number of industries have been visited. In some cases a complete and hearty cooperation was encountered. In other cases some limited information was made available, while in still other cases the industries were quite courteous, although they found

it inadvisable to release any information concerning their waste, its treatment, and disposal.

The information sought from the industries has been the quantity and composition of wastes produced, how they were disposed of or recovered, what changes have been effected in methods and equipment in handling, treating, recovering, and disposing of industrial wastes, and what suggestions the industries have as to problems that need further investigation which they are not in a position to carry out at this time. Some plants have allowed samples of effluents to be taken while others have considered it best not to permit this.

Samples have been obtained over portions of the New, Roanoke, and Jackson-James Rivers. Roughly, there is a heavier concentration of chemical process industries in the central-western part of the state than in other areas. Although trips have been made to most other sections of the state, the greater portion of activities are being centered in this central-western portion of the state.

Analyses have been chemical in nature. Field analyses included temperature, pH, CO_2, and setting of dissolved oxygen samples. Laboratory analyses are made for biochemical oxygen demand, nitrites, nitrates, total sulphides, chlorides, phenolphthalein and methyl orange alkalinity, sulphates, SiO_2, R_2O_3, calcium, magnesium, total hardness, total solids, volatile solids, and residue on ignition.

Sampling stations have been established at various points on the New River from above Radford to below Narrows, on the Roanoke River from above Salem to below Roanoke, on the Jackson-James River from above Covington to Buchanan. The first samples taken for analysis were obtained in January, 1941. Several samples have been obtained from most of these stations. Collection and analysis of samples will be continued during the investigation.

This project is an engineering survey, the purpose of which is to collect and correlate information on the extent, nature, and disposition of industrial wastes in Virginia. Since a great many of the industrial wastes that are not recovered and utilized are disposed of by dumping into the streams, the relationship of industrial wastes to stream pollution will necessarily form the focal point of this investigation. In order that the progress that has been made may be clearly shown, it is desired to collect and correlate data on the advancements that have been made during the past decade by the Virginia industries in treating, recovering, and disposing of wastes. It is planned to prepare a report of this investigation after several more years of study during which time information will be collected on as many industries as possible.

Indications point toward the fact that a considerable amount of the wastes in this state that can be converted to profitable products have been eliminated from the streams. Many wastes that

do not pay a profit but meet the cost of their treatment have also been eliminated from the streams. In some cases, wastes from which there is no recoverable value whatever, have been eliminated or controlled, the expense being borne entirely by the industry, which, of course, results in a higher cost of the manufactured product. The results that have been obtained and the information collected have not been complete enough to warrant any definite conclusions at this time. However, from the data that have been secured, it is indicated that considerable strides have been taken by Virginia industries during the past ten years in the direction of recovering, treating, and utilizing their wastes. During the next several years it will be the purpose of this survey to attempt to translate this trend into quantitative data.

It has been through the courtesy of the Research Committee of the Virginia Academy of Science in granting a sum to partially cover expense of travel that it has been possible to make the trips to the agencies and industries and to collect samples.

Department of Chemical Engineering,
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Some Plants Found in Northern Virginia and West Virginia[1]

H. A. Allard

Color Form of *Senecio antennariifolius* Britton

Senecio antennariifolius is one of the most characteristic and showy plants inhabiting the steep shale barrens of the Massanutten ridges from Signal Knob to Strasburg southward. It is particularly abundant on the steep south slopes of Short Mountain in Shenandoah County, just east of Mt. Jackson.

Here in April, its generous yellow masses interspersed with the pale whitish or pinkish clumps of *Phlox brittonii* Small and the blue of *Astragalus distortus* Torr. & Gray make a veritable rock garden vivid with the warmth and friendliness of varied floral color. There is no plant in this association which contributes such glowing gold as the *Senecio* mentioned.

Here, on Short Mountain at least, two distinct forms appear, differing in color but otherwise indistinguishable. The typical form has deep golden yellow rays. The second form has rays of pale cream color. The latter is much less abundant and the writer has found it only on the shales of Short Mountain, although it may well occur elsewhere. Here, large patches of this color-form have developed by stoloniferous propagation.

Herbarium material of this color form collected April 24, 1938, has been deposited in the collections of the United States National Herbarium under the writer's field collection number 4483.

Isatis tinctoria L.

This showy member of the Cruciferae, an introduction from Europe, was found growing beside the bridge over the South Fork of the Shenandoah, Warren County, at Riverton, Virginia, on highway 55, where it has been established for some years. It was in full bloom on May 8, 1938, and was very showy with its dense masses of yellow. It was collected under the author's field collection number 4658. This plant has been reported as abundant on the northern section of the Skyline Drive in June, 1939. (Va. Jour. Sci. 1:33. 1940.) [See also *idem* 1:119. 1940. Ed.]

Galium verum L.

This deep yellow *Galium*, also an Old World species, was found in great abundance on highway 50, near Romney, Hampshire County, West Virginia, growing along the roadsides and also covering dry hill pastures here. It was in full bloom July 1, 1938, and produced a display of vivid yellow here with its acres of bloom. It was seen nowhere else. Collections were made under the number 6839.

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[1]Specimens of all the plants mentioned have been deposited in the collections of the U. S. National Herbarium. Specimens of *Sedum telephium* have also been deposited in the Herbarium of the U. S. National Arboretum.

Mr. E. S. Steele collected this species at Terra Alta, Preston County, West Virginia, on the Alleghany Plateau, altitude about 2300 feet, on July 7, 1923, this being the only material of this species in the National Herbarium collection from West Virginia.

Cimicifuga racemosa (L.) NUTT. VAR. *dissecta* A. Gray

The writer found a plant of this form on Buzzard Mountain, a diabase knob on the Triassic area in Culpeper County, Virginia, June 21, 1936. This bears the field collection number 1798. At this time the plant was not in flower. This form with dissected leaves appears to be very rare in Virginia.

Lilium canadense L. FORMA *rubrum* BRITTON

A colony of this deep red form of *canadense* was well established in 1936 in an open swale at Hopewell Gap between the Owens and the Costello properties. The plants were in full bloom July 4, and material was collected under the field number 1919. This is the only *Lilium* as yet found in the Bull Run Mountain area. Plants of this form are now being propagated from seed harvested from these parent plants. The writer has found this form at various stations in the mountains of West Virginia, between Davis and Petersburg in Grant County.

Sedum telephium L.

The writer has found this *Sedum* in scattered situations from Thoroughfare Gap to Hopewell Gap in the Bull Run Mountain area.

Several large colonies appear to have become established along the roadside at Hopewell Gap and along fence rows here.

This is the only *Sedum* which to date has been found in the Bull Run area, as the native species *Sedum telephioides* Michx. and *S. nevii* A. Gray, of the higher Appalachian ridges westward, do not occur here. The more generally distributed *Sedum ternatum* Michx. likewise does not occur in the Bull Run area.

Sedum telephium material has been collected under the writer's collection numbers 3417, 7565 and 7566.[2]

Pinus rigida MILL. FORMA *globosa* ALLARD IN THE BULL RUN MOUNTAIN AREA

The Pitch Pine (*Pinus rigida* Mill.) is of more or less general occurrence as an element of the forest of the wooded slopes throughout Bull Run Mountain.

It is also an important element of the old field successions everywhere in this area, in many places competing with the Virginia Pine (*Pinus virginiana* Mill.).

In an old field succession on the west slope just south of Hopewell Gap, the writer has found a particularly beautiful

[2]"*Sedum telephium* L. in the Bull Run Mountain Area, Virginia." H. A. Allard, Castanea, 5:17-19, 1940.

example which has been characterized *forma globosa*,[3] from its interesting and striking globose habit of growth which in this respect resembles the well known European ornamental Swiss Mountain Pine *Pinus mugo* var. *mughus* (Scop.) Zenari.

Rubus laciniatus WILLD.

Plants of this blackberry were found growing along a ravine near the foot of a shale ridge west of Three Top Mountain just north of Woodstock, Virginia, in Shenandoah County, October 9, 1938. Some of these plants were still in fruit at this time. Specimens were collected under the author's collection number 5614. This species is of uncertain derivation and apparently is not common in Virginia.

Amelanchier canadensis (L.) MEDIC. WITH PINK-SUFFUSED PETALS

Some years ago an ambitious young reporter of a Washington newspaper visited the writer to obtain information on some features of his garden. In a few days an article appeared which accredited the writer with the notable achievement of having produced a *"red shad bush"*. This elicited no little humorous comment from certain ones of the reading public and was somewhat disturbing at the time, since it had its origin wholly in the imagination and had no basis of fact to support it then.

On April 18, 1937, while exploring the slopes of a ridge of Bull Run Mountain in Loudoun County, Virginia, about three miles south of Aldie, the writer encountered a vividly pink form of this shad bush. The petals were colored a decided pink outside and the inner surface was also suffused with the same color. Whether or not this color form represented a purely environmental response to some particular quality of soil is not known but the abundance of the usual white forms everywhere indicated that it may have had the stability of a genetic variant.

Herbarium material of this shrub was collected under the number 2516.

With this material at hand, the writer now feels that a red shad bush may be a genuine possibility after all.

Malus lanceifolia REHDER

The writer on December 5, 1937, found several vigorous trees of this wild crab apple in an old pasture on the greenstone area about two miles west of High Point Cliffs. These were four to five feet tall and on this date bore many small, green fruits. Collections and drawings of fruit sections were made under the writer's field collection number 3895.

On April 21, 1938, these wild crab-trees were again visited and specimens of flowers secured under the number 4464. The

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[3]"A globose form of pitch pine (*Pinus rigida*) in Virginia." H. A. Allard, Rhodora 42:308, 1940.

flowers were just opening and the buds and petals were suffused with deep pink or crimson or marked with stripes of this color. The open blossoms were 1 to 1½ inches across and very beautiful. This wild shrub has decided possibilities as a native ornamental.

Setaria faberi HERRM.

On September 19, 1936, the writer found a few plants of this grass growing near the greenhouse at Arlington Farm, Virginia,[4] and specimens were collected under the number 2246.

On September 17, 1940, this grass was found rather generally scattered in waste ground over Arlington Farm, and abundant material was collected under the number 8217. This species, of Asiatic origin, now appears to be well established in the region of Arlington Farm.

It grows best in open waste ground recently abandoned from cultivation and in such areas may become a much branched sprawling plant, three feet in height. In poor sod ground, where *Setaria lutescens* (Weigel) F. T. Hubb. and *Setaria viridis* (L.) Beauv. are quite at home *S. faberi* is less adaptable and becomes of small size, or competes with much difficulty with the native grasses.

Setaria faberi is eminently suited to the naked ground of dumps and roadsides where competition is reduced. It may have been introduced from China in Millet seed.

WASHINGTON, D. C.

[4]W. L. McAtee, Eighth supplement to the flora of the District of Columbia and vicinity. Proc. Biol. Soc., Wash., 53:138, 1940.

Recent Fossil Discoveries in Burkes Garden, Virginia

G. G. Peery

Biologists may have little knowledge of the physical structure of the earth, but the fossils found in its rock strata invariably appeal to them, as they do to most intelligent people, since through them the horizon of our knowledge of organisms is greatly widened. Accordingly it was with great interest that I found in Burkes Garden, Virginia, in the summer of 1939, two types of fossils that were new to me. One of them has since been declared to be at least not uncommon. The identification of the other is still somewhat in doubt.

Burkes Garden is in the southwestern part of Virginia, in Tazewell County. The name applies to a territory ten miles long by seven wide. It is a relatively flat, rolling, blue-grass area, noted for its great fertility and for its fine cattle. It is completely encircled by a continuous mountain range, through which there is only one narrow gap, serving as an outlet for all the drainage from the region. Some of the peaks of the enclosing range reach an altitude of nearly five thousand feet. As one views the area from one of these peaks, it resembles a great bowl with a deep notch in one side.

The geologist tells us that Burkes Garden is a dome-like anticline of sedimentary rock which has been truncated, through the ages, by weathering and erosion. Thus many strata of rock have been exposed, ranging in age from early Ordovician to early Silurian. Most of the floor of the bowl-like region is composed of ancient Ordovician rocks, the oldest being Beekmantown limestone, thrust up almost in the center of the floor. Peripheral to this is an outcropping of Lowville limestone. The mountain making up the side of the bowl is composed of Juniata sandstone on one side and Clinch sandstone on the opposite side, these two layers belonging to the Silurian period.

In the summer of 1939, while visiting an old cemetery at Central Church in Burkes Garden, I found a very interesting stone which had been built into a rock wall surrounding the church. It had obviously been placed there for its decorative effect. On the surface of this stone, looking almost as if it had been carved out of the rock, was a group of worm-like forms. In size, in shape and in segmentation they strongly resembled a group of earthworms. A novice would certainly regard them as such. However, paleontologists tell us that earthworm fossils have never been found. In the main they are in agreement that this is a group of sandstone casts of a fossil known as *Arthrophycus alleghaniensis*. Harlan first described them in 1831 and regarded them as fossil fucoids, a form of sea-weed, and named them *Fucoides alleghaniensis*. In 1906 Sarle gave them the name *Arthrophycus alleghaniensis* and claimed they were worm borings

which had filled up with sand and given rise to the casts such as those I have described. One paleontologist whom I consulted expressed it as his opinion that these worm-like forms are fossil Crinoid columns. I later made a visit to the top of the mountain where the Clinch sandstone prevails, and from where all the stones in the old rock wall were obtained, and found the greatest abundance of what appeared to be Crinoid fossils. They, however, showed marked differences from the forms described as *Arthrophycus*.

The second type of fossil which was found in this region has not as yet been definitely identified. These were discovered on the exposed surface of a flat limestone rock near the entrance to a small cave. The rock in which they occur is an outcropping of Lowville limestone, of the Ordovician period. The location is near the lower end of the Garden area. The surface of the rock has a so-called "worm-eaten" appearance, due to the occurrence of a large number of uniformly shaped depressions, averaging from three to six inches in length, from one-half to three-quarters of an inch wide, and from one-quarter to one-half inch in depth. These depressions show no sign of segmentation or branching. It has been suggested that they are fucoid markings. Fossil fucoids frequently appear as clay casts in gray limestone. Sometimes the clay fillings are removed by erosion, leaving depressions similar to those described above. Certain fucoid markings have been found in the Lowville limestone in this region, but they are described as being definitely branched, while those I observed showed no branching in over a hundred specimens. In addition to fucoids, various paleontologists consulted have made the following tentative identifications: formations due to mechanical causes or to sedimentation or weathering, trails and casts of Benthonic invertebrates, and Bryozoans or worm trails.

In conclusion, it would seem that knowledge of these ancient forms is very vague and indefinite. The names appear to have no particular significance. Their biological relationships are very uncertain. Evidently the ancient oceans mothered many organisms of which we yet know but little.

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A Checklist of the Cicadellidae at Chatham, Virginia, with Thirteen New Records for the State

George Wene and C. B. Dominick

During the summer of 1940, randomized collections of leafhoppers were taken, with the exception of one, within a mile radius of the Virginia Agricultural Experiment Station Field Laboratory, at Chatham. Collections were also taken intermittently with a 100-watt light-trap, using a quart cyanide jar for killing the insects. After identification of the material, types of each species were placed in the insect collection of the field laboratory. A majority of the identifications were checked with the types in the insect collection at Ohio State University.

Sixty-four species, representing 45 genera, were identified from this material. Thirteen of these had not been recorded in the state, and can be considered as additions to Stearns' (1927) checklist. The thirteen new records, collected in such a small area, are very significant, because they show the potential opportunities for work of this type throughout Virginia.

Since the work of Stearns (1927), many changes have occurred in the nomenclature of the Cicadellidae. For this checklist, these are brought up-to-date according to DeLong and Caldwell (1937). In the following list of species found at Chatham, the new records are marked with an asterisk.

List of Species with the Collection Date

1. *Agalliopsis novella* (Say). 5-23-40.
2. *Agallia constricta* V. D. 4-30-40.
3. *Agallia quadripunctata* (Prov.) 6-6-40.
4. *Aceratagallia sanguinolenta* (Prov.) 4-30-40.
5. *Idiocerus pallidus* Fh. 6-2-40.
6. *Oncometopia undata* (Fabr.). 7-14-40.
7. *Oncometopia lateralis* (Fabr.). 4-2-40.
8. *Aulacizes irrorata* (Fabr.). 7-27-40.
9. *Kolla bifida* (Say). 8-28-40.
10. *Graphacephala coccinea* (Forst.). 7-6-40.
11. *Graphacephala versuta* (Say). 6-5-40.
12. **Draeculacephala antica* (Walker). 4-2-40.
13. **Carneocephala flaviceps* (Riley). 7-31-40.
14. *Gyponana octolineata* (Say). 7-6-40.
15. *Ponana scarlatina* (Fh.). 7-14-40.
16. *Xerophloea major* Baker. 4-2-40.
17. *Xestocephalus nigrifrons* Osb. 6-5-40.
18. *Xestocephalus superbus* (Pov.). 7-14-40.
19. *Nionia palmeri* (V. D.). 6-6-40.
20. *Parabolocratus flavidus* Sign. 6-6-40.
21. *Aligia modesta* (Osb. & Ball). 7-14-40.
22. **Bandara aurata* (Ball). 6-12-40.
23. *Osbornellus jucundus* (Uhl.). 7-14-40.

24. *Scaphoideus immistus* (Say). 7-27-40.
25. **Cloanthanus angustatus* (Osb.). 8-28-40.
26. *Platymoideus cinereus* (Osb. & Ball). 6-14-40.
27. *Nastoides frontalis* (V. D.). 5-25-40.
28. *Flexiamius areolatus* (Ball). 6-6-40.
29. *Flexamius sandersi* (Osb.). 6-6-40.
30. *Poyamia weedi* (V. D.). 6-1-40.
31. *Poyamia inicimus* (Say). 5-25-40.
32. *Laevicephalus melsheimerii* (Fh.). 5-25-40.
33. **Laevicephalus orientalis* DeL. & Dav. 6-1-40.
34. **Laevicephalus striatus* (Linn.). 5-6-40.
35. **Amplicephalus osborni* (V. D.). 7-12-40.
36. *Deltocephalus flavicosta* Stal. 6-1-40.
37. *Unerus nigrifrons* (Forbes). 5-6-40.
38. *Driotura gammaroides* V. D. 4-30-40.
39. **Exitanus obscurinervis* (Stal.). 4-30-40.
40. **Ophiola uhleri* (Ball). 7-6-40.
41. *Ophiola anthracina* (V. D.) 6-4-40.
42. *Stirellus bicolor* (V. D.). 7-14-40.
43. *Stirellus obtutus* (V. D.). 4-30-40.
44. *Norvellina seminudus* (Say). 6-2-40.
45. *Phlepsius irroratus* (Say). 6-1-40.
46. *Phlepsius tenessa* DeL. 7-12-40.
47. **Phlepsius pallustris* DeL. 7-20-40.
48. *Colladonus clitellarius* (Say). 6-2-40.
49. **Doleranus perspicillatus* (Osb. & Ball). 7-14-40.
50. *Chlorotettix tergatus* Fh. 8-28-40.
51. *Chlorotettix viridius* V. D. 7-12-40.
52. *Chlorotettix galbanatus* V. D. 6-6-40.
53. *Jassus olitorius* Say. 8-27-40.
54. *Paracoelidea tuberculata* Baker. 8-28-40.
55. *Macrosteles variatus* (Fall.). 7-30-40.
56. *Macrosteles lepidus* (V. D.). 6-2-40.
57. *Macrosteles divisus* (Uhl.). 4-30-40.
58. **Balclutha abdominalis* (V. D.). 5-6-40.
59. *Balclutha punctatus* (Thumb). 5-13-40.
60. *Alebra albostriella* (Fall.). 7-14-40.
61. *Dikraneura abnormis* (Walsh). 5-6-40.
62. **Dikraneura mali* Prov. 5-25-40.
63. *Empoasca fabae* (Harris). 6-14-40.
64. *Typhlocyba gillettei* (V. D.). 7-14-40.

Literature Cited

DeLong, D. M., and J. S. Caldwell, Check List of the Cicadellidae (Homoptera) of America, North of Mexico. Ohio State University; pp. i-iv and 1-93. 1937.

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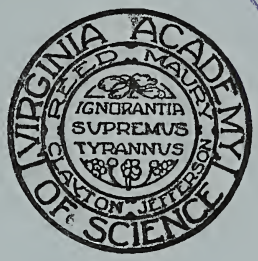
Virginia Agricultural Experiment Station,
Field Laboratory,
Chatham, Virginia.

The Virginia Journal of Science

Vol. 2 OCTOBER, 1941 No. 6

Virginia Academy of Science



Proceedings for the Year 1940-1941

Minutes of the Nineteenth Annual Meeting

Medical College of Virginia

May 1st-3rd, 1941

The Virginia Journal of Science

Official journal

of the

VIRGINIA ACADEMY OF SCIENCE

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CONTENTS

General Program of the Nineteenth Annual Meeting

RICHMOND, VIRGINIA

1941

MEDICAL COLLEGE OF VIRGINIA—HEADQUARTERS

Thursday, May 1

7:30 P. M. Academy Conference. Simon Baruch Auditorium (Egyptian Building).

Friday, May 2

8:30 A. M. Registration. Library Building.

9:30 A. M. Section Meetings.

12:30 P. M. Lunch.

2:00 P. M. Section Meetings.

5:00 P. M. Tea.

7:15 P. M. Banquet. Hotel John Marshall.

Address of Welcome. Dr. William T. Sanger. Response by President-Elect George W. Jeffers.

Presentation of Annual Research Prize of the Academy, the Jefferson Prize and the Inter-Academy Award, by Dr. Frank A. Geldard.

Address—Austin H. Clark, *Curator, Division of Echinoderms, U. S. National Museum,* and *President of the Washington Academy of Sciences.*

8:30 P. M. House of Magic. Hotel John Marshall Auditorium (Virginia Room).

Saturday, May 3

9:00 A. M. Section Meetings.

12:00 Noon. General Business Meeting in Simon Baruch Auditorium.

Minutes of the Council Meeting

April 4, 1941

The members of the Council met for dinner as guests of President Rudd at 6:00 P. M. April 4, 1941 in a private dining room in Hunton Hall of the Medical College of Virginia. The following were present: D. M. Allan, Preston Edwards, Ruskin S. Freer, George W. Jeffers, W. Catesby Jones, C. E. Myers, E. C. L. Miller, Sidney S. Negus, Marcellus H. Stow, and H. H. Zimmerley. Dean Norris was unable to be present.

Considerable time was given to an informal discussion of the VIRGINIA JOURNAL OF SCIENCE. The editor, Professor Freer, was present and there was in hand a rather complete report on the JOURNAL by Dean Ivey F. Lewis. There was also in hand a letter from the printer addressed to Lt. Col. Robert P. Carroll, showing that there is an accumulated debt against the JOURNAL of $919.21. Toward the liquidation of this Col. Carroll has sent $169.|21 being the balance he had in his hands at that time. There was full agreement that as conducted at present the JOURNAL will eventually bankrupt the Academy; there was less unanimity as to what should be done about it. However, in view of the fact that at the V. M. I. meeting the Academy agreed to support the JOURNAL up to a total of $500.00 a year for two years, the Secretary-Treasurer was instructed to send to the printers, Jarman's of Charlottesville, the sum of $500.00 for 1941. This is to be sent directly to the printer (1) to save time and (2) because no request has been received from the JOURNAL committee for funds. (This money was sent the next morning. E. C. L. M.)

It was also agreed that it might be desirable to appoint an assistant business manager whose duties should be to obtain more income for the JOURNAL, such as new subscribers, advertisers, etc. This suggestion will be passed on to the Journal Committee for their consideration.

Mr. Bird, Chairman of the Long Range Planning Committee was present by invitation, and President Rudd requested him to give a short account of the organizational work that has been done so far in this field and the plans that are now developing.

He outlined his conception of the work for the Long Range Planning Committee as a desire on the part of the Virginia Academy of Science to enlarge its program and to give some continuity to its work.

He explained that the Academy should have the benefit of the ideas and personality of each President, but that there are a lot of things that should go on from year to year and not be seriously

affected by a change in the administration. He emphasized the importance of the Academy members giving their full cooperation to the program that is developed and recommended.

The method by which the Long Range Planning Committee has proceeded this year was then outlined: President Rudd has sent to all members of the Academy, as well as to other scientists, a questionnaire. The returns to this questionnaire were remarkably good and, as a result a number of suggestions as to the work of the Academy have been received. Based upon these suggestions and as a result of certain conferences, it has been determined that certain committees should be appointed, the functions of these sub-committees being to study and recommend the work that the Academy should do with reference to the subjects suggested.

The committees were named as follows:

Research
Junior Academy Activities
Education and Publicity
Museum
Finance
James River Project
and possibly a 7th committee having to do with certain other problems regarding health and matters affecting the state.

This was interspersed with much discussion. It was recognized that these plans are so enormous that it will be necessary to develop the full cooperation of all of the members of the Academy. Means of doing this will be more fully developed at the next meeting of the Council which will be held at 4:00 P. M., Thursday, May 1st.

Mr. Bird's statement was taken as a progress report and adopted as such.

Attention was called to the fact that when the Academy was organized in 1923 the cost of a life membership was set at $50.00 which at that time would yield sufficient interest to pay the regular dues of $2.00. At the present time, the earning power of money is so much less that it may be desirable to increase this amount. However, it was not thought desirable at this time to take any action.

It was also brought out that it would be desirable, especially at this time, to make the list of members as printed in the Proceedings more complete by indicating the field of interest of each member and also the class of membership he is in. This will be done this year.

E. C. L. Miller, *Secretary.*

Minutes of the Council Meeting

May 1, 1941

The Council met at 4:00 P. M., Thursday, May 1st in Dean Rudd's office with the following present: Preston Edwards, Ruskin S. Freer, George W. Jeffers, E. Ruffin Jones, Jr., E. C. L. Miller, C. E. Myers, Sidney S. Negus, W. F. Rudd, Marcellus H. Stow and H. H. Zimmerley.

Most of the time was devoted to a discussion of the problem presented by the VIRGINIA JOURNAL OF SCIENCE. No final action was taken, but undoubtedly this presentation of the possibilities and the problems helped to clarify the whole situation in the minds of the members. (For final action see p. 164.)

It came out clearly that important matters of this kind should not go over to the Saturday noon business meeting which is often poorly attended. (See p. 154.)

E. C. L. MILLER, *Secretary.*

Minutes of the Academy Conference

The Academy Conference met in the Simon Baruch Auditorium of the Medical College of Virginia, Thursday, May 1 at 7:30 P. M. with the following present: R. C. Berry, L. C. Bird, Grace J. Blank, W. L. Bullington, Paul R. Burch, R. P. Carroll, Austin H. Clark, Wm. Clift, Justus Cline, D. W. Davis, Hubert J. Davis, H. B. Derr, Gertrude Drinker, J. M. Early, Preston Edwards, Ernst Fischer, Ruskin S. Freer, Pat Gaskins, F. A. Geldard, W. L. Gooch, A. T. Gwathmey, W. D. Hoyt, G. W. Jeffers, J. A. Johnson, E. Ruffin Jones, Jr., W. Catesby Jones, W. H. Keeble, E. C. H. Lammers, I. F. Lewis, A. B. Massey, Mrs. A. B. Massey, W. M. McGill, C. E. Myers, S. S. Negus, Margaret E. Patterson, L. C. Pettit, R. B. Platt, J. Bernard Robb, T. McN. Simpson, Jr., R. F. Smart, Foley F. Smith, M. H. Stow, R. L. Taylor, W. L. Threlkeld, Mrs. W. L. Threlkeld, I. A. Updike, Mrs. I. A. Updike, Frank C. Vilbrandt, I. D. Wilson, and H. H. Zimmerley.

Report of the President

This has been a happy year for the President. He has been privileged to get to know for the first time many leaders in science in Virginia. Indeed, he feels that the experience of contacting through correspondence and otherwise some 900 members of the Academy, who represent a fine cross-section of the scientifically trained and cultured people of our State has greatly enlarged his horizon. He is grateful to the Academy for having given him this privilege.

During the year we have asked a great many questions about what a state academy should do and what it should be. Not only have these questions been asked of all Academy members, they have gone to every state academy secretary in America, to all members of the National Association of Science Writers, to leaders in the American Association for the Advancement of Science, and to a carefully picked number of nationally known scientists somewhat outside of the groups named above. All of this has taken a great deal of work, but the replies—and there have been a great number of them—have been interesting and instructive, and, we believe, have amply justified the effort that has been put into getting them. We wish that all of you, indeed every Academy member, could have opportunity to study these replies or, at least, to go over the digest of the answers which has been prepared with great care and efficiency by one of our younger members—Mr. H. J. Davis of the Matthew Whaley High School at Williams-

burg—who has done so much to get the Junior Academy work started in Virginia. Could you have this privilege, you would doubtless see our Academy through new eyes, as I have been led to do by this experience.

Secretary Miller has given liberally of his time and ripe experience in Academy affairs to the numerous problems with which the President has had to deal in setting up certain new machinery within the Academy which, we trust, will make it more useful to the State and even the whole South in the years ahead.

The fine press relations that the Academy has had during the past year is almost wholly the work of our Assistant Secretary—Dr. Negus. He and Dr. Miller make a secretarial team of which any academy may well be proud.

For this particular meeting of the Academy, for example, Dr. Negus has in the hands of the 20 key science writers of the country now the full manuscripts of 35 of the more newsworthy papers to be read the next two days. Reports of some of these papers are already set up in type in various newspaper and journal offices of the country and will be published at the release times specified. This is the first time this has ever been done by the Academy.

It will interest you to know that on last Sunday the executive committee of the American Association for the Advancement of Science elected Dr. Negus to the position of Director of the Press Service for the Association and its affiliated societies. This fact cannot be generally announced since Dr. Negus has not come to a definite decision as to whether or not to accept the appointment.

I should like to call attention at this point to the invaluable aid and advice given the Academy along this line and others by our good friend, Austin H. Clark, of the U. S. National Museum and President of the Washington Academy of Sciences.

Whatever has been accomplished during the past year is due wholly to the fact that nobody has shirked. Indeed, with rare exceptions, all Academy members who have been asked to do so, and many outside the Academy, have accepted responsible committee assignments and are already hard at work, as reports to be presented later on will show.

Many of you probably read in an early 1941 issue of *Science* a striking article by Dr. A. J. Carlson, for so long professor of physiology at the University of Chicago and one of the leading figures in this field in America. The article was first delivered as the annual Sigma Xi address at the Philadelphia meeting of the A. A. A. S. It has made a profound impression upon me. Were it not quite so long, we would want to read it all to you tonight, and be fully warranted in claiming that it would be a most fitting paper for this occasion. Those of you who read it will probably agree with this statement. Those who would be hearing it for the first time, we suspect, would be asking that certain striking parts

of it be read over again that you might catch the full import of what Dr. Carlson is trying to say. May I quote a few paragraphs from the paper and make certain comments that, try as I may, I have not been able to leave out of this brief word to the Academy as my term of service comes to an end.

Dr. Carlson asks this pertinent question: "Is this the age of science? Or, rather, in what sense is ours the age of science?" An eminent physicist recently observed in this same connection, "In no previous time in human history has life and thinking been so greatly influenced by science as it is today." Dr. Carlson continues, "This is undoubtedly true, but does that alone make ours the age of science. I think not," he says. "It is true that science has, during the last hundred years, increased enormously our understanding of the nature of the world, and the nature of man, and with that greater understanding, has come greater control of the forces of action in man and in his environment. But fundamental discoveries in science are the achievement of but few people. The practical inventions are also the work of a few men, relatively speaking. And the physical and chemical inventions are mostly gadgets that merely modify our tempo and external mode of living." And then comes this astounding statement from Dr. Carlson: "I contend, and think I shall be able to prove to you, that the great mass of people of our age, the rank and file of men and women of our day even in the most enlightened countries, in their thinking and in their motivation, are nearly as untouched by the spirit of science, and as innocent of the understanding of science as the Peking man of a million years ago. The modern man adjusts to an environment greatly modified by the scientific efforts of the few. The Peking man, we may assume, adjusted himself as best he could to nature in the raw. A span of about a million years separate the two. And yet the two are about equally innocent of science in the sense of the spirit and method of science as a part of their way of life, for science is more than inventions, more than gadgets, however useful and important they may be. Science is even more than the discovery of, and correlation of new facts, new laws of nature. The greatest thing in science is the scientific method, controlled and rechecked observations and experiments objectively recorded with absolute honesty, and without fear or favor. Science in this sense has as yet scarcely touched the common man or his leaders. The character of human society in any age is determined by a man's thinking, motivation and behavior, rather than external gadgets. . . . For we must assume that sooner or later reason, based on understanding, will modify human behavior."

My purpose in quoting so liberally from this address must be apparent to you all. The road to any sort of scientific thinking and living is truly a long, hard road. I am wondering if this very fact isn't the sort of challenge that organizations like ours must accept as a part of their obligation to the future.

Why do we meet annually? And have literally hundreds of papers discussed? Is it only that we may bring some little credit to ourselves as individuals? Is it not rather that somewhere in us—and every scientist is a sort of missionary—there is a profound conviction that working together as we do in state academies, we are hoping that in such united effort here and in other state academies, and in the great number of scientific organizations of all sorts, our combined efforts may have at least some small part in spreading, slowly it may be, almost imperceptibly so sometimes, the spirit of science described so ably by Dr. Carlson. To the end that as generations come and go, it may not be said of those in the centuries ahead of us, "The rank and file of people of that day, in their thinking and in their motivation, are as nearly untouched by the spirit of science, and as innocent of the understanding of science, as the Peking man of a million years ago."

This is an objective wholly worthy of all the energy, and intelligence, and faith that you and I and all like minded folk can put into one of the most important obligations that has ever fallen upon the shoulders of privileged people. May we have the courage, and the wisdom, and the devotion to our share of the job in our day and so impress those who are to follow us that there may be no faltering. The Virginia Academy of Science will always have, we believe, its proper place in such a hope and effort for the future of the State.

W. F. RUDD, *President.*

Report of the Secretary

1940 - 1941

This has been an unusually busy and active year. Most of the activity has centered around the appointment and organization of a Long Range Planning Committee and the organization of the Junior Academy of Science.

Last year, President-Elect Rudd, at his own request was authorized to appoint a committee on long range planning, or in other words to find some activity for the Academy commensurate with its importance in the state and with the possibilities latent in its 900 members. This committee has been chosen with great care, has held two meetings and has manifested a realization of the magnitude of its task and of its possible significance for Virginia and for science. Mr. L. C. Bird, the chairman, will report shortly for this committee. The committee was selected as follows: the President addressed a personal communication to a score or more of the members of the Academy who have been active from the beginning, including the past presidents. In this letter, he outlined the plans for the appointment of a long range

planning committee. He asked that each of those addressed submit a list of some five or more men and women who possessed the qualities of initiative and leadership that would fit them for work in such an important organization. This resulted in about 100 nominations, and from these the 20 members of the committee were named by the President, after conferring with the permanent officers of the Academy.

The organization of the junior academy work has gone forward under the able leadership of Mr. Hubert J. Davis. He will report shortly on the work of the year.

It is difficult at this time to grasp the possibilities that may grow out of either of these lines of work. I would urge that each member of the Academy give his or her full enthusiastic cooperation to these possibilities. This increased activity, however, has not caused us to incur a deficit as many new members have been obtained largely through the efforts of President Rudd. The income this year from dues is $1405.00 against $1279.00 last year, or an increase of 10%.

We have also received two gifts this year, one of $50.00 and one of $100.00. This will make both of these donors life members. Altogether our receipts have exceeded the disbursements by $205.00.

We started the year with 823 members, lost 113, and gained 202, so that our present membership is 912.

THE VIRGINIA JOURNAL OF SCIENCE has been issued fairly regularly throughout the year. However, it has received quite inadequate support. It now has only 235 paying subscribers and no advertisement so that it has a mounting deficit. At a meeting of the Council, April 4, it was voted to reduce the number of issues from 8 to 4, two of which will be the Academy Program and Proceedings. The Academy has turned over to the JOURNAL $500.00 as voted last year, but the future of the JOURNAL must receive serious attention at once.

During the year President Rudd has made the following committee appointments:

TO NEW COMMITTEES

Long Range Planning Committee: Arthur Bevan, L. C. Bird, Chairman, Raymond B. Bottom, Julian A. Burruss, Francis S. Chase, Justus H. Cline, Virginius Dabney, Frank A. Geldard, Meta Glass, Sidney B. Hall, W. R. Harlan, J. Shelton Horsley, W. Catesby Jones, Ivey F. Lewis, H. K. McConnell, Robert F. Nelson, Garnett Ryland, R. M. Sanford, and I. A. Updike.

Consultants: V. L. Bohnson, Edwin Cox, J. P. Fishburne, Douglas S. Freeman, Julien H. Hill, Mrs. J. P. Ingram, H. E. Jordan, Gillie A. Larew, E. W. Magruder, Mrs. Stuart McGuire, Elis Olsson, I. C. Riggin, W. T. Sanger, Allen J. Saville, H. G.

Shirley, James H. Smith, Aubrey H. Straus, C. Braxton Valentine, L. M. Walker, Jr., and I. D. Wilson.

Junior Academy of Science—

Committee: Miss J. Frances Allen, Secretary; J. T. Christopher, Hubert J. Davis, Chairman, C. G. Gibbs, Miss E. Gillespie, Wm. T. Hall, H. S. Holmes, Miss Martha Lipscomb, W. I. Nickels, Jr., and W. W. Nofsinger, Vice-Chairman.

Sponsoring Committee: L. F. Addington, L. C. Bird, Francis S. Chase, Geo. W. Jeffers, Vice-Chairman, J. A. Rorer, Chairman, and I. A. Updike.

Place of Meeting—

E. Ruffin Jones, Jr., Chairman, George Williams and Preston Edwards.

Time of Meeting—

Robert F. Smart, Chairman, Raymond L. Taylor, and William Clift.

To Rotating Committees

Nominating Committee: Ruskin S. Freer, so that the committee now stands in order of rotation: D. M. Allan, Chairman, Earle B. Norris, and Ruskin S. Freer.

Research Committee: Ivey F. Lewis, so that the committee now stands in order of rotation: F. L. Apperly, F. A. Geldard, Chairman, F. C. Vilbrandt, Gillie A. Larew, and Ivey F. Lewis.

Committees That Carry Over Unchanged

Committee on Junior Members: Paul R. Burch, A. H. Cooper, Helen Schultz, G. M. Shear, M. E. Taylor, and W. E. Trout, Jr., Chairman.

Conservation Committee: R. P. Carroll, Chairman, A. W. Drinkard, W. C. Hall, L. B. Henderson, W. D. Hoyt, W. M. McGill, J. E. Shillinger, A. M. Showalter, and T. W. Turner.

Fauna Committee: L. D. Anderson, J. W. Bailey, Paul R. Burch, R. P. Carroll, Geo.W. Chappelear, J. R. Christie, G. Talbot French, Geo. W. Jeffers, E. Ruffin Jones, Jr., Chairman, W. A. Kepner, J. J. Murray, B. D. Reynolds, R. T. Taylor, W. L. Threlkeld, H. G. Walker, and I. D. Wilson.

Finance Committee: D. W. Davis, Garnett Ryland, and T. McN. Simpson, Jr., Chairman.

Flora Committee: Lena Artz, R. P. Carroll, R. S. Freer, I. F. Lewis, J. B. Lewis, G. C. Mason, A. B. Massey, Chairman, and R. F. Smart.

Museum Committee: Arthur Bevan, J. S. Bryan, W. E. Carson, Douglas S. Freeman, W. C. Hall, G. W. Jeffers, Chairman, G. C. Mason, Stuart McGuire, J. M. Miller, Jr., W. T. Sanger, and Ida Sitler.

Publicity Committee: William Clift, Douglas S. Freeman, L. G. Hoxton, W. M. McGill, Sidney S. Negus, W. F. Rudd, Chairman, Ellen Shenk, I. A. Updike. C. E. Wheeler, III, and I. D. Wilson.

Virginia Journal of Science—

Committee: Ruskin S. Freer, Editor, Ivey F. Lewis, Chairman, and Robert P. Carroll, Business Manager.

Editorial Board:

Astronomy, Mathematics and Physics—T. McN. Simpson, Jr. and Preston Edwards.
Biology—
Botany—Lena Artz, R. P. Carroll, R. S. Freer, I. F. Lewis, G. C. Mason, A. B. Massey and R. F. Smart.
Zoology—Paul R. Burch and Florence Hague.
Chemistry—W. E. Trout, Jr. and John H. Yoe.
Education—A. M. Jarman and C. E. Myers.
Engineering—A. H. Cooper and D. H. Pletta.
Geology—Ed. Steidtmann and J. K. Roberts.
Medicine—J. E. Kindred and I. D. Wilson.
Psychology—R. H. Henneman and Helen Peak.

E. C. L. MILLER, *Secretary.*

Report of the Treasurer

1940 - 1941

Balance on hand, April 15, 1940			$1,410.80
RECEIPTS			
From Dues:			
597 Regular Members	$1,194.00		
81 Junior Members	81.00		
13 Sustaining Members	130.00		
		$1,405.00	
From Interest	21.20		
From Gifts	150.00		
Total Miscellaneous		171.20	
			1,576.20
Total to account for			$2,987.00

DISBURSEMENTS

Personal service:		
Secretary	$ 150.00	
Assistant secretary	25.00	
Clerical hire	69.50	
Auditor	5.00	
Printing and supplies	201.48	
Postage	261.75	
Express	4.24	
Telegraph	.32	
Corporation tax	5.00	
Badges	20.07	
Speaker's expense	30.00	
Section expense	5.35	
Science club expense	23.63	
A. A. A. S. meeting expense	59.35	
Dues—Virginia Wildlife Association	10.00	
Virginia Journal of Science	500.00	
Total Disbursements		1,370.69
Balance on hand April 15, 1941		$1,616.31
In Morris Plan Bank	$ 864.64	
In First and Merchants National Bank	751.67	
Total	$1,616.31	

Balance April 15, 1941	$1,616.31	
Balance April 15, 1940	1,410.80	
Gain	$ 205.51	

E. C. L. MILLER, *Treasurer.*

Richmond, Virginia
April 18, 1941

Dr. E. C. L. Miller, Secretary-Treasurer
Virginia Academy of Science
Richmond, Virginia

Dear Doctor Miller:

I have examined the above statement of the receipts and disbursements of the Virginia Academy of Science for the year ending April 15, 1941. This statement represents the receipts and disbursement as recorded in the records of the Academy, and the bank balance of $1,616.31 has been reconciled to the bank accounts.

Yours very truly,
F. B. MILLER.

Report of Conservation Committee

R. P. Carroll, Chairman—No report.

Report of Fauna Committee

E. Ruffin Jones, Jr., Chairman—No report.

Report of Finance Committee

T. McN. Simpson, Jr., Chairman—No report.

Report of the Flora Committee

The flora survey of the state is developing. Since all of the Committee members are hampered with academic work and lack of funds for field work, progress is slow. An estimate shows that by the end of 1941 the survey will have made definite progress in the counties of the major watersheds as follows:

James River basin	55% of the counties
Potomac River basin	50% " " "
Rappahannock-York River basin	33% " " "
Roanoke-Chowan basin	33% " " "
Ohio basin	33% " " "

The Bull Run Mountain area has been completely surveyed by Dr. H. A. Allard. Dr. Fernald has continued his southeastern Virginia survey and has issued seven extensive reports on his work. Messrs. E. H. Walker and F. R. Fosberg of Washington, D. C. have made large collections in the Shenandoah National Park and have a report ready for publication.

The Northern Neck Peninsula has been included in the District of Columbia Flora area and will be extensively surveyed this year.

Members of the Committee on Virginia Flora plan to make forays in different parts of the state.

Sales of the *Flora of Richmond and Vicinity* have picked up during the year with a total of $62.00 including $8.00 outstanding.

Committee funds now stand:

Cash in National Bank of Blacksburg	$ 126.53
One account outstanding	8.00
Cash deposited with the Academy, Dr. E. C. L. Miller, Secretary-Treasurer	100.00
Total funds	$ 234.53

A. B. MASSEY, *Chairman.*

Moved and carried to accept the report.

Report of the Committee on Junior Members

The responses to a questionnaire returned by representatives of the Committee in the Colleges indicate that the following proposals might well be considered by the Academy:

1. The formation of a division of the Academy composed of undergraduate students, which might receive the name COLLEGIATE DIVISION.

2. A special program, probably short, including perhaps only one principal address for undergraduate students.

3. Some form of recognition for the best contribution made by an undergraduate: an essay, a research report, a report on a student project of college character, an exhibit, or the like.

4. The formation of a speakers' bureau, arranging for tours by speakers who can interest the *average* undergraduate and yet remain scientific.

5. Provision for circulating news of collegiate science club activities among the colleges of the state, and for publishing the contributions of undergraduates.

The Committee will welcome the violent attack or the energetic support of every member of the Academy concerning these suggestions, in the hope that the highest service might be rendered the undergraduate members.

In order to avoid confusion with the Junior Academy of Science membership, the Committee wishes to propose the following changes, to be discussed at the Business Meeting:

1. That the name Junior Member be changed to Collegiate Member.

2. That this membership include undergraduate college students and graduate students.

3. That the name of the Committee on Junior Members be changed to the Committee on Collegiate Members.

Respectfully submitted,

Committee on Junior Members:

PAUL R. BURCH,
ALBERT H. COOPER,
HELEN M. SCHULTZ,
G. M. SHEAR,
MILDRED E. TAYLOR,
WM. E. TROUT, JR., *Chairman.*

Report of the Committee on Research

The current year has been one of somewhat unusual activity for the Research Committee, chiefly occasioned by other vigorous movements within the Academy. The Committee held its customary meeting in the Fall for the making of grants and also a special Spring meeting to consider matters of general policy. In addition the Committee has enjoyed representation on both the Long Range Planning Committee of the Academy and the Executive Committee of that body.

The Fall meeting was held on Saturday, November 2, 1940 in Charlottesville at the home of the chairman. The entire Committee was present. Notice of intention to consider applications

for grants had been sent out by the Secretary on October 18, the dead-line for submitting such applications being set for October 29. Fourteen applications for research aid were received. After careful consideration of each application, the following grants were made:

1. Albert D. Delisle, College of William and Mary, $46.00 for the purchase of propagation boxes for use in the study of synthetic plant hormones.
2. Robert A. Fisher, Virginia Polytechnic Institute, $63.00 to cover travel expense in a study of the present disposal of industrial wastes.
3. Ernst Fischer, Medical College of Virginia, $100.00 for the purchase of a large vacuum chamber and experimental animals to be used in a study of the influence of high altitudes upon drug susceptibility.
4. W. Joe Frierson, Hampden-Sydney College, $50.00 for the purchase of a Nesslerimeter for use in his work in search of organic reagents.
5. James McD. Grayson, Virginia Polytechnic Institute, $28.65 for the construction of twelve special cages for use in his study of the coloration of grasshoppers.
6. J. Frank Hall, Medical College of Virginia, $50.00 for the purchase of materials in connection with a study of the reaction of the teeth of monkeys to prosthetic appliances.
7. J. G. Harrar, Virginia Polytechnic Institute, $75.00 for the construction of temperature and humidity controlled cages to be used in a study of the control of the mealy bug.
8. E. Ruffin Jones, Jr. and F. F. Ferguson, College of William and Mary, Norfolk Division, $25.00 to help defray expenses of travel in a continuation of their work on the Turbellaria of the Norfolk region.
9. L. C. Pettit, Washington and Lee University, $40.00 for the purchase of traps and other equipment in a study of the small woodland mammals near Lexington, Virginia.
10. G. Z. Williams, Medical College of Virginia, $76.00 for the purchase of animals and chemicals in a study of the effects of X-rays and radium on cancerous tissue.

The remaining requests were not granted for various reasons. Certain of the applications clearly lay outside the purview of the Academy's policy with respect to research grants. In the case of one applicant, Dr. Walton C. Gregory, winner of the Academy Award last year and now associated with Tennessee Polytechnic Institute, the Committee felt that it should not give financial aid to projects being pursued outside the State and his request was regretfully denied. However, the Secretary subsequently brought to the attention of both the Tennessee Academy of Science and the A. A. A. S. Dr. Gregory's need for research assistance with the happy result that the A. A. A. S. made him a suitable grant.

One other application was held over to the spring meeting pending the receipt of more detailed information concerning it.

Total grants amounted to $553.65. This amount fell short to the extent of $96.50 of the sum available for distribution, indicating as on former occasions the desirability of more and better applications on the part of the members of the Academy.

At a meetings of the Executive Committee of the Long Range Planning Committee held at the Medical College of Virginia on February 7, 1941, the Chairman, Mr. Bird, indicated his intention to appoint a special committee to consider the general problem of research objectives for the Academy. The replies to Dean Rudd's questionnaire concerning what should be the chief concern of the Academy had met with a widespread response indicating the promotion of research to be the most important single aim of the Academy. After some considerable discussion the group concluded that it would be desirable for the regularly constituted Research Committee to investigate the present status of research needs in the State and to formulate a broad policy for research on the part of the Academy. The Chairman, accordingly, undertook to determine whether the Research Committee would find it possible, in view of its somewhat scattered personnel, to implement this plan. The response from the members of the Research Committee was immediate and enthusiastic, although it was considered by some to be highly desirable to have the membership of the Committee temporarily amplified to the end that a wider sampling of viewpoints would be available.

A special Spring meeting, prompted by these considerations, was therefore held. On the kind invitation of Dr. and Mrs. J. Shelton Horsley a group consisting of: Mr. L. C. Bird, Dr. J. S. Horsley, Dr. Gillie Larew, Dean I. F. Lewis, Dr. E. C. L. Miller, Dr. S. S. Negus, Dean W. F. Rudd, Mr. R. M. Sanford, Dr. F. C. Vilbrandt, and the chairman met at Dr. Horsley's home on the evening of Saturday, April 5. Two matters concerned with applications for grants were first disposed of, the first being a request from Dr. E. S. C. Handy of Fairfax, Virginia, for financial support of a project in the field of physical and cultural anthropology, the second being a request from Dr. Stanley T. Brooks of the Carnegie Museum of Pittsburgh for partial support of a study involving the making of a comprehensive collection of the snails of the Appalachian Highlands. It was voted to aid Dr. Handy's project to the extent of making a grant of $200.00, the maximum allowable within the Committee's policy. (New revenue had become available since the Fall meeting.) The Committee is particularly happy to be able to give encouragement to a type of scientific work not extensively pursued within the State in recent years and to welcome Dr. Handy into our midst. The request of Dr. Brooks was regretfully denied and for much the same reasons as those prompting a similar action in the earlier

case of Dr. Gregory. It is hoped that the projected work may be carried forward through some other more appropriate subsidy.

The remainder of the meeting was given over to a general discussion of research activities and potentialities for research in the State. The Committee attempted to arrive at a delimitation of its duties and yet to avoid neglect of any consideration that might be its proper concern. While the discussion was spirited and thoughtful, it early became apparent that it is practically impossible to confine such a discussion to research matters exclusively, so intricately interwoven is research with all other interests of the Academy.

This is apparent also, that where general questions of research activity are involved, a strange ineffability exists on the part of those attempting to arrive at concrete proposals. Whereas over 70% of those answering Dean Rudd's questionnaire indicated research to be a vital matter, there were few replies that contained any suggestions so specifically stated as to serve as a guide for action. Perhaps the difficulty lies in the fact, so frequently reiterated in meetings of this Committee, that research is not so much an organized effort as it is a state of mind on the part of the individual investigator and the Chairman takes the responsibility, professionally, for the opinion that states of mind are notoriously unpredictable affairs.

One definite proposal did come out of the discussion, however, and it is likely to lead to results of some consequence. The desirability was indicated of having the Research Committee serve as a clearing-house for problems having mutual scientific and industrial appeal. There is a definite need for some measure of cooperation between the Academy and Virginia industry. An illustration is to the point. One Virginia concern frequently encounters problems best worked out in the pure science laboratory. It has been its custom to "farm" the problems out, not only outside of its own precincts but outside the State. It is the opinion of the Committee that skill and facilities for the solution of these particular problems are not lacking within our own institutions. Perhaps such illustrations might be multiplied, were the facts known. To the end that the Academy may know them an effort will be made in the coming year to arrive at an appreciation of the scope of the problem through the agency of the Virginia Manufacturer's Association. The Executive Secretary of that body has evinced a warm interest in the Academy and, with the hope of effecting better cooperation, has invited the Academy to organize a panel discussion at the October meeting of that body. The possibility that the Academy might serve as a coordinating agency for scientific research in the State is thus not too remote a one.

As is customary, the Research Committee will make a supplementary report concerning the annual competition for the Academy Award and Jefferson Award at the proper time.

Respectfully submitted,

Committee on Research:

F. L. Apperly,
Gillie Larew,
I. F. Lewis
F. C. Vilbrandt,
F. A. Geldard, *Chairman.*

Mr. Hubert J. Davis then reported on the work of the Committee on Science Clubs and his report was received with approval.

Report of Committee on Science Clubs

At a meeting in Dean Wortley F. Rudd's office Wednesday, June 5th 1940 to discuss the personnel of the two committees necessary for the functioning of the Virginia Junior Academy of Science, authorized at the Lexington meeting of the Academy, the following were present: Dean W. F. Rudd, Dr. E. C. L. Miller, Mr. L. C. Bird, Dr. Geo. W. Jeffers, Mr. H. J. Davis, and Dr. Sidney S. Negus.

After some discussion of the possible membership of the two committees, the group agreed upon two important committees which are as follows:

Virginia Junior Academy of Science Committee

Mr. H. J. Davis, Chairman, Matthew Whaley High School, Williamsburg, Va.
Mr. W. W. Nofsinger, Vice-Chairman, Jefferson High School, Roanoke, Va.
Miss J. Frances Allen, Secretary, Pulaski High School, Pulaski, Va.
Mr. J. T. Christopher, George Washington High School, Danville, Va.
Miss Elizabeth Gillespie, Maury High School, Norfolk, Va.
Mr. C. G. Gibbs, Floyd High School, Floyd, Va.
Mr. William T. Hall, Clarksville High School, Clarksville, Va.
Mr. H. S. Holmes, Petersburg High School, Petersburg, Va.
Miss Martha Lipscomb, Thomas Jefferson High School, Richmond, Va.
Mr. W. I. Nickels, Jr., Lane High School, Charlottesville, Va.

VIRGINIA ACADEMY OF SCIENCE SPONSORING COMMITTEE

Mr. John Alex Rorer, Chairman, University, Va.
Dr. Geo. W. Jeffers, Vice-Chairman, Farmville, Va.
Mr. L. F. Addington, Wise High School, Wise, Va.
Mr. Francis S. Chase, Executive Sec., V. E. A., Richmond, Va.
Dr. I. A. Updike, Ashland, Va.

At the end of the school year we found sixty active science clubs scattered all over the State, with thirty prospective clubs, and about 20 clubs which were affiliated with the American Institute of Science and Engineering Clubs.

Little was done during the summer months other than to cultivate contacts. During the early months of the school year 1940-41 speakers such as Dr. Negus, Dr. Jeffers, and Mr. Rorer and others were provided for districts D, F, G, J, K, and M educational meetings with evident success in every case. Kits of literature on science clubs were assembled and distributed to the members of the Junior Academy Committee. A survey of the science clubs of the State was conducted in November. Twenty-six clubs responded that they would be interested in helping to form a Junior Academy of Science.

Dean Rudd, Dr. E. C. L. Miller, and others appeared on the Virginia Education Association Science section program in November to explain the science club movement.

On November 21st, a meeting of the Junior Academy Committee and the Virginia Academy sponsoring committee was held in the John Marshall high school to complete the organization of the Virginia Junior Academy of Science. Mr. John Alex Rorer presided. A representative group of both committees was present.

These committees worked out a temporary constitution, set up membership requirements for science clubs, appointed committees, established other necssary machinery for the proper functioning of the organization. Temporary officers for the Junior Academy were selected.

Invitations to join the Junior Academy were sent out to all of the science clubs which had indicated that they were interested. Charters for the Junior Academy of Science were printed. Through the cooperation of Dr. E. C. L. Miller, Mr. John Alex Rorer, and several science club sponsors a *Project Kit* was worked out and several copies distributed to clubs.

A special committee on the Junior Academy of Science prepared and reported to the Long Range Planning Committee on the objectives and means of cooperation between the two organizations.

Through the untiring efforts of Miss J. Frances Allen, our secretary, to date seventeen clubs have affiliated with the Junior Academy of Science, two clubs have applied for membership too late to be admitted before our meeting on May 3rd, and several

clubs have exhibited interest and will probably soon be admitted.

The American Institute of Science and Engineering Clubs cooperated with us in the matter of the project kit by supplying one hundred pamphlets on *How to Organize a Science Club* and has recently arranged to print and distribute four hundred copies of our annual program.

Our First annual meeting will be held in conjunction with the Virginia Academy at the George Wythe High School Saturday, May 3rd. Attached to the report is a copy of this program.

Throughout the year in conducting this work our committee has been financially supported by the Virginia Academy through Dr. Miller, encouraged and inspired by the officers of the Academy, and its activities well publicized through Dr. Negus' assistance.

Respectfully submitted,

HUBERT J. DAVIS, *Chairman,*

Junior Academy Committee.

Meeting of the Virginia Junior Academy of Science

A committee of the officers of the Virginia Academy of Science consisting of Dean W. F. Rudd, Dr. George W. Jeffers, Mr. L. C. Bird, and Dr. E. C. L. Miller, the Virginia Junior Academy of Science represented by Hubert J. Davis, Chairman of the Junior Academy Committee, and Miss J. Frances Allen, Secretary, and Miss Margaret Patterson of the American Institute of Science and Engineering Clubs of the City of New York, met in Dean Rudd's office at 9:00 A. M., May 2, 1941.

At this committee meeting an agreement was reached whereby the Virginia Junior Academy would combine its member clubs with those of the American Institute to form a cooperative organization. The American Institute agreed to conduct all business with Virginia clubs through the Junior Academy organization, to help finance the organization, and to cooperate in any way possible in promoting science club activities.

At this same meeting it was decided to have the secretary-treasurer of the Virginia Academy of Science handle all of the money for the Junior Academy, but to let the Junior Academy secretary do the bookkeeping.

The committee agreed to sponsor a science club exhibit at the annual meeting of the Virginia Education Association, Thanksgiving, at Richmond. It was decided to try to secure a nationally known speaker on science clubs and schedule him to appear, if possible, before a joint meeting of the science section and the secondary school principals.

It was further suggested that the State be divided into districts with science centers located at nearby colleges.

On May 3, at 10:00 A. M. the first annual meeting was called to order by Hubert J. Davis, presiding, in the George Wythe Junior High School Building.

More than two hundred high school boys and girls, delegates from member clubs, visiting officers of the Virginia Academy of Science, and many guests were present.

A very brief welcoming address was made by the chairman. The presidents of the member chapters represented were introduced, and each in turn presented his delegation. Danieltown High School had the largest delegation present.

Dr. George W. Jeffers, Chairman of the Virginia Academy of Science introduced the guest speaker of the occasion, Sir Austin H. Clark, Curator of Echinoderms, National Museum, Washington, D. C. Dr. Clark made a most inspiring and scholarly address. This was followed by a group of elementary pupils from Matthew Whaley High School, Williamsburg, who gave a glimpse of their science club in action.

The following committees were appointed and instructed to have reports ready for the afternoon business meetings:

Sectional Meeting: Miss J. Frances Allen, Chairman, Pulaski High School, Pulaski, Va.

Constitution Committee: Alfred Fisher, Chairman, Jefferson Senior High School, Roanoke, Va.

Nominating Committee: Miss Mary Oglesby, Chairman, Appalachia High School, Appalachia, Va.

Pin Committee: Miss Vada C. Miller, Chairman, Warren County High School, Front Royal, Va.

The following pupils were named to participate in the science quiz program over WRNL at 2:00-2:30.

James Burton—Einstein Science Club, Appomattox High School, Appomattox, Va.

Gordon Burnett—Lane Science Club, Lane High School, Charlottseville, Va.

Forrest Pitts—Thomas Jefferson Science Club, Thomas Jefferson High School, Richmond, Va.

Robert MaCadoo—Roy Chapman Andrews Science Club, Pulaski High School, Pulaski, Va.

Louise Yost—Jefferson Science Club, Jefferson Senior High School, Roanoke, Va.

Phyllis Brown—Sperryville High School, Sperryville, Va.

Ima Reed—Leeuwenhoek Science Club, Floyd High School, Floyd, Va.

Louise Minnick—Mt. Vernon Science Club, Mt. Vernon High School, Alexandria, Va.

The morning meeting adjourned promptly at 10:00 to the Virginia Room of the John Marshall Hotel where the members of the Junior Academy witnessed the *House of Magic.*

Between the morning and the afternoon meetings of the Junior Academy the science exhibit was arranged in the library of the Medical College of Virginia. Such scientific materials as a home-made weather instrument, mechanical scale models of engines, collection of medicinal herbs of Virginia, collection of the complete flora of the Mt. Vernon section, and many other electrical or mechanical devices were displayed. First prize went to the collection of flora of the Mt. Vernon District because of its completeness and scientific classification.

The business session of the Junior Academy was held in the Egyptian Building of the Medical College of Virginia at 3:00 P. M.

Committee reports were read and adopted. A completely revised constitution which provided the necessary machinery for the affiliation with the American Institute of Science and Engineering Clubs was adopted unanimously. Harmony, interest and confidence marked the whole meeting.

The new constitution provided for a governing council of four counselors and the student officers of the Junior Academy. The members of this council are as follows:

President of Junior Academy: A. J. Davis, Test Tube Tinkerers Club, George Washington H. S., Danville, Va.

Vice-President of Junior Academy: Patsy Whitaker, Roy Chapman Andrews Science Club, Pulaski High School, Pulaski, Va.

Secretary of Junior Academy: Catherine Christian, Einstein Science Club, Appomattox High School, Appomattox, Va.

Pres.: Junior Academy Committee: Hubert J. Davis, Matthew Whaley High School, Williamsburg, Va.

Counselor: Mr. W. I. Nickels, Jr., Lane Science Club, Lane High School, Charlottesville, Va.

Counselor: Mr. Alfred Fisher, Jefferson Science Club, Jefferson Senior H. S., Roanoke, Va.

Counselor: To be selected. The sponsor of the host club of the next annual meeting.

Before the meeting was adjourned the following awards were announced for the Junior Academy exhibits and other contributions:

First Prize: Honorary membership in the A. A. A. S. one year. Gordon Jones and John Tompkins, for plant collection. Mt. Vernon High School, Alexandria, Va.

Second Prize: Honorary membersip in the Virginia Academy of Science. Microscopic Photography, a paper read by Walter Brown before the Astronomy, Mathematics and Physics Section of the Academy. Lane Science Club, Lane High School, Charlottesville, Va.

Third Prize: Honorary membership in the Virginia Academy of Science, Engine models by Martin Milroy, Randolph Henry High School, Charlotte Court House, Va.

Fourth Prize: Medicinal herbs grown in Virginia, Patsy Whitaker, Roy Chapman Andrews Science Club, Pulaski High School, Pulaski, Va.

Mr. Forrest Pitts was awarded honorary membership in the A. A. A. S. for one year for outstanding participation in the science quiz program over WRNL in Richmond.

The meeting was adjourned.

J. FRANCES ALLEN, *Secretary.*

Report of Sponsoring Committee for the Junior Academy

This committee was authorized at the Lexington meeting last year and appointed by President Rudd on June 5, 1940. The first meeting was called in Richmond during Thanksgiving week. It was planned to have a full meeting of the committee in order to define the functions and outline the work for the year. Since several members could not attend such a meeting it was decided to combine our meeting with that of the Virginia Junior Academy of Science Committee. Accordingly, the following members of our committee met in the John Marshall High School on Friday evening, November 21, with the Junior Academy Committee to work on a constitution and other matters: George W. Jeffers, L. F. Addington, L. C. Bird, J. A. Rorer. Francis S. Chase was so busy with affairs of the Virginia Education Association then in session, that he found it impossible to attend. Dr. Updike conferred with us before the meeting but found it inconvenient to attend this meeting. At the meeting, the skeleton of the constitution for the Junior Academy of Science was drawn up for submission to absent members and officials of the Senior Academy.

The chairman has been in constant touch with Mr. Hubert J. Davis, Chairman of the Junior Academy of Science Committee, and given him whatever assistance he could. This was a most stimulating contact with an enthusiastic chairman, who has done such a fine job that little has been left for the sponsoring committee. We have felt that our main function this year should be to work as closely as possible with the chairman of the Junior Academy in response to his request for advice and assistance. In addition to helping with the framing of the constitution we also prepared a list of motion picture films on science which was distributed by the Junior Academy Committee in its kit to high school science clubs.

With the final organization of the Junior Academy of Science effected at this meeting a more definite function of the Sponsor-

ing Committee becomes apparent. That is the function of providing material assistance to the Junior Academy and its local clubs. We believe we can help in somewhat the following manner:

A. Provide a list of speakers from the Virginia Academy of Science who will appear before local high school clubs for talks and demonstrations.
B. Assist with an annual science exhibit for the Junior Academy of Science.
C. Encourage members of the Virginia Academy of Science to make contact with high school science clubs in their localities and assist them in every way possible.
D. Provide, if possible, a part-time or full-time field worker whose duty will be not so much to organize clubs as to stimulate activity and provide assistance to clubs already organized. It is recommended that the new Sponsoring Committee be authorized to investigate the possibilities of getting such assistance.

Other activities are suggested in the special committee report on the Junior Academy of Science made to the Long Range Planning Committee's Consultant's Council.

In closing our report we wish to state that the very capable chairman of the Junior Academy of Science Committee and his colleagues have been so active that we have felt content to follow their lead with the greatest confidence. We believe the function of the Sponsoring Committee in the immediate future will continue to be that of serving as a liason and advisory body for the Junior Academy Committee. The specific activities to be performed will be determined from time to time through requests from the Junior Academy, suggestions from members of the Virginia Academy of Science and the vision of the members of the Sponsoring Committee.

Sponsoring Committee:
L. F. Addington,
L. C. Bird,
Francis S. Chase,
I. A. Updike,
Geo. W. Jeffers, *V.-Chrmn.*,
Jno. Alex Rorer, *Chairman.*

Dr. T. McN. Simpson, Jr. suggested that the Virginia Academy of Arts and Sciences be approached to see if the name of the two organizations could not be made more distinct and the omission of the word "science" from the name of their organization.

Mr. Winslow L. Gooch spoke concerning the new section on forestry.

A short oral report was given by Dr. I. A. Updike summarizing "A Study of Virginia Scientists in American Men of Science" by Dr. and Mrs. Updike.

Report of the Committee on Time of Meeting

Your Committee on Time of Meeting recognizes the seriousness of any attempt to change the time of meeting of the Virginia Academy of Science. Yet, in view of the increasing number, and often embarrassing, conflicts the meetings of the Academy have run into with May Day celebrations, Apple Blossom Festivals, meetings of the Mathematical Society, and this year the meetings of the American Physical Society, it does seem desirable for the Academy to consider some date other than the first week-end in May for its annual meetings.

To more fairly arrive at a proposal, your committee sent out letters to members of the Academy in various institutions and industries requesting that they canvass the other academy members of their respective institutions on this question and to report their findings back to the committee. This request was met with a splendid spirit of co-operation, and it is upon the basis of these reports that your committee has drawn its conclusions and bases its recommendations.

The inescapable conclusion must be drawn that for the majority of members canvassed, the meetings should be scheduled for either the first week-end in May as in the past or for the second week-end in May, with the majority of those reporting favoring the second week-end.

Your committee, therefore, recommends that the Council set the second week-end in May for the 1942 meetings and that at that time (1942) after the year's trial with the new date, the Academy in business meeting assembled be requested to vote upon making the second week-end in May the permanent date of meeting or to return to the first week-end in May or to some other more favorable date then decided upon.

Having fulfilled its duties with the presentation of this report, your committee now begs to be discharged.

Respectfully submitted,
Committee on Time of Meeting:
ROBERT F. SMART,
WILLIAM CLIFT,
R. L. TAYLOR.

Report of Committee on the Virginia Journal of Science

The following statement submitted to the Council on February 14, summarizes the status of the JOURNAL as seen in the light of one year's experience. The action of the Council which will determine the program for 1941 is also given below.

The Committee will endeavor to follow the suggestions made by the Council in the present year. The results will determine the future of the JOURNAL.

Statement

The first volume of the Virginia Journal of Science contains about 322 pages, of which 28 were devoted to Program and 101 to Proceedings. The remaining pages were devoted largely to the presentation of research results classified as follows:

	Articles	*Pages*
Botany	8	45
Zoology	4	28
Conservation	1	7
Chemistry	14	47
Geology	5	34
Physics	1	8
Astronomy	1	10
Education	2	16
Total	36	193
Program		28
Proceedings		101

It will be seen that all sections except Medical Science and Engineering took advantage of the facilities offered by the Journal. This general participation is significant of a need for the Journal. It is greater than was anticipated.

On the whole the Journal was well received. The chief criticism was lack of readability, a criticsm that applies to all similar publications. There are two possible ways of meeting such criticism—first, by giving up the scientific character of the Journal and publishing popular rather than scientific material; second, by distributing the articles so as to cover at least to some extent the technical interests of Academy members from the different sections.

The first scheme shows what seems to me to be insuperable difficulties. With the plethora of interesting popular material now available in newspapers, magazines and books, it is by no means likely that really good popular articles capable of standing up against the competition of commercial journals can be obtained. Furthermore, Dr. Negus' success with the Commonwealth furnishes now an outlet for such articles. There is neither need nor opportunity for the Academy to enter the competitive field of popular science.

The second plan in my opinion is the only way by which the Journal will really strengthen the Academy and the scientific output of its members. The amount of money needed over and above the routine cost of publishing and distributing the Program and Proceedings is not so great as to be beyond the capacity of the Academy.

The Council is asked to give early consideration to the status of the Journal. We must decide once for all whether the advantage of being represented nationally by a recognized journal (as will undoubtedly be the case if the 1940 quality of articles

is maintained), and of furnishing a publication outlet for our members are worth the cost to the Academy. In my opinion, looking at our situation in terms not of years but of decades, the stability of the Academy and its continued usefulness are more likely to be guaranteed by a good journal than by any other means. The cost is likely to become less rather than greater as the JOURNAL becomes more widely distributed, known, and cited.

It is proposed for the consideration of the Council that the first question to be settled is: Shall we continue the JOURNAL or revert to Proceedings and Program only?

If the JOURNAL is to continue, shall we cut it to six, or even four issues in order to bring down the cost?

If the JOURNAL is to continue at its present size, how shall we raise the $242 needed each year to keep it going?

There seem two possibilities here which I submit for consideration.

1. Raise Academy dues to $3.00 so that each member will be a subscriber, appropriating what is needed to sustain the JOURNAL.

2. Put the matter in a personal letter to each member in hopes of finding perhaps thirty of the present membership who will contribute as sustaining members ten dollars a year for the purpose of keeping the JOURNAL going.

If the JOURNAL is to be discontinued, we should publish the spring numbers, the Program and the Proceedings as Volume 2 and then suspend publication.

COST ANALYSIS

Total cost, Vol. 1, 1940		$1,220.05
Jarman	$ 140.00	
Permit, postal	25.00	
Deposit	36.00	
Jarman	250.00	
Jarman	752.05	
Envelopes	13.00	
Other envelopes	7.50	
Incidental	4.00	
	$1,227.55	
Cash on hand	146.00	
Net cost	$1,081.55	
Income		
Subscriptions (number subscriptions, 235)	$ 265.50	
Academy appropriation	300.00	
	$ 565.50	

Analysis of Subscriptions	
Members Academy	196
Institutions	23
Non-members	16
	235

1939 Costs to Academy		
Program	$ 223.00	
Proceedings	290.75	
Postage	60.00	
	$ 573.75	
Cost of Journal (8 issues)		$1,081.55
Cost of Program and Proceedings (1939)		573.75
Cost of 6 numbers other than Program & Proceedings		$ 507.80
Subscription receipts 1940		265.50
Balance to be raised above what it costs to print and distribute Program and Proceedings		$ 242.30

Reply of Council

At a meeting of the Council held Friday night April 4th here in Richmond, the status and prospects of the Virginia Journal of Science were rather thoroughly discussed. It was recognized that if the Journal is continued on the present basis, it will ultimately bankrupt the Academy. Four possible courses were considered:

1. Increase the income. The Secretary was accordingly instructed to suggest to the Committee on the Journal that they take some steps to increase the number of subscribers or to obtain remunerative advertisements, or both. Possibly an assistant business manager could do this if carefully chosen.
2. Decrease the expense. As a temporary expedient the Council decided to reduce the number of issues from 8 to 4, two of these to be the Program and the Proceedings numbers.
3. Both decrease outgo and increase income.
4. Discontinue the Journal.

It was decided not to take any such action at this time, but to make one more trial.

Respectfully submitted,

Ivey F. Lewis.

An active discussion followed led by Dr. D. W. Davis, Dr. Ernst Fischer and many others. Finally, Dr. T. McN. Simpson, Jr., offered the following motion:

RESOLVED:

1. That the dues of senior members be raised to $3.00, to include subscription to the Journal.
2. That the size of the Journal as an outlet of publication be not reduced.

Just before the vote Dr. Miller offered the following substitute motion which was carried by acclamation.

MOVED that in view of the fact (1) that the Academy is now obligated

to turn over to the JOURNAL $500.00 next year as agreed at last year's meeting (2) that during this past year no adequate effort has been made to obtain subscriptions or advertising, that the Academy Conference recommends that the Committee on the VIRGINIA JOURNAL OF SCIENCE be given one more year of trial with no drastic changes forced on them, but with full opportunity to effect such changes as they may consider wise and best.

Report of Long Range Planning Committee

The membership consists of the following: Dr. Arthur Bevan, Dr. Julian A. Burrus, Francis S. Chase, Justus H. Cline, Dr. Frank A. Geldard, Dr. William R. Harlan, Dr. J. Shelton Horsley, W. Catesby Jones, Dr. Ivey F. Lewis, Dr. Garnett Ryland, Dr. I. A. Updike, Raymond B. Bottom, Virginius Dabney, Dr. Meta Glass, Dr. Sidney B. Hall, H. K. McConnell, R. M. Sanford, L. C. Bird, Chairman, Dr. Sidney S. Negus, Secretary, Dean W. F. Rudd, President of the Academy, and Dr. George W. Jeffers, President-Elect, Ex-Officio.

A copy of the minutes of the first meeting of the committee is filed with this report and becomes a part of the record. This gives details as to the organization of the committee and a list of consultants or advisers to the committee selected by your president, Mr. Rudd.

This Long Range Planning Committee was authorized at the last annual meeting of the Virginia Academy of Science. It was created upon the recommendation of Dean Rudd and was an outgrowth of conferences held by Mr. Rudd in 1939 when he was president-elect. These conferences were with past presidents of the Academy and others active in the work of the Academy. In a paper prepared by Mr. Rudd and read before the Academy Conference at the meeting of the A. A. A. S. in Philadelphia, he stated: "Some of us saw in the Virginia Academy of Science, with a membership of almost a thousand, drawn from every field of science represented in the state and from intelligent lay groups as well, what seemed to us an opportunity for a greatly enlarged service."

Before the Long Range Planning Committee was appointed, a questionnaire containing the following questions was sent to the membership by the president:

1. What, in your judgment, should be the primary objectives of a state academy of science?
2. Please outline rather carefully, and in order of their importance, three or more distinct contributions that the Academy may and should make to Virginia in the next five years.

The same questions, with full explanatory letters of transmittal, were asked all state academy secretaries in the country. Likewise, all members of the National Association of Science Writers, and a cross-section of other leading scientists throughout the country were asked to consider and answer the same questions. Replies in large numbers were received. All of these

replies were fully abstracted and tabulated with great care. This work was done by Mr. Hubert J. Davis. A copy of his summary is attached to this report. The Committee, therefore, had for its guidance a cross-section of the best opinions available as to what a local academy should do.

These opinions or suggestions were classified under fourteen heads as follows:

1. Research
2. Publicity of Academy's work
3. Teaching and educational program
4. Problems concerning the State
5. Science Clubs and Junior Academy
6. Guidance program
7. Academy meetings
8. Providing material aids
9. Water pollution problem
10. Problems of national defense
11. Science museums
12. Problems concerning industry
13. Retaining Virginia-trained scientists
14. Miscellaneous

For the purpose of getting the answer or a suggested answer as to what plan the Virginia Academy of Science should adopt concerning these several suggestions six sub-committees have been appointed. It is important that all of us keep in mind the function of our committee; that is, that we are to develop a plan or outline the work that will guide the academy for the next several years.

The sub-committees which have been appointed are as follows:

I. Junior Academy and Science Club Work—Mr. Hubert Davis, Chairman

(Mr. Davis submitted the report of the committee which is attached and becomes a part of this report.)

II. Research—Dr. Frank A. Geldard, Chairman

(While this Academy has had an excellent permanent committee on research and much has been accomplished, the subject was mentioned so many times in the answers to the questionnaire that it was felt that it should be studied. This is being done by the existing Research Committee of which Dr. Frank A. Geldard is chairman.)

III. Education and Publicity—Dr. I. A. Updike, Chairman

IV. Science Museum—Dr. George W. Jeffers, Chairman

V. Finance—Dr. Harvey B. Haag, Chairman

VI. Monograph of the James River Basin—Dr. Marcellus H. Stow, Chairman

(Dr. Stow presented a report which becomes a part of this report.)

We are making the definite recommendation at this time that the Virginia Academy of Science undertake the preparation of a monograph of the James River. The suggestion that the James River be studied came as a result of the many replies to the questionnaire denoting interest in conservation, forestation, soil erosion, stream pollution, game and fish, etc.

The preparation of a monograph of the James River affords the opportunity for the membership of the Academy to get information that is basic to these and other interests, and as Justus Cline has said will enable us to find out what civilization does to a river.

In the words of Dr. Henry B. Ward writing to Dr. E. C. L. Miller:

"With its breadth, its careful analysis and proposed thorough scientific study of every feature involved, it easily ranks as the best venture yet set before any state academy. It is also in desirable and radical contrast with the ordinarv political scheme."

Dr. Ward states further:

"Now in this case after the general problem has been decided upon a committee might indicate the lines of work and the individual workers choose the particular place and type of work they prefer to take. If you should take the James River Project with sub-divisions on aquatic life, shore environment, pollution, forestry, birds, mammals, health, industry, weather or any number you please each one of them might have 20 or possibly even 50 persons working on that problem or part of it at a certain point in a county, township, or the influence of tributaries, the effects of springs and all sorts of modifications that attach themselves to the main project. As these bits are worked up and short reports made you would have the material to put together for a picture of the entire state in its relations to that one famous river which is its own. Because it is Virginia's famous stream the whole population would be interested in the work of the Academy as never before either there or from what I can see in any state in the Union."

Mr. Austin H. Clark in a letter to Dean Rudd writes as follows:

"The James River project suggested and outlined by Mr. Justus H. Cline and Professor I. D. Wilson appeals to me as the ideal project for the Virginia Academy of Science.

"It is a project that involves all branches of science and at the same time is most intimately concerned with the history of the State both before and after European settlement. The integration of the many diverse aspects of the project would be very difficult, if not impossible, under any other auspices.

"Much has been written on the James River. But the information is very widely scattered in a great number of books and periodicals.

It would be worth while to assemble a card catalogue containing a bibliography of everything concerning the river to serve as a point of departure for future work.

"Not only is the detailed study of the river most important from the scientific viewpoint, but the project is most desirable from the standpoint of integrating the various lines of science, and of coordinating science in all its branches with the historical and other cultural aspects of life within the State."

We have quoted from letters written by Dr. Ward and Mr. Clark because they are successful, practical men. They have endorsed the proposal without qualifications and in doing so they have furnished us a description of and conception of the possibilities of the study and have indicated to some extent at least how it can be accomplished.

Recommendations

The committee recommends:

I. The adoption of the report with reference to Junior Academy and Science Club work.
II. We recommend that the Virginia Academy of Science prepare a monograph of the James River.
III. We ask that our committee with its sub-committees be continued for the purpose of completing certain work already started, organizing the James River project and exploring additional avenues of usefulness and service for the Virginia Academy of Science.

L. C. Bird, *Chairman.*

Report of Sub-Committee on the James River Project

During the summer of 1940, President Rudd distributed a questionnaire to many members of the Virginia Academy of Science and to others throughout the State. The two questions concerned primary objectives of the Virginia Academy of Science and specific contributions the Academy should make during the next five years. There were one hundred and fifty-two letters of response containing four hundred and fifty-seven suggestions. These were classified under the fourteen topics of Research, Publicity of Academy's Work, Teaching and Educational Program, Problems Concerning the State, Science Clubs and Junior Academy, Guidance Program, Academy Meetings, Providing Material Aids, Water Pollution Problem, Problems of National Defense, Science Museums, Problems concerning industry, Retaining Virginia-Trained Scientists, and Miscellaneous. Even casual study of these topics will reveal a wide variety of interests, all of importance and of scientific value. Since some of the topics and problems were suggested by as many as seventeen individuals and since the questionnaire was widely distributed and the number of replies received was adequate, it can be reasoned that these suggestions are representative of the general interests of the members of the Academy.

How can such a wide diversification of valuable ideas be unified into a single objective that not only will hold the interest of the entire membership of the Academy, but will appeal also to the imaginations of the people of Virginia? It was obvious from the nature of the topics suggested that only a project of wide range could elicit the active interest of a body such as the Virginia Academy of Science. It seemed to the Long Range Planning Committee that by setting up some natural and resourceful feature of the State, with which everyone is already familiar, and which has played a profound part in scientific, economic, romantic, and social life of the State, the worthy aims of the Academy could be accomplished. The Long Range Committee has appointed a Special Committee to initiate and develop such a project.

It was considered by the Long Range Committee that the James River Basin would not only meet all these requirements, but would supply a field of research for all sections of the Academy, with the common ideal of laying a sound scientific foundation for the ultimate improvement of one of the most historic and beautiful areas in the United States as a human habitat. It is believed by many that such a project, if properly executed, would attract nation-wide interest.

Careful inspection of a map of Virginia will show that the headwaters of Back Creek are in the extreme northwest corner of Highland County near the edge of the Appalachian Plateau, that Johns Creek has its source near Mountain Lake in Giles County, and that Dunlap Creek heads in Alleghany County. These counties are at the westernmost boundary of the State. As these small streams join and form larger ones and hundreds of others add water, the mighty James that flows past Richmond and into Chesapeake Bay at Norfolk is formed. From the westernmost boundary to Chesapeake Bay, the James transects all of the physiographic provinces of the State—the Alleghany Ridges, the Great Valley, the Blue Ridge, the Piedmont, and the Coastal Plain. Of the one hundred counties in Virginia, forty-two of them are either wholly or in part within the James River drainage basin. All branches of science are represented within this area. There are problems of Biology, Chemistry, Conservation, Education, Engineering, Forestry, Geology, Physics, Public Health, Sociology—the list is infinite. The great majority of the universities, colleges, and research institutions are located in the forty-two counties of the James River Basin.

In this great river we have our unifying idea around which can be correlated scientific, sociological and historical research. The project is enormous; the results are of inestimable value. The methods of approach are essentially two-fold—first a survey and compilation of information on what is *known* about *existing* conditions within the area of investigation—What is the *present*

land-use? What is the *present* status of conservation of mineral resources, of wild life, of forests? What is the *present* status of of education, of public health, agriculture, industry? The second phase of the project would be toward *scientific* improvement of existing conditions. For the success of the work, it must be emphasized that the object is NOT A REFORM MOVEMENT! The Academy would NOT attempt to put trout in all the mountain streams of the State, but by *scientific* study would attempt to determine conditions under which trout would thrive in the streams. The Academy would NOT undertake a direct campaign denouncing stream pollution, rather, it would undertake a *scientific* study to determine exactly what constitutes pollution and a study of means whereby pollution can be avoided, to the mutual advantage of all. It is proposed that the work on the James River Project be kept on the highest plane of careful scientific research; it should not become involved with the vagaries of politics nor in crusades against "vested interests". It should study the James River Basin as a human habitat and should indicate, wherever possible practical means for improving this human habitat.

Most of the members of the Academy who have been consulted about the Project have expressed whole-hearted enthusiasm for it. A few have been skeptical about the possibility or probability of practical accomplishment; none has been opposed to the principles of its main objectives.

Details of administration will have to be worked out over a period of some months, but tentatively it has been planned to have an executive committee to serve as a general co-ordinating group, in association with which will be the various established committees of the Academy and a committee from each of the sections of the Academy.

It probably will be desirable for each section to determine and state the fields of investigation and problems with which it will be most concerned. These can be co-ordinated through the section committees.

As a means of obtaining concrete expression of the results of the work on the Project it will be necessary to publish a monograph on the James River. Until such a compilation can be made, individual papers should be published in the VIRGINIA JOURNAL OF SCIENCE or in other journals as specific contributions to the general project.

With co-operation among the leaders of science and scientific thought in Virginia, a new approach to scientific values and practical application of scientific knowledge can be attained that will be of national significance.

R. P. CARROLL,
J. H. CLINE,
I. F. LEWIS,
J. F. SMITH,
M. H. STOW, *Chairman*,
I. D. WILSON.

Minutes of the Saturday Noon Business Meeting

The meeting was called to order by President Rudd at 12:15 p. m. in the Simon Baruch Auditorium.

1. Two committee reports which were not read at the Academy Conference were called for. The Secretary presented the reports, but they were accepted without reading and are printed in the minutes of the Academy Conference. One is by Dr. William E. Trout, Jr., for the Committee on Junior Members (hereafter to be known as the Committee on Collegiate Members) (see p. 142) and the other by John Alex. Rorer for the Sponsoring Committee for the Junior Academy of Science. (See p. 152.)
2. A report was then called for from the Council. The Secretary then presented some recommendations coming jointly from the Council and the Academy Conference. It is recommended:

   (a) That the VIRGINIA JOURNAL OF SCIENCE be continued for another year with the financial support already pledged by the Academy, namely $500.00. This recommendation was adopted.

   (b) That the time of the meeting next year be the second week-end in May or May 7th, 8th and 9th as recommended by the Committee on Time of Meeting (see p. 154). It is understood that this change is experimental and if no serious conflicts or difficulties are encountered it should be adopted next year as the regular time of meeting. This recommendation was adopted.
3. The President called for and received a list of the new officers of sections as follows:

Astronomy, Mathematics & Physics
Chairman, Isabel Boggs
Secretary, W. H. Keeble

Biology
Chairman, Paul M. Patterson
Vice-Chairman, Raymond L. Taylor
Secretary, Paul R. Burch

Chemistry
Chairman, F. H. Fish
Secretary, L. J. Desha

Education
Chairman, F. G. Lankford, Jr.
Secretary, Fred M. Alexander

Engineering
Chairman, Paul S. Dear
Secretary, J. B. Jones

Forestry

Geology
Chairman, R. S. Edmundson
Vice-Chairman, R. J. Holden
Secretary, Wm. M. McGill

Medicine
Chairman, J. E. Kindred
Secretary, Guy W. Horsley

Psychology
Chairman, W. M. Hinton
Secretary, Evelyn Raskin

4. The Report of the Committee on the Place of Meeting was then called for. The Committee consisting of George A. Williams, F. G. Lankford, Jr., and Preston Edwards. The Committee recommended the College of William and Mary-Virginia Polytechnic Institute Extension in Norfolk. The recommendation was adopted.
5. In the absence of Chairman Geldard, the Secretary reported that at the luncheon meeting Friday the Committee designated Dr. Allan T. Gwathmey for the Jefferson prize. The title of his paper was "The Action of Some Gases on the Surface of a Single Crystal of Copper", and Dr. Charles Ray, Jr. for the Academy award. The title of his paper was "Cytological and Genetic Studies on the Flax Genus, *Linum*." At the Friday night meeting the Interacademy award of a gold medal was given to J. H. Yoe and Lyle G. Overholser for a paper entitled "The Application of a New Class of Organic Reagent to the Detection and Determination of Palladium".
6. A resolution was presented from the floor to make the forestry group a regular section of the Academy. Carried.
7. The Committee on Resolutions presented the following which were adopted:

WHEREAS, the Medical College of Virginia so graciously and so cooperatively has extended its hospitality to this organization, therefore

BE IT RESOLVED, that the Virginia Academy of Science express its heartiest gratitude to President William T. Sanger, Dean Wortley F. Rudd, Dr. H. B. Haag and to all the members of the Local Committee on Arrangements, whose kindly and efficient services have made this meeting such a pleasant and memorable one; and further

BE IT RESOLVED, that the Academy hereby express its appreciation to those groups or individuals in the City of Richmond who have contributed to the success and pleasure of the meeting.

WHEREAS, the Virginia Academy of Science recognizes the special services of President Wortley F. Rudd whose inspired creation of the Long Range Planning Committee will doubtless remain a lasting monument to his administration, to Secretary-Treasurer E. C. L. Miller, Assistant Secretary Sidney S. Negus, President-elect George W. Jeffers, and the several committees of the Academy during the meeting, and particularly to L. C. Bird and Hubert J. Davis and all those members who have laid such a firm foundation and made such a promising beginning of the James River project and the Junior Academy of Science,

BE IT RESOLVED that the Academy, collectively and individually extend a note of thanks to each and all of these for their devoted and efficient work.

Respectively submitted,

D. Maurice Allan,
Richard H. Henneman,
Raymond L. Taylor, *Chairman*,
Committee on Resolutions.

8. The Nominating Committee presented the following slate:

President-Elect—Marcellus H. Stow
Secretary-Treasurer—E. C. L. Miller
Assistant Secretary—Sidney S. Negus
Member of the Council—H. B. Haag

There being no nominations from the floor, these men were elected by acclamation.

9. By request Dr. Stow, Chairman of the Sub-Committee then read his report on the James River Project. (See page 161.)
10. Acting on a request from the Committee on the Junior Academy the Academy authorized the officers to grant honorary junior memberships to certain outstanding members of science clubs when requested to do so by the Junior Academy officers. These honorary memberships to serve as one form of recognition of good work done.
11. Dr. Myers then escorted President Jeffers to the front. The chair was turned over to him, and he spoke a few appropriate words.

Under business from the floor Dean Ivey F. Lewis brought up the desirability of conserving time in some of our large sections especially by doing away with the formal reading of long papers and substituting a short oral statement by the author of his problem and results so as to give time for more and better discussion. No action was taken on this, but the officers of the Academy will again bring this matter to the attention of the officers of sections and recommend its adoption.

Dr. Donald W. Davis moved to make this Academy Conference an official meeting of the Academy empowered to pass finally on matters that may come up.

Dr. Preston Edwards moved as a substitute motion that the incoming President appoint a committee to study this matter and the whole organization and timing of our meeting schedules. Substitute accepted by Dr. Davis and carried. (See p. 154.)

Sections	*Members*	*Non-Members*	*Section Total*	*% Non-Members*
Astronomy, Math. & Phy.	29	6	35	17.1
Biology	76	43	119	36.1
Chemistry	69	69	138	50.0
Education	8	1	9	11.1
Engineering	12	13	25	52.0
Forestry	2	6	8	75.0
Geology	18	11	29	37.9
Medicine	43	41	84	48.8
Psychology	17	17	34	50.0
Non-specified	11	46	57	80.7
Gross Total	295	253	548	40.3
Deduct for duplication	24	10	34	
Net registered	271	243	514	
% of registration	52.7	47.3	100	

Minutes of the Section of Astronomy, Mathematics and Physics

F. B. HAYNES, *Chairman*

ISABEL BOGGS, *Secretary*

FRIDAY, MAY 2—10:00 A. M.

1. A Study of the Internal Resistance of a Dry Cell.

W. R. Greer and J. F. Ryman; *Virginia Polytechnic Institute.*

Several #6 dry cells were subjected to various loads ranging from 0.003 amperes to 14.5 amperes, and the internal resistance was calculated for each different load. Except for very small currents the internal resistance remained about constant. (0.1 ohms). The time of discharge as compared to the recovery time was studied, and both the discharge and recovery were rapid during the first minute, after which it remained constant. Using a potentiometer and a resistance of 0.001 ohms, a current of 50 amperes was obtained from the cell, this current decreasing slowly over a period of four hours to about 5 amperes.

2. A Semi-automatic Spectrographic Exposure Control.

J. R. Cosby, F. B. Haynes, and H. D. Ussery; *Virginia Polytechnic Institute.*

In recent years the spectrograph has evolved from a small optical instrument with little resolving power to a massive structure having dispersive powers of the order of 1.0 angstroms per millimeter. The necessity for some device whereby duplicate exposures on photographic plates may be obtained naturally arises, especially in quanitative spectrographic analysis. A need for such a device is readily grasped when one observes the image of the arc or spark source on the slit of the spectrograph wandering from side to side, changing in intensity and even failing. One wonders at the correct exposure time wishing he had some means of duplicating the exposure from one sample to another. Some device which would even partially eliminate these errors would be a great aid and stress should be placed on the importance of some type of automatic control to insure duplication of results. This would be particularly advantageous in the analysis of samples in the electrode form.

A method of performing this task was described by the authors. The apparatus consisted of an ordinary commercial photocell, relays and a cold cathode gas triode. The light energy was measured by an "integrating" method of charging a condenser, actually only the interelectrode capacitance of the associated vacuum tubes. The results obtained were evident from a series of spectrograms of copper each of uniform density and having a time variation of over three times for the shortest and the longest exposure times, the ratio of 82 seconds to 253 seconds for the actual exposure times.

It is hoped that others may profit by these results.

3. Orbital Motion of Wolf 424.

Dirk Reuyl; *Leander McCormick Observatory, University of Virginia.*

In May, 1938, this faint star was claimed, on the basis of spectral data, to be the nearest star. This claim was disproved by the preliminary parallax of + 0″22 ± 0″03, derived from early McCormick photographs. Subsequently, from additional plates, the star was found to be a close binary with a separation of about 1″.

The final determination of the parallax from 31 plates gives + 0″217 ± 0″010. Selecting those plates on which the duplicity is well measurable, an attempt has been made to ascertain the amount of orbital motion during the past three years. Since the conventional method of bisection cannot be applied on blended images of this type, a substitute method has been used, whereby settings are made on the image borders and the effect of guiding on distance and position angle is taken into account.

During 1938 and 1939 the observations indicate a slight decrease in the position angle, with the distance remaining practically constant at 0″8. In the past year, however, the distance is found to have decreased by at least 0″4, showing that this interesting binary system, consisting of two red dwarf stars, presumably surrounded by a common envelope, is in rapid orbital motion.

4. Two Recent Naked-eye Comets.

Claude M. Anderson, Jr.; *Leander McCormick Observatory, University of Virginia.* (8 min.)

Photographic observations of Comets Cunningham and 1941c were made with the ten-inch Cooke camera at the Leander McCormick Observatory during the past winter. These two comets are the brightest which have appeared since Finsler's comet of 1937.

5. Spectral Classification of Reference Stars used in the Derivation of Cepheid Motions.

C. A. Wirtanen; *Leander McCormick Observatory, University of Virginia.*

In connection with Professor Mitchell's program for the measurement of the motions of Cepheid variable stars, considerable care must be used in the choice of the reference stars in order to avoid as far as possible the effects of cosmical errors. The selection is made after the spectra of all possible reference stars have been determined. These are classified from plates taken with the ten-inch Cooke camera with objective prism.

6. Intercomparison of Various Spectral Classifications of Faint Stars.

A. N. Vyssotsky, *Leander McCormick Observatory, University of Virginia.*

The establishment of a homogeneous system of spectral classification for faint stars is a prerequisite for researches concerning the structure of our galaxy. It is shown that the catalogues of spectra published by the Harvard, Mount Wilson, Bergedorf and Potsdam observatories have marked systematic differences. Intercomparison by means of 5,500 stars classified at the McCormick Observatory has established the corrections to use used for the reduction of the various catalogues to a common system.

7. Quantity or Quality in High School Science.

Preston H. Edwards; *Sweet Briar College.*

The most desirable quality in a high school graduate is the power and habit of clear thinking, in tackling problems that arise either in further study or in any line of work that the student may enter. A certain amount of factual material is essential, for purposes both of stimulating and maintaining interest, and of furnishing basic material for reasoning processes. But there is not time to impart a great mass of facts without a risk of neglecting the training of the reason. Mathematics, being almost pure reasoning, is probably the best medium for such training, therefore should be stressed through the entire school course. In the sciences, a small amount well taught and thoroughly mastered is far preferable to a large undigested mass of information. Science teachers should be among the most carefully chosen and highly recognized of the school staff.

FRIDAY, MAY 2—2:00 P. M.

8. Business Meeting.

The following resolution was adopted: "The section of Astronomy, Mathematics and Physics calls the attention of the Council of the Virginia Academy of Science to the conflict of the Academy meeting this year with that of the American Physical Society, and asks the Council to see that this conflict be avoided in future meetings."

A motion was passed to permit the Chairman and Secretary to ask for assistance from a Program Committee in planning the next meeting.

The following officers were elected for the coming year:

Isabel Boggs, Chairman,
W. H. Keeble, Secretary.

9. A Back Reflection X-ray Camera of Simple Design.

W. Richardson; *Virginia Polytechnic Institute.*

In an X-ray powder diffraction pattern the line appearing at angles of nearly 180° are used in the precision measurements of lattice parameters of metals and their alloys. A camera for conveniently recording these lines is described. The design is simple so that the instrument may be constructed in the average physics shop.

10. Vector Operations in Plane Geometry.

B. Z. Linfield; *University of Virginia.*

The traditional introduction of vector operations in connection with the applications of mathematics to physics, while in harmony with historical developments, has obvious disadvantages. An alternate approach was illustrated by expressing conclusions from observations on the triangle as vector equations, and new conclusions derived from them by the laws of vector operations,—laws that are immediate generalisations of the familiar algebra.

11. Rotational Analysis of the (O, 4) Angstrom Band of CO for High Rotational Energies.

Myron S. McCay; *Virginia Polytechnic Institute.*

The rotational structure of the P, Q and R branches of the Angstrom band at $\lambda 6080$ has been extended to higher rotational terms by analysis of spectrograms of the band made in the first order of a 21-foot concave grating. A re-determination of the initial lines of the series shows essential agreement with the results of previous investigators. The new region affords a check on a perturbation in the final $(A'\pi)$ level which has been reported from analyses of the Fourth Positive bands of CO. A marked decrease in intensity of the band-lines sets in near the region of $Q(20)$, a possible indication of molecular predissociation in these states.

12. The Use Made of Scientific Films in the General Course of Physics at the Virginia Military Institute.

S. M. Heflin; *Virginia Military Institute.*

The scientific films are used at the Virginia Military Institute in connection with laboratory and class work both in introducing a given subject to a class and in summarizing the subject matter for review. The department of Physics is convinced that the films have much educational value.

13. Demonstration of Equipment for Projecting Sound Motion Pictures.

James B. Newman; *Virginia Military Institute.*

SATURDAY, MAY 3—9:00 A. M.

14. The Solution of Differential Equations by Operational Calculus, Part II.

A. Lee Smith; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Read by title.)

In former papers[1] we proved that, by means of operational calculus, it is possible to solve many differential equations with constant coefficients. However, there are many differential equations which do not have constant coefficients, but which also may be solved by means of operational calculus.

In this paper we shall limit ourselves to Bessel's Function. First, we derive six theorems; second, we show that many interesting relations may be obtained by certain operational equivalents.

15. Photography.

Walter Brown; *Junior Academy of Science, Lane High School, Charlotesville, Virginia.*

16. Some Simple Lecture Demonstration from the A. A. P. T. Manual.

Joseph D. Elder; *Lynchburg College.*

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[1]A. Lee Smith, Virginia Academy of Science Proceedings, p. 25 (1938-1939). *Ibid.*, p. 202 (1939-1940).

17. Demonstration of Sound Motion Picture Projector.
    Erpi Films, Inc.

18. Trip to the Roentgenology laboratories of the Medical College of Virginia.

This trip was conducted by Mr. Jonah Larrick, who showed the group through the new hospital. Dr. Frederick B. Mandeville, professor of Roentgenology in the Medical College, explained his equipment, and told of some of the problems arising in its use. The department is excellently equipped, and it is a great privilege to have been able to see it so informally and closely.

Minutes of the Section of Biology

E. DeWitt Miller, *Chairman*

Lena Artz, *Vice-Chairman*

R. F. Smart, *Secretary*

FRIDAY, MAY 2—10:00 A. M.

1. Spermatogenesis and oogenesis in *Haemonchus contortus*, a Nematode Worm Parasitic in the Fourth Stomach of Ruminant Animals.

William Logan Threlkeld and Myron Eugene Henderson; *Virginia Polytechnic Institute* and *Roanoke College.* (Lantern, 10 min.)

No spermatogonial stages were observed. Development of the primary spermatocyte proceeds from a typical primitive stage developing into a primary spermatocyte possessing nine bivalent chromosomes. Upon reduction division secondary spermatocytes characterized by four and five chromosomes are present. In a few instances chromosome aberrations were noted in which the secondary abortive stages were composed of six and three chromosomes.

*Normal chromosome number in male: N = 4 and 5, 2N = 9.

*Abnormal chromosome number in male: N = 3 and 6, 2N = 9.

In oogenesis the complete development of the cells has not been observed. In secondary oocytes five chromosomes were consistently found. Fertilization was not observed but reduction divisions believed to be stimulated at the time of fertilization produced polar bodies with five chromosomes each.

*Normal chromosome number in female: 1N = 5, 2N = 10.

2. Helminth Parasites of Sheep.

William L. Threlkeld; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

A study is made of the viability of the infective larvae of *Ostertagia circumcincta* under field conditions. These larvae withstand temperature as low as —10° F. and remain infective in paddocks for a period of 11 months.

High egg counts in lambs infested with this species generally occur after increased precipitation. The number of adult *circumcincta* established in 2 lambs grazing during a dry season of two weeks duration preceded by slight precipitation was increased over the number of adults found in 2 lambs grazing for a period of two weeks drought preceded by two days totaling 2 inches of precipitation.

Copper sulphate in strengths of 1 per cent to 4 per cent administered to lambs in compatible doses is an inefficient anthelmintic against *O. circumcincta.* Tetrachlorethylene administered as described in this study is an efficient anthelmintic against adult *O. circumcincta.* The employment of 2.5 c. c. to 3 c. c. of 10 per cent copper sulphate solution for stimulating

*These chromosome numbers are tentative.

closure of the oesophageal groove in 62 animals was 70.96 per cent effective in directing capsules not larger than 16 mm. in diameter by 20 mm. in length to the abomasum and has approximately a 2.5 to 1 ratio advantage over the method employed without preliminary treatment with copper sulphate. A tabular comparison is made of the efficiency of various chemicals employed in field treatments of 66 sheep. Results of field treatments with phenothiazine in doses ranging from 0.16 gm. to 0.6 gm. per pound of body weight of animal are described. These animals, slaughtered at intervals of from 15 days to 3 months and 18 days after such treatments, show an extremely small degree of parasitic infestation. The most persistent species after treatment with phenothiazine are *Trichostrongylus* species in the small intestine and *Bunostomum trigonocephalum*. The efficiency of various chemicals including thionol and phenothiazione administered to sheep maintained under controlled conditions are recorded. Further experimental work with phenothiazone is indicated.

The seasonal fluctuation of helminth parasites in sheep in Southwest Viriginia is ascertained and recommendations for seasonal treatments with phenothiazine are made. In general, two treatments at the rate of 0.6 gm. per pound of body weight are recommended in the late summer, one treatment in November, and one in January or March depending upon the prevailing local customs of breeding.

10 tables—10 figures—61 references.

3. Chromosome Number and Winter Hardiness Relationships in the Higher Plants.

Wray M. Bowden; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

The significance of chromosome number in relation to cold resistance in the higher plants was investigated, and the relationships between chromosome number, winter hardiness, genetics of cold resistance, and geographical distribution were found to be involved in the problem.

Data have been directly obtained on the winter hardiness and chromosome numbers in 222 collections representing 80 genera and 194 species of Spermatophytes; and indirectly on more than 400 species compiled from the literature. The chromosome complements of 188 species from 47 families have been recorded by camera lucida drawings.

Mixtures, of non-hardy, less hardy, and fairly hardy species are found in tropical and subtropical floras; while in colder regions, there is a higher percentage of cold-resistant species. Variation in degree of hardiness is primarily associated with genic differences but may be secondarily affected by chromosome doubling. These data reinforce the conclusion of Bowden (1940) that the available evidence does not support the conclusions of Tischler (1935), Hagerup (1933) and Müntzing (1936), that polyploids are usually hardier than diploids and are therefore better adopted to climatically unfavorable regions. Clausen, Keck, and Hiesey (1940) were also unable to support the view that forms with the higher chromosome numbers occupy the more adverse environments.

Future lines of investigation are briefly indicated.

4. Time and Rate of Nutrient Absorption by Bright Tobacco.

L. R. Kangas and A. L. Grizzard;[1] *Virginia Polytechnic Institute.* (15 min.)

In the fertilization of a crop, light bright tobacco, which uses a special and complicated formula, some of the main questions to consider are: (1) How efficient is the crop in utilizing applied nutrients; (2) At what

[1]Graduate student and Associate Agronomist, respectively.

stage or stages during its growth do maximum absorption and utilization of nutrients occur; and (3) What is the affect of different forms of nitrogen on nitrogen absorption?

An experiment was designed in the spring of 1939, and continued again in 1940, to answer these questions for the bright tobacco plant. Chemical analyses of bright tobacco plants were made at the following stages of growth: When the plants were ready for transplanting; 21 days after transplanting; and at 14-day intervals thereafter until the plants reached maturity. The tobacco was grown at Chatham on Granville sandy loam soil, and was fertilized with 900 pounds per acre of a 3-10-6 fertilizer.

Three weeks after transplanting, the plants had produced only 3.1 per cent of the total weight per acre (leaves and stems combined). At the end of five weeks, the plants had produced an additional 18.0 per cent of their total weight. It is important to note that 78.9 per cent of the total weight per acre was produced during the last twenty-eight days of the 63-day growing period.

Chemical analyses, made on the plants at the end of each growing period, show that a total of 28.72 pounds of nitrogen per acre was absorbed during the nine weeks of growth. The maximum absorption of nitrogen occurred during the fourth and fifth weeks—9.17 pounds, or 32.4 per cent of the total, was used in this period. However, the absorption of nitrogen was high during the next two periods of growth, being 29.0 per cent in the sixth and seventh weeks and 31.2 per cent during the eighth and ninth weeks. Also there were no marked or significant differences in nitrogen concentration in the expressed say or in total content of the dry plant, due to variations in the sources of nitrogen used in the fertilizers.

The rate of absorption of phosphoric acid was very similar to that of nitrogen, but in about one-third the quantity. Of the total of 9.03 pounds per acre of phosphoric acid utilized by the tobacco, 30.3 per cent was absorbed during the sixth and seventh weeks. However, 42.4 per cent of the total was utilized during the eight and ninth weeks.

The tobacco absorbed a total of 56.8 pounds per acre of potash during its nine weeks of growth, of which 25.2 per cent was utilized during the fourth and fifth weeks; 31.9 per cent in the next two weeks; and 38.6 per cent during the eighth and ninth weeks.

The tobacco absorbed a total of 12.5 pounds per acre of magnesia during its nine weeks of growth, of which 46.0 per cent was utilized during the eighth and ninth weeks. Four times as much calcium as magnesia was utilized by the tobacco plants. A total of 44.3 pounds of lime per acre were taken up by the crop, of which 50.1 per cent was absorbed during the eighth and ninth weeks.

Tobacco was found to be 100 per cent efficient in utilizing each applied nitrogen and potash. It used only 10.0 per cent of the calcium; 62.8 per cent of the magnesia; and 10.4 per cent of the sulphur applied in the fertilizer.

5. Time and Rate of Nutrient Absorption by Peanuts.

John Strauss and A. L. Grizzard;[1] *Virginia Polytechnic Institute.* (15 min.)

During the growing season of 1940, ten fields of peanuts were sampled at four different stages of growth in order to determine: (1) the stages of growth when maximum absorption of nutrients occurred; (2) the effect of previous fertilization practices upon nutrient absorption; and (3) the efficiency of the peanut in utilizing applied nutrients.

Peanuts absorbed, during the first six weeks of growth, approximately 10 per cent of each of the total nitrogen and phosphoric acid utilized and

[1]Graduate student and Associate Agronomist, respectively.

approximately 2 per cent of the potash, 5 per cent of the calcium, 3 per cent of each the magnesia and sulphur.

During the next six-week period, peanuts absorbed approximately 90 per cent of each the total nitrogen and phosphoric acid utilized, 98 per cent of the potash, 95 per cent of the calcium, and 97 per cent of each the magnesia and sulphur.

Previous fertility practices had a marked influence upon yield of hay and salable nuts per acre. This, of course, means that those fields which were in a good state of fertility produced larger crops and absorbed more plant nutrients per acre. The stage of absorption of nutrients followed a rather uniform and upward trend, being most rapid as plants were making the greatest growth.

6. Results of a Three Year Study on the Control of *Cercospora* Leaf Spot of Peanuts.

Lawrence I. Miller; *Virginia Agricultural Experiment Station, Holland, Va.* (Lantern, 15 min.)

Studies initiated in 1938 were continued during 1939 and 1940 in Southeastern Virginia in an effort to evaluate the relative damage caused by Cercospora leaf spot and also to determine the effectiveness of different sulphur dust application schedules in the control of Cercospora leaf spot. Results of field experiments indicate that leaf spot causes approximately 30 per cent reduction in yield of nuts and 40 per cent reduction in yield of hay. Dusting 3 times with a conditioned 325-mesh sulphur reduced the amount of leafspot to such an extent that excessive shedding of leaves was prevented. As a result, the sulphur-dusted peanut plants not only yielded more nuts and hay than untreated plants, but also produced higher quality nuts and hay. It was also demonstrated that sulphur-dusted plants may be held in the ground 5 to 10 days longer than untreated plants without serious loss of nuts through shedding, which is a feature that should prove to be a great asset to peanut growers faced with a labor shortage at digging time.

7. Feeding a Perfect Human Diet to Rats.

Joseph Z. Schneider; *Madison College.*

Rats of four different strains which were raised on uncontrolled diets for several generations were changed to perfect human diet and were continued through four generations on this diet. Although the males of the second generation raised on the dietetically perfect diet reached a high weight and size, the size of the second generation fell down and the weight of the fourth generation was relatively close to that of the first generation born after the change.

In case of females the second and third generation was in size and weight distinctly above the first generation, but the weight of the fourth generation was practically the same as that of the first generation raised on the perfect human diet.

The feeding of a nutritionally perfect human diet to rats influences the size and weight materially through the second and third generation after which the weight returns to the level observed on the first generation raised on this diet.

8. Schools of Training for National Park Service Work.

R. C. Robinson; *National Park Service, Region one.* (Motion Pictures.) (By invitation.) (Introduced by Robert F. Smart.)

FRIDAY, MAY 2—2:00 P. M.

9. Further Observations on a Perennial Woody Gall on Hickory.

Alphonse F. Chestnut; *College of William and Mary.* (Lantern, 15 min.)

Continued efforts towards the isolation of the causative organism of a perennial woody growth on the bitternut, *Carya cordiformis* (Wang.) K. Koch, have yielded only negative results.

A few observations in connection with further work, noted during the past year were: (1) the apparent increase of young galls on previously infected trees; (2) spreading of the growth to nearby trees of the same species, previously without any outward appearances of infection; and (3) no other species of hickory or any other genus has been noted to have these growths.

10. Observations on the Spectroscopic Properties of Leaf Green Solutions.

Lewis W. Webb, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Lantern, 10 min.)

A report summarizing three studies on the optical properties of leaf-green solutions. The first research deals with the production of accurate transmission spectrograms of an ethyl alcohol solution of leaf-green taken from Kentucky Blue-grass. These graphs may be helpful in teaching plant physiology. The second study concerns the changes in the spectrograms caused by continued irradiation of a master solution and emphasizes the part that light plays in the disintegration of alcoholic solutions of chlorophyll. The third research relates to the character of graphs taken from different concentrations of leaf-extract. A detailed study is made of the transmission peak at 530mμ and the absorption trough at 660mμ. Exponential equations with corresponding curves are presented based upon the relationships which exist at these wave bands. The Coleman Regional Spectrophotometer was the instrument used in the study.

11. Response of Aquatic Micro-organisms to Sulfanilamide, Sulfathiazole, and Sulfapyridine.

Jane R. Holmes and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (10 min.)

This study seeks an insight into the mechanism by which the toxic effects of the sulfonamides are wrought. The micro-organisms *Hydra*, rotifers, *Stenostomum* sp., *Dero* sp., Crustacea, *Paramecium caudatum*, *Amoeba proteus*, *Halteria grandinella* and various heterotrichs were subjected to these drugs in aqueous solutions and the effects studied microscopically. From this study it appears that sulfapyridine is absorbed more rapidly than either sulfanilamide or sulfathiazole. Generally speaking there is a marked toxic effect upon free-living organisms with the disintegration of the tissues. This may be accompanied by body edema, decolorization, and brittleness of the tissues. Protozoa are more resistant to the toxic effects of the drugs than the Metazoa studied. This research shows an increasing toxicity for the drugs in this order; sulfaguanidine, sulfanilamide, sulfathiazole and sulfapyridine.

12. A Preliminary Survey of the Flora and Fauna of the Polluted Waters of the Norfolk Area.

E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Read by title.)

13. Notes on the Anatomy of a Rare Archiannelid *Dinophilus sp.* from the Norfolk Area.

E. Ruffin Jones, Jr. and Frederick F. Ferguson; *College of William and Mary-Virginia Polytechnic Institute, Norfolk Division.* (Read by title.)

14. The Biological Control of the Mealy-Bug.

J. G. Harrar and J. J. McKelvey, Jr.; *Virginia Polytechnic Institute.* (Lantern, 15 min.)

The mealy-bug is an insect pest of great economic importance and one which is extremely difficult to control. Recently a fungus has been isolated from dying mealy-bugs, which has been shown to be a virulent parasite of several species of the genus *Pseudoccus.*

The taxonomy of the pathogen has been studied by the authors in collaboration with Miss V. H. Charles, of the United States Department of Agriculture, and Dr. J. N. Couch of the University of North Carolina. From cultural and microscopic studies it has been determined that the organism is an imperfect fungus which has not previously been described. Reproduction is by means of conidiospores and a type of sclerotium peculiar to the species.

Methods have been evolved for the production and dissemination of inoculum and in tests under favorable conditions complete control of mealy-bugs in the laboratory and greenhouse has been obtained experimentally. Experiments are in progress to determine the potentialities of the parasite in the practical control of mealy-bugs in the orchard and in commercial greenhouses. Should such experiments prove to be successful the pathogen will be made available to orchardists and horticulturists throughout the state.

15. Physiologic Studies of Some Entomogenous Fungi.

J. G. Harrar and J. W. Showalter; *Virginia Polytechnic Institute.* (Lantern, 12 min.)

The entomogenous fungi comprise an heterogenous, poorly understood group of organisms. With the exception of early classical work on the *Laboulbeniales* and the *Entomophthorales,* little effort has been made to accurately identify those fungi parasitizing insects. In general morphologic characters and host relationships have been the only criteria used in taxonomic diagnosis of such forms. However physiologic characters may be of great importance in the separation of entomogenous species.

Six entomogenous fungi have been studied relative to their physiological characteristics. The pathogens are *Beauveria* "A", *Beauveria* "B", *Entomophthora apiculata, E. coronata, E. sphaerosperma,* and an undescribed parasite of the mealy-bug. Forty-six different culture media were used in an attempt to establish criteria for the separation of entomogenous forms. These physiologic studies have concerned the following several phases: sugar fermentation, protein decomposition, growth on acid salts, nitrate reduction, hydrogen sulphide production, pH tolerance and O-R poten-

tials. From data obtained it is evident that physiological characters are necessary to supplement morphological and pathological characters in the identification of entomogenous fungi.

16. Some Effects of Theelin on the Mucus in the Genital Tract of the Guinea Pig.

Roy Talmage; *University of Richmond.* (Introduced by H. I. Myers.) (Lantern, 15 min.)

The Castrate female guinea pig consistently showed a mucification of the entire vaginal and uterine body epithelium. When given in subminimal doses for cornfiication, the theelin-injected castrates showed a definite increase in the degree of mucification but no change in the extent. The change in the degree was correlated more with the length of time in which the theelin was allowed to act rather than the amount of theelin used.

Theelin doses large enough for cornification caused both an anterior and posterior decrease in the extent of mucification, bringing the anterior extent in the uterine body down approaching that found in the normal pig just before heat (Cornish 1939), and partially eliminating it from the vagina. These increased doses given in two or more injections caused a marked increase (110$m\mu$.) in height of mucus in that part of the epithelium in which it still remained.

Theelin is not the causative agent for the production of mucus, but if administered in small quantities will cause an increased degree, and if given in sufficient quantities will decrease the extent while further increasing the degree. Large injections of theelin probably will completely eliminate mucus from the body of the uterus.

17. Notes on the Sclerotium of *Fuligo septica.*

W. T. Allman; *University of Richmond.* (Introduced by Robert F. Smart.) (Lantern, 10 min.)

Sclerotia of *Fuligo septica* were allowed to reactivate under optimum conditions of temperature and moisture. At regular intervals during this reactivation, sclerotia were killed and studied microscopically.

In resting condition the unit of sclerotium, the spherule, possesses a definite membrane, is densely filled with cytoplasm, contains from one to ten nuclei and varies in diameter from 10.5 microns to 19.8 microns with the average from 14.5 microns to 16.7 microns.

Reticulation of the cytoplasm is barely visible until reactivation is begun, when such reticulation is clear and beautiful. After the first two and one-half hours during reactivation several small vacuoles appear in each spherule which unite, just prior to escape of the ameoboid mass of protoplasm, to form, usually one large central vacuole.

Escape of the protoplast was observed first in the interior of the sclerotium, the escaping protoplasts coalescing with adjoining similar individuals to form a plasmodium in the interior of the sclerotium. Peripheral protoplasts were observed to be the last to escape.

18. Research in Progress at the Virginia Fisheries Laboratory.

Curtis L. Newcombe; *Virginia Fisheries Laboratory and College of William and Mary.* (Lantern, 15 min.)

19. Growing Oysters in the York River.

J. W. Bailey; *University of Richmond.* (Motion pictures, 20 min.)

1. In early years a great part of the York River bottom was probably well covered with shells and oysters striking one on the other until at times they were bare at low water. Man soon de-oystered the river until today scarcely any hard bottom remains.
2. Similar man-made conditions in the drainage basin made a soil erosion problem which deposited thousands of tons of silt on the oyster flats of the river.
3. Quick run-off during rainstorms made for very sharp fluctuations in the river salinity.
4. With this change in salinity and silt condition come new conditions as well as new pests.
5. Sanitary regulations restricted the methods of operation on some thousand acres of oyster planting ground.
6. These changes were slow and oyster planters in the river did not see them. They wished to continue operations as their fathers had done. Drastic changes in methods were necessary to meet new conditions and the fact that they were not made, left the planters with some 3,500 acres of unprofitable oyster planting ground on their hands.
7. The York River, suffering from lack of conservation as it does, is not a good gamble as an oyster farming project. With progressive methods and proper care, however, it can be brought back as a profitable enterprise. In those areas that have suffered the least positive results are already being obtained. It is questionable whether some of the areas can ever be put back in profitable production.

20. Utilization of Apple Products in Lowering the Curd Tension of Milk for Infant Feeding.

C. C. Flora and C. W. Holdaway; *Virginia Polytechnic Institute.* (15 min.)

Botany Division

SATURDAY, MAY 3—9:00 A. M.

1. Native Grapes of Virginia.

A. B. Massey; *Virginia Polytechnic Institute.* (Lantern, 12 min.)

The native grapes are an important group of plants. One species *Vitis labrusca,* the fox grape, has given rise to a number of varieties of cultivated grapes. Some of the native species as they occur in the wilds are of culinary value. Various forms of wildlife feed extensively upon the fruit of grapes. Deer commonly browse the vines. The native vines are functionally male or female hence it is frequent that we find vines which do not bear fruit. Of the 30 species of grapes native to North America seven are known to occur in Virginia. These are: the fox grape *Vitis labrusca,* Linn.; the silverleaf or blue grape *Vitis argentifolia,* Munson (= V. bicolor, Auth.); summer grape *Vitis aestivalis,* Michx.; winter grape *Vitis cordifolia,* Lam.; 'possum grape *Vitis Baileyana,* Munson.; frost grape *Vitis vulpina,* Linn. and the muscadine and scuppernong *Vitis rotundfolia,* Michx. The sand grape *Vitis rupestris,* is said to occur in Virginia.

2. Some Notes on *Buckleya distichophylla.*

J. R. Mundie; *King College.* (Read by title.)

3. Moisture Content of Bryophytes at Different Levels of Humidity.

Paul M. Patterson; *Hollins College.* (Lantern, 10 min.)

The per cent of moisture content gained or retained by living xerophytic, mesophytic and hydrophytic bryophytes over calcium chloride, at 42%, 71% and 93% humidity as determined by oven dry weight subsequently taken and calculated as zero showed that the bryophytes retain approximately 4-5%moisture over calcium chloride, and absorb 13-15% at 42% humidity, 20-23% at 71% and 29-40% at 93%. Bryophytes with alcohol and water soluble materials and pectates removed showed little difference from fresh bryophytes in the retention or imbibition of moisture over calcium chloride and at 93% humidity. Pectates were present only in traces. Thus the differences in the retention and absorption of moisture from air by bryophytes apparently plays an insignificant role in their adaptation to xerophytism.

4. A Preliminary List of the Mosses at Mountain Lake, Virginia.

Paul M. Patterson; *Hollins College.* (10 min.)

One hundred and forty-five species and varieties excluding *Sphagnum* are reported. Examples of the cosmopolitan, northern and southern species are given. Rare species and genera expected to be found in the area were also mentioned.

5. Further Genetical and Cytological Studies on a Sea-side Ecotype of *Aster multiflorus* Ait.

A. L. Delisle and Mary R. Old; *College of William and Mary.* (Lantern, 10 min.)

A sea-shore ecotype of *Aster multiflorus* with stiff descending branches collected at Montauk, Long Island, and later grown under identical conditions with the type species, has retained its characteristic habit. Further, second generation seedlings obtained from the ecotypes have the same type of branching as their parents, indicating that this peculiar branching is inherited.

Cytologically, the type and ecotype have each 5 pairs of similar chromosomes. Except for consistently larger cells and larger chromosomes, in the variant, there is no apparent difference in chromosome morphology between the type species and the variety.

Additional genetical and cytological work is contemplated, but it is felt from preliminary evidence that the morphological variation in branching of the ecotype from the type species (*A. multiflorus*) is probably in the nature of a mutation.

6. The Genes for Floral Colors in *Impatiens balsamina* and a Correlation with those Reported by other Investigators.

Lucy Ann Taylor and Donald W. Davis; *J. A. C. Chandler High School* and *College of William and Mary.* (Lantern, 15 min.)

The numerous colors of the garden balsam (magenta, purple, red, pink, rose-lavender, lavender, rose, nearly-white pink, hermosa-lavender, hermosa,

nearly-white lavender and white) are determined by genes at three loci, L, H, and P. The complete recessive is white flowered. Gene L produces nearly-white lavender petals, white spurs, and green stems. H produces hermosa petals. At the P locus there occur a series of multiple alleles. Pg, Pg′ and Pg″ produce flowers with pale pink petals, deeper pink spurs, and green lower stems, differing only in intensity of color. Pr, Pr′ and Pr″ produce bright pink petals, reddish spurs, and red color on the lower stems of differing intensity. Combinations of these genes account for the different phenotypic color effects. Kanna, Bedell, Hagiwara and Rasmuson who previously reported on the inheritance of floral colors in the garden balsam made similar analyses of the deeper colors but did not correctly distinguish the effects of single genes in the pale colors and were led to assume unnecessarily complex genic relations.

7. Seven-Year Experiment in Cotton Breeding at Hampton Institute.

Thomas W. Turner; *Hampton Institute.* (Lantern, 8 min.)

Cotton breeding projects have been in progress at Hampton Institute for about a decade. The chief aim has been to secure by crossing and selection, a strain of coton stable genetically for the five-lock boll character. The quality and length of the lint are also included in the study.

Many varieties (55 in all) were grown at the beginning for the purpose of identifying those which would come to maturity most satisfactorily under the climatic and soil conditions obtaining along this northern rim of the cotton belt.

The two varieties singled out for special study were *Oklahoma Triumph,* a variety producing rather large bolls with three, four, and five locks to the boll,—the five-lock bolls being less than 40 per cent of the total for the plot, and *Trice,* a variety producing bolls of the same general character as to number of locks, but somewhat smaller and maturing earlier. In the preliminary studies not a single plant was observed among the 55 varieties which produced five-lock bolls only, and as stated above, the number of five-lock bolls was less than 40 per cent for the plot count in the two strains selected.

Bolls with five locks are generally larger and may produce 10 to 11 per cent more lint than those of 4 locks.

A brief statement of results shows that for 1934 there were 33 plants bearing five-lock bolls only, and the percentage of five-lock bolls for the plot was 92; in 1940, the number of plants beaing 5 locks only was 312, while the percentage of 5 locks was 96.

The results show a consistent increase in the number of five-lock bolls per plant as well as in the number of plants growing 5 locks only.

8. Further Work on the Effect of Indole-acetic Acid on the Vegetative Propagation of *Castanea, Albizzia* and some Ornamental Gymnosperms.

Albert L. Delise; *College of William and Mary.* (Read by title.)

9. Books on Botany, Gardening, and Agriculture in the Library of Thomas Jefferson.

Edwin M. Betts; *University of Virginia.* (10 min.)

A brief description of Jefferson's library is given with a list of the more important books on botany, gardening, and agriculture. Extracts from letters are read to show his interest in certain books.

10. Developing a Wilt Resistant Spinach Variety for Virginia.

T. J. Nugent and Harold T. Cook; *Virginia Truck Experiment Station.* (Lantern, 10 min.)

Fusarium wilt of spinach has become increasingly destructive in Virginia during the last ten years. This disease causes a root decay and also a vascular discoloration of the root that leads to wilting, stunting and eventually the death of the plants. The greatest damage is caused to the early fall planted spinach, the plants being killed soon after the stand has been thinned. It also causes considerable damage to spinach that is not harvested until late in the spring.

Since wilt is caused by a fungus that is capable of living for long periods as a saprophyte in the soil, the most practicable method of control is by the use of a resistant variety. In 1936, selections of resistant plants were made in a severely infected field of Virginia Savoy spinach. Seed from these plants were planted in the same field early in the fall of 1937 and further selctions were made for resistance. The same procedure was followed in 1938 and 1939. By 1940 a strain of Virginia Savoy had been obtained in which only 30 per cent of the plants were killed by wilt as compared with a 67 per cent loss in a regular commercial strain of the same variety. Seed of this wilt resistant strain will be tested in commercial fields in 1941 and probably released for general use the following year.

11. Developing Wilt Resistant Watermelons for Virginia.

Harold T. Cook and T. J. Nugent; *Virginia Truck Experiment Station.* (Lantern, 10 min.)

Watermelon, wilt, which has been known since 1894, became a serious limiting factor in the production of this crop in the Smithfield area about 1933. Tests of available wilt resistant varieties and a watermelon breeding project were begun by the Virginia Truck Experiment Station in 1934 in order to obtain suitable wilt resistant varieties for use in Virginia. Three varieties, the Klondike R7, Leesburg, and Hawkesbury were recommended for use in Virginia in 1938. The Blue Ribbon variety is being distributed this year for trial by growers. A number of hybrids developed by the Virginia Truck Experiment Station are being tested under commercial conditions this year. The watermelon project has now been expanded to include breeding for a variety that is resistant to both wilt and anthracnose.

12. Cytology and Genetics in the flax genus, *Linum.*

Charles Ray, Jr.; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

The aim of this study was to discover what fresh insights into the problems of mode of origin, evolutionary relationships, and type of differentiation of the species of *Linum* could be attained by a comparative study of the chromosomes of the species, observations of interspecific hybridization atempts; and intraspecific hybridization.

A study of the chromosome number and chromosome size of eighty-six collections, including thirty-one species reveals that there are differences in chromosome morphology as well as in chromosome number. The five different haploid numbers established for the genus are: 8, 9, 10, 14, and 15. The groups of chromosomes fall into three different size groups. Taking chromosome number and size group together, seven different karyotypes are recognized.

With few exceptions, the evidence from the cytological study of the species confirms the taxonomic relationships made on the basis of morphological studies.

The chromosome number of commercial flax, *L. usitatissimum*, is: $n = 15$ and $2n = 30$. If there are races which have other chromosome numbers they are rare.

The most frequent haploid number in the genus is 9 (50% of those studied). The next most frequent number is 15 (22%). The other haploid number 8, 10, and 14 taken all together account for but 28% of the species.

Hybridization of the varieties of *Linum usitatissimum* L. indicates that flower color, flower size, seed color and capsule dehiscence are determined by multiple factors. Ciliation of the false septa in the capsules is determined by a single factor, with ciliation dominant.

Heterostylism in *Linum grandiflorum* and in *Linum austriacum* is determined by a single factor difference.

A total of 3,236 crosses were attempted between ten of the species. Hybrids were obtained only in the cross *L. usitatissimum X L. angustifolium* and its reciprocal. Two causes of incompatibility of the species have been recognized: non-functioning of pollen on foreign pistils and arrested development of hybrid embroys. The possibility of obtaining hybrids from species incompatible for the latter reason exists, if immature embryos are removed from the plant and cultured in nutrient solutions.

13. Genetic Studies on Wild and Cultivated Watermelons *(Citrullus)*.

Orlando E. White; *The Blandy Experimental Farm, University of Virginia.* (Lantern, 15 min.)

Most authorities on the origin of cultivated plants regard the watermelon *(Citrullus vulgaris)* as having originated from certain wild types present today in Tropical and South Africa. These types are commonly known by their native names, *tsama*, or *tsamma*, *kengwe*, *keme*, and *mokate*. The writings of Livingstone, Anderson, Harvey, Passarge, Jameson, Wilson, and Murray, Barth, Burton, and Cameron describe either semi-wild or wild types as present south of the Sahara. A number of these authors as well as some very recent ones, describe the abundance in certain years of these fruits in the Kalahari desert. According to Passarge, this wild type reaches its northern limit in the Kalahari desert region. These wild melons exhibit numerous variations, one of the most striking being their range in flavor from intense bitterness, through insipidness, to intense sweetness.

The colocynth or bitter watermelon has a much wider native range. According to Vavilov and Post, it is common in desert regions of central Asia, through Egypt, and northern Africa. It closely resembles the watermelon in general characteristics and has been shown by Whitaker and others to readily cross with it. There seems to be no question about its being a native of the Old World regions, since it was known to the ancient Egyptians as a drug. Whitaker showed that it has the same chromosome number as the common watermelon, $n = 11$.

Recently, Carrier in "Beginnings of Agriculture in America" has indicated his belief that the sweet watermelon was native to America and domesticated by the Indian. The writer reviews Carrier's arguments and concludes from his own studies that the domesticated watermelon is a mutation from the bitter watermelon; that this mutation occurred and survived in the Kalahari desert regions of South Africa. It remained unknown to the ancient Greeks and Romans and to some of the early African travelers because of its relative inaccessibility and because of the barrier of the Sahara desert. Speculatively, the author believes it was distributed in early times through the primitive South African tribes' contact with the Portuguese, who brought it to Brazil, from whence it was eagerly taken up by the American Indian tribes, since it grew so efficiently on new land. The author describes some preliminary genetic work involving crosses between colocynths, citrons, and these wild melons, which may throw further light on this subject.

14. The Embryology of *Crepis capillaris.*

Ladley Husted; *Miller School of Biology* and *The Blandy Experimental Farm, University of Virginia.* (Read by title.)

The development of the embryo of *Crepis capillaris* follows the "Aster type". Both cells of the 2-celled stage contribute to the formation of the embryo. Numerical data are recorded which show that development takes place in a definite and regular manner and that up to the latest stage where cells may be accurately counted each cell of the 2-celled stage has contributed an approximately equal number of cells to the developing embryo. By means of a chromatid deficiency induced by X-ray treatment of the fertilized egg and subsequent study of the chromosomes in cells of the 6-day embryo derived from the treated egg, it is shown that the basal cell of the 2-celled stage produces approximately one-third of the volume of the 6-day embryo and the apical cell two-thirds. The basal region of the 6-day embryo, including the region from which the shoot system may be later differentiated, contains cells deficient for a part of the long arm of chromosome "A". The cells of the cotyledons contain a normal chromosome complement. The possibility is suggested, that in Crepis the new plant is derived entirely from the basal cell of the 2-celled proembryo and that the apical cell contributes to the formations of transitory structures such as cotyledons.

Zoology Division

SATURDAY, MAY 3—9:00 A. M.

1. Further Notes on the Control of the Pea Aphid.

Harry G. Walker and L. D. Anderson; *Virginia Truck Experiment Station.* (Lantern, 15 min.)

Eighty per cent free nictoine, when properly applied at the rate of three pounds per acre with *Standard Vaporizer Unit,* has continued to give excellent control of the pea aphid. Derris-talc dusts containing from 0.75 to 1.0 per cent rotenone, when appled at the rate of 35 to 40 pounds per acre, have given excellent control in some instances and poor control in others. Derris sprays have Atomized Oils containing rotenone and nictoine have given high kills of the aphids hit. However, due to the difficulty of securing complete coverage of the infested plants with the equipment available, these treatments have not given entirely satisfactory results. Preliminary test with a *Lethane* (an ailphatic thiocyanate)-derris dust indicate that the addition of about 2 per cent of Lethane to a derris-talc dust will increase the toxicity of the dust for the control of the pea aphid.

2. Coloration Studies on *Melanoplus bivittatus* Say.

James McDonald Grayson; *Virginia Polytechnic Institute.* (Lantern, 20 min.)

Work begun at the Iowa State College in 1939, pertaining to the occurrence of two distinct color types of the grasshopper, *Melanoplus bivittatus,* is being continued in Virginia. The yellow pigment primarily responsible for the variation in color type was identified by spectroscopic and chemical analysis. Quantitative estimates were obtained of the intensity of the yellow pigment. Investigations were made of the effects upon the coloration of the

grasshoppers of such factors as high or low temperatures, rearing under crowded or solitary conditions, rearing in darkness or light, rearing under lights of different color, and high or low humidity. Data were obtained on the offspring of the F_1 generation arising from mating typical males and females of each color type.

3. Ecological Observation on the Ribbed Mussel, *Volsella demissus.*

J. H. Lochhead; *Virginia Fisheries Laboratory* and *College of William and Mary.* (Lantern, 15 min.)

A study has been made of the distribution and habitat of this mussel in Virginia. On the Sea-side of the Eastern Shore it occurs in marshes lying in the upper half of the inter-tidal zone. Many of the mussels here are found in characteristic raised clumps, in which they are embedded among the roots of a luxuriant growth of reeds. The age of these clumps is thought to be considerably greater than that of individual mussels. On the shores of Chesapeake Bay the mussels are largely restricted to a narrow strip running along reed-covered banks. Sometimes they are found in other locations, for example in muddy oyster rocks above the low tide line.

4. Recent Fossil Discoveries in Burkes Garden, Virginia.

George Gose Peery; *Roanoke College.* (Lantern, 5 min.)

Location of Area

Burkes Garden is in the southwestern part of Virginia, in Tazewell County. It is about fifty miles northeast of Bristol, Virginia, and about forty miles southwest of Bluefield, West Virginia.

Topography

The name "Burkes Garden" applies to an area ten miles long by seven miles wide. It is a relatively flat, rolling, blue grass area, noted for its great fertility and for its fine cattle. It is completely encircled by a mountain chain, through which there is only one narrow gap, serving as an outlet for all the drainage from the region. Some of the peaks of the enclosing range reach an altitude of nearly five thousand feet.

Geology

Burkes Garden is a dome-like anticline of sedimentary rocks which range in age from early Ordovician to early Silurian. The oldest rock is Beekmantown limestone, thrust up almost in the center of the floor of the bowl-like area. On all sides this is flanked by an upthrust of Stones River limestone. Encircling this and forming most of the floor of the area is about four hundred feet of red and greenish mottled mudstone. Flanking this is Lowville and Moccasin limestone. Peripheral to the latter, and lying next to the base of the mountain all around, is Martinsburg Shale. Juniata sandstone makes up the mountain side facing the Garden, while from the top of the mountain down on the opposite side is Clinch sandstone, the latter two being of Silurian age.

Location and Description of Fossils in Question

One of the fossils in question is found in Clinch sandstone on top of the mountain. They are about the size and shape of a good-sized Earthworm and are definitely segmented. These fossils are not uncommon. They were first described as fucoids under the name Fucoides alleghaniensis, and were believed to be plants. Later they were described as worm borings and were given the name Arthrophycus alleghaniensis. The formations shown are regarded as casts of worm borings. Whether the worms were Annulata or not is not known. One authority whom I have consulted has called these fossils crinoid stems.

The other fossil to be described was found probably in Lowville limestone, of Ordovocian age, in the floor of the Garden area. These appear as distinct impressions on the surface of the exposed rock, varying in size from three to six inches in length, from one-half to three-fourths inches in width, and from one-quarter to a half inch in depth. They show no signs of branching or segmentation. Authorities seem to be in disagreement as to their identity. The following are some of the identifications: trails and casts of Benthonic invertebrates, Bryozoans or worm castings, formations due to sedimentation or weathering, and fucoids.

Comments

Knowledge of these forms seems very vague and indefinite. The names appear to have no particular significance. Their biological relationships are very uncertain, even as to whether they are plants or animals.

5. A Study of the Brown Thrasher, *Torostoma rufum.*

Edna E. Becker; *Hollins College.* (Lantern, 15 min.)

A life history study of the brown thrasher, with emphasis on the nesting habits as observed in an intensive study of the five pairs of thrashers which nested on the campus of Hollins College during the season of 1940, was made. The literature on the thrasher was reviewed and incorporated into the work, as well as the findings from a study of the banding records on file at Washington, D. C. Check-up was made on the nesting birds banded at Hollins College in 1940 and which returned to the same territory for a second season.

6. On the Biology of Male Mosquitoes.

Kenneth B. M. Crooks; *Hampton Institute.* (Lantern, 10 min.)

7. A New Hymenolepid Cestode from the Shrew.

Arthur W. Jones; *University of Virginia.* (Lantern, 10 min.)

8. Preliminary Cytological Observation in Trematodes.

H. Grady Britt; *University of Virginia.* (Introduced by B. D. Reynolds.) (10 min.)

A preliminary cytological study has been made of several species of trematodes from three families. Observations made in this study show that there are differences in chromosome numbers, morphology, and configurations between genera of the same family and between genera of different families. It is believed that this evidence will be useful in determining the true taxonomic relationships of species assigned to the various family groups.

9. A Study of Abdominal Hernia in the Frog, *Rana catesbeiana.*

Thomas G. Hurdle; *Roanoke College.* (Introduced by Myron E. Henderson.) (Lantern, 5 min.)

Subject

The subject of the study is a large female bullfrog, *Rana catesbeiana.* The bullfrog is of normal adult size and measures 38 cm. In length and 15 cm. in width. Externally the frog shows no signs of deformity or stunted growth. There are also no scars on the skin of the abdomen showing that the skin has been broken.

Background

I know nothing at all of the background of the frog. It was purchased from a biological supply house and there is no record of its environment, heredity, or age. The frog had been preserved and injected.

Condition

The frog possesses an extreme case of abdominal hernia. When the skin of the abdomen was removed about half of the internal organs were exposed. The pyloric portion of the stomach, the duodenum, the urinary bladder, the right oviduct, and the right ovary lie between the skin and the abdominal muscular wall. They occupy the large sub-cutaneous lymph sinus covering the abdomen.

These organs protrude through a circular opening about 2 cm. in diameter in the abdominal muscular wall. There is no adhesion of the muscles to the protruding organs. The opening is in the right rectus abdominis and the right obliquus externus muscles. The esophagus, which is abnormally elongated, part of the cardiac portion of the stomach, and the ileum are inside the abdominal cavity. These organs, as well as the remainder of the reproductory organs, and the excretory organs occupy their normal position in the body.

Possible Causes

It is very apparent that the frog lived for some time in the above described condition. The hernia might even be embryonic in origin. It is possible that the duodenal loop ruptured the muscles when it first elongated in the tadpole stage.

A second and perhaps more plausible possibility is that the frog struck a pointed object when it landed after a long jump at a period when the ovaries were greatly distended with eggs. The sudden external pressure could have ruptured the muscle without breaking the skin.

Occurrence

Biological supply house estimates that abdominal hernia occurs in about two specimens per thousand, or less. None of these seem to be quite as extensive as the specimen just described.

10. A Transitory Membrane in the Formation of Midgut in the Cockroach, *Blattella germanica.*

Lincoln C. Pettit; *Washington and Lee University.* (Lantern, 15 min.)

Recent discoveries associated with the formation of mid-gut epithelium in several species of insects stimulated investigation of the unsolved problem of this tissues origin in the common household cockroach.

Using a technique which preserved the delicate yolk, a temporary membrane was found between yolk and embryo from the time of coelomic sac disintegration to blastokinesis. The nuclei are minute, and the membrane itself is less than one micron thick. After blastokinesis, the influx of cells obscures the membrane, and its identity is lost when splanchnic mesoderm cells proliferate dorsad to cover the yolk.

The origin of cells which form the transitory membrane is not clear. The cells appear at the time of the disintegration of coelomic sacs, suggesting that they have "inner layer" (mesodermal) origin. There is no connection of the membrane with the ectoderm. The definitive mid-gut epithelium forms as two cups at the stomodaeum and proctodaeum late in development; these cups grow toward each other inside the cells which cover the yolk at the time. Vitellophags have no part in mid-gut epithelium formation, nor do they contribute to the transitory membrane. The sub-oesophageal body, double and mesodermal in origin, does not take part in forming cells for the membrane or epithelium. The cells of the transitory membrane are distinguishable from 160 hours to 200 hours in the total developmental time of 495-506 hours at 80° F.

11. *Haptophyra plethodonis,* a New Species of Astomous Ciliate Found in the Intestinal Tract and Gall Bladder of *Plethodon cinereus* Green and *Pletodon glutinosus* Green.

Martha H. Lipscomb; *Thomas Jefferson High School and The Mountain Lake Biological Station.* (Lantern, 10 min.)

Haptophrya plethodonis, described in this paper is found to be a new species. It more nearly resembles *H. michiganensis* and *H. virginiensis* than any other members of the genus. However, it is found to be different from *H. michiganensis* because of its smaller size, proportionately larger macronucleus, existence of longer and more persistent chains, and the lack of a definite micronucleus. It is found to be different from *H. virginiensis* because of its greater size, the existence of an endoplasmic cone, and the vacuolated appearance of the macronucleus. The fact that *H. Plethodonis* is found in an entirely different host and in a different location in the host also distinguishes it from *H. virginiensis.*

12. *Plagiostomum dahlgreni* n. sp.

William A. Kepner, M. A. Stirewalt, and F. F. Ferguson; *University of Virginia* and *Flora McDonald Norfolk Branch of the College of William and Mary.* (Lantern, 10 min.)

Plagiostomum dahlgreni n. sp. Anatomy described. Each eye is provided with a retinula that presents rhabdome, ellispsoid, and myoid as in the retinula of vertebrates. Transfer of spermatozoa from one animal to the other, is effected through wounds, made in the epidermis at indifferent regions, by an ensheathed penis, which is armed by battines of aciula.

13. The Butterflies of Roanoke and Montgomery Counties.

Carroll E. Wood, Jr. and Carl W. Gottschalk; *Roanoke College.* (Introduced by Myron E. Henderson.) (Lantern, 10 min.)

A list of the 104 species and subspecies of butterflies occurring in Roanoke and Montgomery Counties, Virginia, with dates and places of capture, is presented. Of these, 92 are known from Roanoke County and 93 from Montgomery County, leaving 23 probably occurring in both counties, but known only from one or the other. Special attention is drawn to the faunal zones, Upper Austral, Transition and Canadian, occurring in the area, and species characteristics of these zones are mentioned. Overlapping of the zones is mentioned. Kodachromes of some of the more interesting and showy species occurring in the region are shown.

Minutes of the Section Of Chemistry

W. G. Guy, *Chairman*

F. H. Fish, *Secretary*

FRIDAY, MAY 2—9:30 A. M.

1. The Chemist in War.

Leonidas R. Littleton; *Emory and Henry College.* (15 min.)

The earliest weapons used in war were physical and not chemical. Stones, clubs, spears, and arrows were first used, later, burning pitch, sulphur, and crude petroleum. Potassium nitrate was probably the first explosive to be used by Arabians. Chinese used Roman candles to frighten their opponents. Full use of the energy of explosives was long in being utilized because guns could not be made strong enough to use it. First shells were used against ships and masonry as men could run away before they exploded.

Two classes of explosives, propellants and high explosives. Compressed air, motors, and smokeless powder chief propellants. Nitro-glycerine, picrates, and TNT chief high explosives.

War gases include smoke screens, sneeze powders, lacrymators, and vesicants.

Incendiary bombs of various kinds are much used.

The product of the chemist is not only used for destruction but also to relieve suffering, improve sanitation, make safer airplanes and autos, etc.

2. Vapor Phase Catalytic Hydrolysis of Halogenated Hydrocarbons.

James W. Cole and Lester Van Middlesworth; *University of Virginia.* (10 min.)

A preliminary report on the catalytic hydrolysis of chlorobenzene and bromobenzene in the temperature range 300-700° C. under ordinary pressures. The experimental results will be presented from the viewpoint of effect of temperature and a series of inorganic catalysts on the hydrolysis of the halogenated compound to the corresponding hydroxy compound.

3. The Straus Reaction on Hydroxycodeinone.

Harris W. Bradley and Robert E. Lutz; *University of Virginia.* (10 min.)

Phosphorous pentachloride converts hydroxycodeinone, an α,β-unsaturated ketone, into a complex mixture from which seven compounds have been isolated. One is monochlorinated, two are dichlorinated (probably ketochlorides with the 14-hydroxyl group intact), three are trichlorinated (probably 14-chloroketochlorides). The seventh apparently is a pentachloro derivative.

14-Bromo- and the hitherto unknown 14-chlorocodeinone were made in or-

der to find an alternative approach to this series and to determine the physiological activity of the latter as compared with the extreme toxicity of bromocodeinone. Chlorocodeinone was prepared in 80% yield by the action of phenyliododichloride on thebaine. Formation of the same hydroxycodeinone oxime from both the chloro- and bromocodeinones proves that the chlorine occupies the 14 position. 14-Chlorocodeinone differs from the monochlorinated product from hydroxycodeinone. Physiologically, in contrast to bromocodeinone, chlorocodeinone shows no more toxicity than the normal morphine derivative. Attempts to hydrolyze both the chloro- and bromocodeinone and to prepare polyhalogen derivatives by phosphorus pentachloride action were unsuccessful.

Quantities of the individual materials suitable for further investigation are in preparation according to the original method. A procedure has been developed giving 60% yields of crude crystalline mixture which will be separated by fractional crystallization and by taking advantage of the varying degrees of basicity of the several products.

4. Lantern Slides of Crystals.

Warren W. Williamson and Harriett H. Fillinger; *Hollins College.* (15 min.)

"Permanent" lantern slides of actual crystals suitable for demostration in elementary courses have been prepared. Some points on the technique of preparing such slides will be discussed and representative slides will be shown.

5. Application of Physico-chemical Methods of Analysis to the Chesapeake Bay Waters.

A. R. Armstrong; *College of William and Mary* and *Virginia Fisheries Laboratory.* (20 min.)

The College of William and Mary and the Virginia Commission of Fisheries have established the Virginia Fisheries Laboratory for a biological study of the Chesapeake Bay waters.

Fluctuations in abundance of plants and animals in water are governed by the physical and chemical factors of the environment.

The dominant physical factors that affect life present are the estuarine character of the water and, in the summer months, pronounced stratification.

Chemical factors include the dissolved gases, oxygen and carbon dioxide, the nutrient salts, e.g., phosphates, and substances whose effect on plant and animal life is as yet unknown.

Methods now in use for the quantitative estimation of certain of these chemical factors will be presented.

6. The Determination of Glycogen in Oysters.

A. R. Armstrong; *College of William and Mary* and *Virginia Fisheries Laboratory.* (10 min.)

The rate of hydrolysis of oyster glycogen was studied in relation to acid concentration and temperature; this is compared to the rate of hydrolysis of glycogen from other sources.

The centrifuge has been applied to the glycogen determination to shorten the procedure.

Changes in filycogen content of the oyster carcass under commercial storage conditions has been determined.

7. New Quinoline Derivatives in Chemotherapy.

Alfred Burger, Luther R. Modlin, Jr., Stanley E. Krahler and Kenneth Bass, Jr.; *University of Virginia.* (15 min.)

The established effect of quinoline derivatives containing basic side chains in chemotherapy prompted the synthesis of a number of new substances in this series as potential chemotherapeutic agents. The kerosene base 2,3,8-trimethylquinoline from California petroleum, and 2-hydroxy-4-methylquinoline (2-lepidone) which has recently become available industrially, served as starting materials for our investigations. The use of these bases made unnecessary ring closure of the quinoline nucleus as it had been done hitherto in most quinoline therapeutics. The materials for the introduction of the side-chains were mostly new aliphatic polyamines, and polyethylene glycols, and some of their derivatives. The synthesis of 5-hydroxy-6-amino-2,3,8-trimethylquinoline has been accomplished; diazotization of this compound furnished a diazooxide derivative which gave 2,3,8-trimethylquinoline-5,6-quinone dioxime with hydroxylamine; dehydration of the dioxime gave a furazan derivative. Hydrogenated phenolic and amino derivatives of the kerosene base have been prepared. 2,3,8-Trimethyl-5-quinoly-N^1-sulfanilamide (m. 218 – 9°) was prepared by hydrolysis of its N^4-acetyl derivative (m. 253 – 5.5°); likewise, 2,3,8-trimethyl-5-methoxy-6-quinolyl-N^1-sulfanilamide (m. 230°) was obtained from its N^4-acetyl derivative (m. 274°). The reaction of 2-chlorolepidine with diethylene glycol yielded β-(2-oxylepidine-ethyleneoxy) ethanol (oily; hydrochloride, m. 151.5 – 3.5°) which could be converted to β-(2-oxylepidine-ethyleneoxy) ethyl chloride (hydrochloride, m. 125.5 – 8.5°), and 2-lepidyldioxyethylene-2-oxylepidine (m. 121°; hydrochloride, m. 140 – 2°; dinitro derivative, m. 210.5, diamino derivative, m. 214°). N-Aminoethylmorpholine and 2-chlorolepidine yielded N-2-lepidylaminoethyl morpholine (dihydrochloride, m. 272 – 3° [dec.]), piperazine 1,4-(bis-2-lepidyl)piperazine (m. 236.5 – 7°; dinitrate, m. 183 – 6° [dec.]; dihydrochloride, m. 316 – 7°; dinitro derivative, m. above 350°). From the reaction mixture of diethylene triamine and chlorolepidine, diethylene-tri-(2-lepidyl)amine (m. 186 – 6.5°) was separated. Seven of these compounds are being tested for chemotherapeutic activity.

8. The Synthesis of Some Iodinated Aromatic Compounds.

Louis Long, Jr. and Alfred Burger; *University of Virginia.* (10 min.)

A series of aromatic idoine compounds have been prepared for biological experimentation in order to study their application to clinical x-ray visualization and chemotherapy.

N^1-2,4-Diiodosulfanilamide was made from 2,4-diiodoaniline to be tested for use as a chemotherapeutic agent. 2,4-Diiodophenylurea was prepared from the same starting material but proved too water-insoluble for X-ray application. However, the sodium salt of 2,4-diiodophenylglycine was sufficiently water-soluble and was obtained in moderate yield from the iodination of phenyl-glycine. The failure of 2,4,6-triiodoaniline to react under similar conditions is attributed to steric hindrance.

A series of dialkylaminoalkyl ethers of 2,4,6-triiodophenol was also made with reasonable yields. By application of the Williamson ether synthesis sodium 2,4,6-triiodophenolate was condensed with 1-diethylamino-2-chloroethane, 1-diethylamino-3-chlorobutane, and 1-diethylamino-3-chloropentane to yield 1-diethylamino-2-(2,4,6-triiodophenoxy)ethane, 1-diethylamino-3-methyl-3-(2,4,6-triiodophenoxy)propane, and 1-diethylamino-3-ethyl-3-(2,4,6-triiodophenoxy)propane, respectively. The combination through an ether linkage of a highly iodinated aromatic nucleus and a dialkylaminoalkyl side-chain represents a new type of compound for biological experimentation in chemotherapeutics.

9. The Effect of Cold Rolling on the Acid Corrosion of Certain Alloys.

J. A. Addlestone and M. W. Duke; *Virginia Polytechnic Institute.* (10 min.)

The corrosion rates of Monel, 18-8 stainless steel, 4% phosphor bronze, and 8%phosphor bronze were measured in 5% sulphuric acid and 5% nitric acid. Temperature, rate of aeration, rate of motion of sample, and concentration of the corroding solution were closely controlled. Corrosion rates were obtained for different specimens of the same alloy which had been cold rolled to obtain different hardnesses. This investigation shows that there is no appreciable difference in the corrosion rates of these alloys in 5% sulphuric acid over the range of hardness studied. The corrosion rates in 5% nitric acid are somewhat inconsistent and this phase is to be further investigated.

10. Mono and Dienol Acetates of 1,2,4 Trimesitylbutanedione—1,4.

Vernon R. Mattox and Robert E. Lutz; *University of Virginia.* (15 min.)

Theoretically there should be four cis-trans monoenols and four cis-trans dienols of 1,2,4-trimesitylbutanedione-1,4. It has been possible to isolate only one monoenol and one dienol; others have been characterized as magnesium enolates, but in the free state either ketonize, oxidize, or furanize before they can be crystallized. The object of this investigation is to prepare crystalline derivatives of these, acetates or benzoates, in which the structure is fixed.

The cis and trans forms of 1,2,4-trimesityl-1,4-butanedione-4-magnesium enolate reacted with benzoyl chloride or with acetyl chloride to give stereoisomeric compounds which differed in their ease of hydrolysis. One type involves oxygen acylation. The other gives reactions characteristic of either an oxygen acyl or carbon acyl compound, and an attempt is being made to decide between these two alternatives by preparing the carbon acyl compound by another method.

Of the two possible 1-monoacetates, one has been prepared by treating the 1-magnesium enolate with acetyl chloride. It has not been possible to prepare the stereoisomer which in the free state is known to furanize readily.

Two of the four possible diacetates have been prepared. Attempts will be made to transform these into the other cis-trans forms by sunlight reactions and to partially hydrolyze these to monoacetates.

11. The Action of Some Gases on the Surface of a Single Crystal of Copper: I. Single Gases; II. Catalytic Reaction Between Two Gases.

Allan T. Gwathmey; *Department of Chemistry, University of Virginia.* (20 min.)

Many phenomena, such as corrosion, contact catalysis, adsorption, thermionic and photoelectric emissions are dependent on, or influenced by, the action of gases on metals. It is therefore important to understand the mechanism by which gases and metals interact.

Experiments have been conducted on the effect of gases on the surface of large single crystals of copper made in the form of a sphere and specially surfaced. It is hoped that from a knowledge of the behaviour of these large

single crystals information can be obtained which will be of value in understanding the surface properties of polycrystalline metals as ordinarily used.

The action on the metal surface of both single gases and combinations of gases which react catalytically on the surface has been studied. Two main effects have been observed. In the case of oxidation the rate of the reaction was found to vary with the crystal plane along which the surface was prepared. In the case of a catalytic reaction between gases, a rearrangement of the metal atoms in the surface took place and, in some cases, facets parallel to preferred crystal planes could be identified. A different type of pattern was obtained for each combination of gases tested, showing that the type of surface exposed varied with the nature of the gases.

Third Symposium on Organic Analytical Reagents

FRIDAY, MAY 2—2:00 P. M.

12. Introduction.

    John H. Yoe; *University of Virginia.* (10 min.)

13. A Summary Report on 250 Organic Compounds.

    W. J. Frierson and P. M. Simpson; *Hampden-Sydney College.* (5 min.)

14. A Report.

    W. H. Wrenn and F. H. Fish; *Virginia Polytechnic Institute.*

The use of Bz. 2 Oxybenzanthrone as an acid base indicator has been established. Full report to be published elsewhere.

15. A Progress Report.

    Jean L. Larner and Wm. E. Trout, Jr.; *Mary Baldwin College.* (5 min.)

16. A Progress Report.

    Edwin C. Markham; *University of North Carolina.* (5 min.)

17. The Salogenic Organic Compounds.
    L. A. Sarver; *American Viscose Corporation.* (20 min.)

18. A Progress Report.

    O. W. Clark, Jr., R. M. Irby, Jr. and Ira A. Updike; *Randolph-Macon College.* (5 min.)

19. A Progress Report.

    J. R. Taylor; *Washington and Lee University.* (5 min.)

20. Some Complex Compounds of Copper, Silver and Mercury with Ethanolamines.

J. W. Cole and M. Brook Shreaves; *University of Virginia.* (15 min.)

21. A Progress Report.

E. Louise Wallace and A. R. Armstrong; *College of William and Mary.* (5 min.)

22. A Progress Report.

Thomas B. Crumpler and Earl B. Claiborne; *Tulane University.* (15 min.)

23. A Progress Report.

W. E. Clark and L. R. Stallings; *Virginia Military Institute.* (5 min.)

SATURDAY, MAY 2—9:00 A. M.

24. β-Monoalkylaminoethyl Alkoxybenzoates as Local Anesthetics.

J. Stanton Pierce, J. M. Salsbury, and J. M. Fredericksen; *University of Richmond.* (15 min.)

β-Monoalkylaminoethanols have been prepared and condensed with alkoxybenzoyl chlorides to yield β-monoalkylaminoethyl alkoxybenzoates. All of the amino esters thus prepared were isolated as the hydrochlorides. Most of these hydrochlorides have some local anesthetic action.

25. The Electrolytic Preparation of Bromoform and Iodoform.

J. B. Lucas and Irving Gray; *Virginia Polytechnic Institute.* (10 min.)

The purpose of this work was to simplify the electrolytic preparation of these compounds so as to make them suitable as laboratory preparations for a course in general organic preparation. Water solutions of potassium iodide and acetone (or ethanol) made slightly alkaline with sodium carbonate gave fair yields of iodoform. All our efforts to make bromoform resulted in a low yield and was complicated by the presence of bromoacetaldehyde or bromoacetone which have properties of lacrymators.

26. Structural Models of Cortin Compounds. I. 1,6-Disubstituted Hydronaphthalenes.

Louis Long, Jr. and Alfred Burger; *University of Virginia.* (10 min.)

The two most potent crystalline compounds isolated from the suprarenal cortex have been desoxycorticosterone and corticosterone. It has been shown that the ketol side-chain and the α,β-unsaturated ketone group are essential parts of the molecule for the production of the cortin effect. It is the purpose of the present research to synthesize an analog of desoxycorticosterone, Δ^5-6-keto-1-(1′-keto-2′-hydroxyethyl)octahydronaphthalene,

in which a decahydronaphthalene skeleton will be substituted for the cyclopentanophenanthrene structure.

Two routes to the desired compound have been attempted. In one, 6-methoxy-/-tetralone has been hydrogenated to 6-methoxy-/-tetralol, b.p.$_1$ 109° (α-naphthylurethane, m.p. 130 – 131° [dec.]), and attempts have been made to convert the latter compound to 6-methoxy-/-tetrahydronaphthoic acid via the bromide and nitrile. Using hydrogen bromide, only 6-methoxy-1,2-dihydronaphthalene, m.p. 73 – 74°, could be obtained, due to the ease of dehydration of the secondary alcohol group in the alpha position. In the other, hydrogenations of 6-hydroxy-1-naphthoic acid to 6-hydroxy-1-decahydronaphthoic acid has been tried. A new method of synthesis of 6-methoxy-1-naphthoic acid from 6-methoxy-1-iodonaphthalene was accomplished through the nitrile in satisfactory yield. Various methods of hydrogenation have been tested using platinic oxide as a catalyst at room temperature and atmospheric pressure. These include glacial acetic acid as a solvent, absolute ethanol, ethanolic hydrogen chloride, and ethanol-acetic acid mixtures. The results of these investigations are discussed. The reactions to be used for the synthesis of the ketol side-chain and the α,β-unsaturated ketone group are also described.

27. The Effect of pH on the Drying of a Sulfonated Product.

R. A. Fisher and H. N. Nix; *Virginia Polytechnic Institute.* (10 min.)

A study has been made of the effect of varying the pH of the original solution on the physical condition of the products when drying a commercial wetting agent on a double roll drum dryer. The product was desired in a flake form but was often obtained as a powder or in tight rolls. Its composition was that of the sodium salt of an alkylated benzene sulfonate, the side-chain being very long. It has been found that not only the form of the product but also its residual moisture content was affected by the pH of the solution fed to the dryer. When a solution at pH 10.1 was dried an excellent flaky product with low moisture content was obtained. An undesirable powdery product with high moisture content was obtained from a solution at pH 2.4.

28. Factors Influencing the Composition of Cigaret Smoke.

O. L. Hillsman; *American Tobacco Company.* (20 min.)

The transfer of a portion of the nicotine in the tobacco of a cigaret to the main smoke stream has been repeatedly demonstrated. Due to differences in smoking procedure, the amounts of nicotine reported differ widely. The present study shows the influence of the variables which affect this transfer and the limits between which the nicotine content may vary. The results have been presented graphically in an effort to make them readily available to those interested in, but unfamiliar with tobacco smoke research.

29. Cis-β-Aroyl Acrylic Acids and Related Compounds.

G. W. Scott and Robert E. Lutz; *University of Virginia.* (10 min.)

Trans isomers of β-aroylacrylic acids are known, but the existence of cis isomers has not previously been reported. The cis isomers of β-benzoylacrylic acid and of β-(p-bromobenzoyl)acrylic acid have been prepared and esterified. No evidence of any cyclic structure has been found.

β-Aroylacrylic acids contain an ethylene linkage which shows remark-

able ease of addition. Addition compounds of diazomethane, of methyl alcohol, and of hydrogen chloride to β-(p-bromobenzoyl)acrylic acid have been prepared.

Hydrolysis of either the cis or trans methyl ester of β-(p-bromobenzoyl)acrylic acid with alcoholic sodium hydroxide solution or treatment of the acrylic acid itself with sodium hydroxide yielded a dimolecular condensation product: 3-(p-bromophenacyl)-4-carboxymethyl-5-(p-bromophenyl)-5-hydroxyfuranone-2. On esterification, this furanone gave an open-chain diester which, on hydrolysis with concentrated hydrochloric and concentrated acetic acids, reverted to the hydroxy furanone. A series of potentiometric titrations of the furanone were carried out in order to confirm the cyclic-open-chain isomerism involved in the esterification reactions.

30. The Ring-Chain Tautomerism of Hydroxyfuranones Contain Alkyl Groups.

Ralph C. Downing and Robert E. Lutz; *University of Virginia.* (10 min.)

The investigation outlined below is a part of the program of study on the reactions of saturated and unsaturated 1,4-diketones. It is concerned particularly with that phase of the work which deals with the 1,2,4-triketone enol and hydroxyfuranone types and the ring-chain tautomerism involved.

The earlier work has involved compounds in which the substituent groups have all been aryl or aroyl. This report deals with the effect of substituting alkyl for aryl groups in the 2 and 5 positions.

To this end, 2-tert-butyl-4,5-diphenyl-2-hydroxyfuranone-3 was first made and studied since it was easily prepared from available materials. This compound was found to exist chiefly in the cyclic form as was shown by its failure to react with ferric chloride and diazomethane, the resistance toward ozonization, the stability of the 2-methyl ether toward bases, the low rate of bromine addition, and the ease of hydrolytic fission of the sodium salt.

During the preparation of 2-tert-butyl-4,5-diphenyl-2-hydroxyfuranone-3 the orientation of nitration to the beta phenyl group in the furan was determined. A further study of the orientation showed that bromination occurred in the alpha phenyl group in the furan but in the beta phenyl group in the hydroxyfuranone.

31. The β-Hydroxyfurans and Hydroxyfuranones with Particular Reference to the 2,5-Dimesityl Derivatives.

C. Edward McGinn and Robert E. Lutz; *University of Virginia.* (10 min.)

The β-hydroxyfurans are unstable and elusive substances. In solution they react with oxygen forming peroxides. Attempts to isolate them result in the formation of the more stable keto forms, namely furanones.

The bromomagnesium derivatives of 2,5-diphenyl-3-hydroxyfuran and 2,5-diphenyl-3-hydroxy-4-methylfuran are prepared by the action of the Grignard reagent on the corresponding acetoxyfurans. In both cases the bromomagnesium derivatives react with acetyl and benzoyl chlorides to regenerate the acetates and benzoates respectively. Hydrolysis of the bromomagnesium derivative of 2,5-diphenyl-3-hydroxyfuran and subsequent treatment with diazomethane gave a methyl ether.

The bromomagnesium derivative obtained from 3-acetoxy-2,5-dimesitylfuran reacted normally with acetyl chloride and benzoyl chloride to yield the acetate and benzoate respectively, but on hydrolysis gave 2,5-dimesityl-

2-hydroxyfuranone-3. This peculiar oxidation in what appears to be a reducing medium was shown to be absorption of oxygen from the air. The hydroxyfuranone is converted to the acetoxyfuran by the action of the Grignard reagent followed by treatment with acetyl chloride; this is essentially a reduction comparable with the reduction of an α-bromoketone by a Grignard reagent. A proposed mechanism for this reaction is 1-4 addition of methylmagnesium iodide to the oxygens of the α-hydroxyketone system with loss of methanol. Hydrolysis of the hydroxyfuranone gave the open chain isomer, 1,4-dimesityl-1,2,4-butanetrione enol.

32. Hydrolysis of Amides.

George Sands and A. I. Whitenfish; *University of Richmond.* (10 min.)

In an attempt to show that aminolysis is similar in nature to alcoholysis, a preliminary study has been made on the hydrolysis of certain amides at 200° C. Methods of analysis and data are presented.

33. Business Meeting and Election of Officers.

Minutes of the Section of Education

PAUL G. HOOK, *Chairman*

E. B. BROADWATER, *Secretary*

FRIDAY, MAY 2—10:00 A. M.

1. The Life and Work of Joseph Dupuy Eggleston.

   E. F. Overton; *University of Virginia.*

2. Higher Education for Women in Virginia.

   W. Hall Cato; *University of Virginia.*

3. A History of the Constitutional Provisions for Education in Virginia.

   R. A. Meade; *University of Virginia.*

This study gives the history of the constitutional provisions for education as found in the 1868 constitution, the 1902 constitution, and amendments to these. Major proposals for free schools prior to 1861 are traced. A picture is given of political events from 1861 to 1867 as a basis for explanation of the free school situation during these years. The discussion of the Congress of the United States as to free schools for the South is summarized, the implications of this discussion being stated. A description is presented of the development of the provisions of the 1868 constitution in the convention of that year, of the 1902 provisions in the provisions in the convention of that year, and of the amendments of the 1820's. The study concludes with an analysis and summary of these provisions.

FRIDAY, MAY 2—2:00 P. M.

4. Negro Education in Virginia.

   Fred M. Alexander; *State Board of Education.*

5. Ability of Virginia Counties to Support Schools.

   R. F. Williams; *Supt. of Smyth County Public Schools, Marion, Va.*

6. The Content for a Course in Social Mathematics for the Senior High School.

   Francis G. Lankford; *University of Virginia.*

7. Vocational and Educational Counseling with Adults.

John A. Mapp; *State Board of Education.*

The Richmond Consultation Service is operated by the State Board of Education with the cooperation of the National Youth Administration and the Virginia State Employment Service. The Service began its work in May, 1939, with a staff of four counselors and one psychological tester.

The Consultation Service was inaugurated as an experiment in adult education. It was designed to assist the out-of-school individual in making an adequate occupational adjustment and to develop methods, techniques, and plans for this type of education in Virginia. This Service is operated on a free basis to the individual in the same way that the high school and the Employment Service are free. Counselees come to the Service at the suggestion of the Virginia State Employment Service, Richmond agencies, etc. The largest source of intake is those persons with whom the Consultation Service counselors have advised and who suggest to others that they also come in for consultation.

The Richmond Consultation Service does not undertake to lay down a definite program guaranteed to assure future employment or success. On the other hand, it is intended to (1) discuss with individuals their previous training and work experience in relation to possible employment or additional training; (2) help them discover their special aptitudes and skills which may be useful in certain occupations with due regard to their personal potentialities; (3) discuss with them a satisfactory program which is related to their background, interests, and ambitions, and help them appraise their opportunities in various fields.

The Consultation Service is the only service of its kind in the State. Its staff has no connection with employers, schools, or social agencies. It does not directly find employment for anyone. Immediate and future employment opportunities naturally are considered when the counselor and counselee are deciding "what the counselee wants to do, what he can do, and how to go about doing it."

Staff counselors have been chosen on the basis of their variety of successful work experience in private industry, and their interest in and adaptability to personnel work.

The difficulties involved in evaluating this newer type of out-of-school, individualized education, complicated by many human and unpredictable forces, are multitudinous. The Service, to date, cannot be scientifically sure of its proportion of successes and failures or of the degree involved in either. Considerable follow-up work is being done from time to time where such work is practical and desirable. Every effort is made to keep adequate records, with the hope that eventually it will be possible for one or more outside experts to make an objective evaluation of the work accomplished. Much, however, has been done to date, including the establishment of a growing, up-to-date occupational information file and library, and it is felt that thus far the work of the Consultation Service has been highly successful in the relatively new field of realistic, out-of-school, vocational guidance.

Minutes of the Section of Engineering

DAN H. PLETTA, *Chairman*

PAUL S. DEAR, *Secretary*

FRIDAY, MAY 2—9:30 A. M.

1. Factors Controlling Commercial Utilization of Industrial Casein from Soybean Meal.

Leland M. Read and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

Soybean, with its constituent oil, protein and casein, and subsequent by-products has great commercial possibilities for industrial purposes. Various problems involved in isolating the casein from the seed were undertaken in this investigation. Prior to casein extraction, the oil must be removed. This can be accomplished by hot or cold expression, or by solvent extraction. Solvent extraction is now considered the most satisfactory method by which the oil can be removed, producing a meal suitable for casein extraction. Grinding, mixing, with the solvent, and controlling the pH and temperature offer little difficulty. It is the separation of the casein solution from the meal and the clarification of the solution which has given considerable trouble. Filtration has proven very unsatisfactory because of the mucilagenous material present inducing stoppage of the filter, thus preventing the further passage of liquid. A convenient method of separating the slurry is by continuous centrifuging, but this requires special and costly equipment. Precipitation of the casein from the alkaline solution by addition of a specific acid requires carefully controlled pH and temperature in order to secure a curd suitable for separation, washing and drying. Optimum conditions to reduce costs are obtained.

2. Cross-connection Pollution Hazards, and Methods of Detection.

Alvin F. Meyer, Jr.; *Virginia Military Institute.*

One common engineering fault that has lead to a major public health problem is inadequate design of plumbing and pipe connections. This paper shows two typical instances of what happens when cross-connections occur. One instance is that of a bank building in Shreveport, La.; another is that of a small town water supply. Bacteriological test results, and general design of cross-connection are discussed, as well as methods of following down cross-connections. Use of brilliant green dye and the chlorides test are discussed. Sterilization methods are shown, and the prevention of cross-connections by proper painting of all pipes in industrial and office buildings is also discussed.

3. Preliminary Studies in the Design of a Commercial Plant for the Purification of Tall Oil.

Jerome M. Crockin and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

Tall oil is a mixture of unsaturated fatty acids, containing dissolved rosin, which is obtained as a waste product from the spent cooking liquor of the Kraft pulp process. It is used widely in soaps, especially in Europe, and its fatty acid content forms the basis of its use in many commodities where more expensive fatty acids were once used.

The crude material is objectionable because of its dark color and unpleasant odor, caused by impurities. The classical method of purification is through distillation, although the high temperatures, the high vacua, and a persistent corrosion problem make this method a costly one.

A process employing small quantities of strong sulphuric acid gives promise of commercial success, and of eliminating many of the troublesome features of the distillation method. The product obtained is a limpid, straw-colored oil, which on standing yields clean abietic acid crystals. The development of the process is now in the pilot plant stage, construction of which is proceeding. A plant has been designed to produce about 1,000 pounds of tall oil per day on a continuous basis and should be in production soon. The present problem is to determine the operating variables in terms of commercial equipment and to estimate the process costs, before a commercial design is attempted.

Flow sheet and plans are presented.

4. Esterification for Development of Drying Characteristics of Tall Oil.

Charles F. Eck and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

During the recovery of the waste black liquor from the sulfate pulp cooking process, soaps of the organic fats and resins separate from the liquor. These soaps on acidification form a material called tall oil. Tall oil consists essentially of fatty acids and rosin acids, with a small amount of unsaponifiables. With its fatty acid composition, tall oil can be used as a raw material for drying oils.

Most of the natural drying oils, linseed, tung, perilla, and oiticica oils, are imported. To relieve this situation domestic production of natural oils and development of synthetic drying oils are being promoted.

A drying oil has two structural requirements: the first is a polybranched molecule, needed to form a three dimensional structure; the second is ethenoid linkages of sufficient number to form films in a short time. To increase the unsaturation, castor oils and other oils have been dehydrated catalytically. The proper type of molecule has been obtained by esterification of higher fatty acids from semi-drying and drying oils with aliphatic alcohols.

Esterification with polyhydroxy alcohols has been tried to improve the characteristics of tall oil. The effect of rosin acid content of the tall oil, the structure of the complex alcohol produced, time of esterification and temperature of esterification were studied.

5. Factors Affecting the Corrosion Rates of Metals in Tallol.

I. M. Markwood and R. A. Fisher; *Virginia Polytechnic Institute.*

The work of previous investigators on the resistance of metals to corrosion by tallol has raised a number of questions with regard to the manner in which the tests were conducted and their correlation with plant experience. The present work was undertaken for the purpose of determining the effect of various factors involved in the laboratory tests which might have a bearing on such correlation. These factors include the effect of long exposure of the tallol to a high temperature, the removal of certain volatile components, the presence of water and the presence of metal ions other than those of the metal under test. As a result of these tests it was concluded that corrosion tests of metals in tallol should be made with crude tallol, replacing it at the end of every 18 hours and allowing the volatile components to escape. Since some metal ions affect the corrosion rate of other metals, such groups of metals should not be tested in the same vessel at the same time.

6. Roanoke River Stream Pollution Survey.

Henry F. Eich and P. H. McGaughey; *Virginia Polytechnic Institute.*

This investigation was begun on July 1, 1940 to determine what constitutes pollution in varying degrees and phases from both the sanitary and biological aspects and to attempt to establish a procedure for similar future projects.

The data are derived from weekly samples taken at seven significant stations beginning at Salem and terminating at Hardy's Ford, in Bedford County, thus covering a stretch of stream measuring some 18 miles. These waters are forced to take the effluents from a tannery, a meat-packing house, a viscose plant, and a chemical industry, besides the sewage from Salem, Roanoke, and Vinton.

A series of chemical tests consisting of chlorides, alkalinity, carbon dioxide and four nitrogen determinations are run on each sample. Dissolved oxygen, biochemical oxygen demand, total bacterial count, presumptive and confirmative runs for most probable number, and microscopic examination and organism count of the concentrated waters with an accompanying microscopic survey of the river muds were also undertaken.

7. Utilization of Rosin and Waste Fatty Acids for the Production of Adipic and Sebacic Acids.

William R. Keller and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

The export of rosin from the United States has been practically stopped by the war and the importance of its utilization has strongly increased.

Previous investigators have shown that abietic acid, the principal constituent of rosin, can be oxidized to a cyclohexane derivative, 1,3 dimethyl cyclohexane 1,2,3 tricarboxylic acid. This acid is similar to cyclohexanone used in the commercial production of adipic acid. In the utilization of rosin it is necessary to determine the optimum conditions for the formation of this derivative and its conversion to adipic acid.

Sebacic acid has been obtained from oleic acid, one of the fatty acids present in tall oil. Tall oil is a mixture of waste fatty acids obtained from Kraft pulp manufacture. The application of the process of making sebacic acid from the mixture instead of the pure fatty acid involves a study of the factors which will affect the production of sebacic acid first on a laboratory scale, then on larger quantities.

8. The Industrial Utilization of Carbide Generator Lime Wastes.

Robert L. Teeter and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

The disposal of calcium hydroxide wastes resulting from the production of acetylene from calcium carbide and water presents a special problem since the resulting slurry cannot be flushed into the streams. The slurry cannot be dried by ordinary means because it cakes up in the equipment. At present, the solids in the slurry are allowed to settle in great ponds, the excess liquid flowing off into the streams. The settled material is putty-like, and dries only on the surface. Farmers of the vicinity carry away the calcium hydroxide "mud" for use in liming their lands, but the hard lumps formed as the "mud" dries in the field, prevent even distribution. A much more useful material would be a powder form which could be spread evenly over the fields or could be used as chemical lime.

This paper presents the results of a drying process in which the slurry is first broken up by introducing an azeotropic solvent which is partly or wholly miscible with water. After filtration, the subsequent drying should produce a fine, non-caking powder. The material should be easily handled in ordinary equipment by the use of this process.

9. Industrial Waste Survey in Virginia.

Dudley Thompson and R. A. Fisher; *Virginia Polytechnic Institute.*

A general survey is being made of industrial wastes in Virginia. This project, while an entity in itself, is also being considered as the first step in a broader, long-range program in which an intensive study is to be made of the industrial waste problem in Virginia. It is expected that a valuable by-product of the investigation will be to define the specific problems of waste disposal in the state. There is very little in the published literature concerning industrial wastes in the Old Dominion. The current program is concerned with the collection of data necessary to more fully understand the problems involved.

The central-western part of the state, roughly within a radius of 100 miles of Blacksburg, is the area upon which the study is being concentrated. The remainder of the state is being considered in a more general way. It was decided to choose this area since it contains three of the larger rivers, the Roanoke, the New, and the James, along the banks of which are located varied and representative industries in a greater concentration than in most other areas of the state.

Information is being collected on amounts and nature of wastes produced in the industries and the manner in which they are disposed of. The general means of treating and handling wastes and the development and progress made during the past decade are being studied. This information is being obtained by personal observation during visits to plants, streams, localities; conferences with plant managements, state agencies, and others versed in one or more phases of this field; chemical analysis of the streams; and a review of the literature.

Information thus far collected indicates that the individual industries are doing a great deal toward recovering, treating, and disposing of their wastes.

10. The Utilization of Paper Mill Wastes in the Flotation of Manganese Ores.

Hugh F. Smith and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

Chief among the reasons for the vigorous development of flotation in recent years has been the rapid depletion of available tonnages of direct smelting ores, and ores suitable for concentration by gravity methods. Particularly is this true of the manganese deposits of Virginia where large ore-bodies of low-grade manganese await development. From the standpoint of national defense requirements alone, it is important that efficient methods of utilizing such deposits be investigated.

In close proximity to these manganese deposits, Virginia has several large paper mills which have available the waste product known by various names such as, "tall oil", "tallol", "liquid rosin". Disposal of this waste is one of the problems of the paper industry. The utilization of this tallol, in its original form, as one of its derivatives, or as a modifying agent of other oils, for the flotation of low-grade Virginia manganese ores would furnish a valuable market for the waste product.

Experimental data have been obtained showing the effect of the tallols in flotation of low-grade manganese ores from the Paint Bank deposits of Virginia. The chief function of the tallols in flotation is that of a collecting agent for the manganese dioxide. Other reagents used in conjunction with them perform either as frothers, or as gangue dispersors and depressors.

11. A New Extensometer.

H. R. Puckett and D. H. Pletta; *Virginia Polytechnic Institute.*

Many extensometers in current use consist of several parts which must be assembled when mounting the instrument on the tensile specimen. The inherent disadvantages of such designs are eliminated in the extensometer described in this paper, but the requirements of accuracy and sensitivity combined with ruggedness are retained. The complete instrument consists of five main parts, only two of which are moving parts. It is of the dial type, enabling the reading of elongations to 0.00005 inches without the necessity of stopping the test. It has a maximum range of one-half inch, and can accommodate specimens up to 1″ x 2″ in cross section. The complete instrument is virtually one piece, before, during, and after a test, there being no detachable or loosely connected parts to become troublesome or lost. The instrument can be adapted to any gage length by interchanging permanent gage bars.

12. Business Meeting, Appointment of Nominating Committee.

The meeting was called to order by Prof. D. H. Pletta, Chairman, at the conclusion of the presentation of the papers of the morning session.

The minutes of the last meeting were read and approved. A nominating committee was appointed to select a slate of officers for the coming year. The committee was instructed to report back to the meeting at its resumption after lunch. The meeting was then recessed until after lunch.

FRIDAY, MAY 2—2:00 P. M.

13. Continuation of Business Meeting.

At 2:00 p. m., the business meeting was again called to order. The nominating committee presented the following slate of officers: Chairman, P. S. Dear; Secretary, J. B. Jones; Associate Editor, R. A. Fisher. There were no further nominations from the floor and a unanimous ballot was cast for the nominees.

The business meeting was concluded at 2:15 p. m. with the resumption of the presentation of the papers for the afternoon session.

14. Barium Carbonate as a Material for Adjusting "Glaze-Fit" on Talc Bodies.

Fred W. Bull; *Virginia Polytechnic Institute.*

A typical talc-containing wall tile body has been used as the basis for the investigation. Such a body is often subject to the common glaze defects of "crazing" or "shivering". Systematic additions of small amounts of barium carbonate were made to the body. Specimens were formed by dry-pressing and then bisque-fired in a commercial tunnel kiln under commercial firing conditions to pyrometric cones 1, 3, 5, 7, and 9. Thermal expansion determinations were made on the fired specimens. A typical wall tile glaze was applied to the specimens and matured at pyrometric cone 1. Glaze warpage determinations were made on the body-glaze combination by means of a micrometer measuring device. The results were correlated with autoclave tests for crazing and shivering of the glaze and moisture expansion of the body.

Results show that small percentages of barium carbonate added to a talc body increase the firing range several cones and produce satisfactory glaze fit. The moisture expansion of such a body is increased slightly, but not sufficiently to promote delayed crazing to any marked extent. The net results show that barium carbonate is a very valuable addition to talc bodies for adjusting glaze fit over a wider range of firing temperatures.

15. Design of Non-Diaphragm Calcium Chlorate Cell.

Frank W. Tober and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

The chlorate-type weed killer used is made by dissolving crystals of sodium chlorate and calcium chloride in water. Solvay Process waste, consisting principally of a solution of calcium chloride and sodium chloride, constitutes a rather bothersome industrial waste. The development of a cell to electrolyze this solution into a chlorate-type weed killer involves a design eliminating clogging by the precipitation of calcium compounds on the cathode surface.

The electrochemical characteristics of the Solvay process waste were studied. An attempt was made to find some way to prevent the formation of the calcium compounds or to overcome the undesirable effects of the precipitated compounds. A sketch of the cell resulting from this investigation is presented.

16. Clarification of Wool Scouring Liquors Containing Sulfated Higher Alcohols.

Louis J. Sitomer and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

Raw wool, before it is made into yarn or cloth, is usually scoured or cleansed by one of two major processes; namely the soap-alkali method or the solvent method, the former being more prevalent in industrial practice.

When wool is scoured by the soap-alkali method a very highly polluting waste is formed, which contains wool grease, potash salts, nitrogenous matter, and scouring agents. Recently sulfated higher alcohols were developed, and they are being used as detergents in place of soaps, replacing them in part or entirely. One of the advantages of using these synthetic wastes is that they may be used with hard waters. Methods which have been developed for the treatment of soap-alkali wastes cannot be used to clarify the very stable colloidal wastes formed when they contain a large amount of synthetic detergent.

Mechanical and chemical treatments, such as dialysis, precipitation, agitation, absorption on stone in a packed column and electrolyisis were studied to undertake the clarification of these stable colloidal wastes. Combinations of the mechanical and chemical treatments were also studied. Electrolysis showed very little promise. Dialysis seems to indicate best possibilities.

17. Problems Encountered in Utilization of Red Cedar.

E. H. Lane, Jr.; *The Lane Co., Altavista, Va.*

The physical and chemical properties and method of reproduction of Red Cedar (Juniperus Virginiana) are discussed. Particular attention is given to the chemical composition of the cedar oil.

Cedar presents many machining problems. The wood is brittle; the color is fugitive to light, et cetera. The processes of treatment are complicated further by the cedar oil which is volatile and, consequently, must be handled with care to prevent its loss as far as possible and the weakening of its moth-killing properties thereby. This oil can do much damage to articles placed in the chest if it is not properly controlled.

The care taken to protect cedar logs in storage; the kiln-drying of cedar lumber; the humidity control necessary during the manufacture of cedar products are discussed. A brief discussion is presented of what to do with cedar waste; how to prevent cedar aroma loss from the finished chest; and how to control the flow of cedar oil from the wood.

18. The Relationship Between Nozzles and Solvent-Solute Characteristics in Solvent Extraction.

Edward L. Bragg and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*

Recent developments in solvent extraction have led to its extensive use in the oil refining industry to remove objectionable substances from the crude. This extraction is usually effected by the counter-current flow of the oil and the solvent in a vertical column.

Besides the oil industry, solvent extraction is applicable to the separation of phenol from aqueous liquors, cresols from coal tar, and organic substances from water.

While solvent extraction is not as economical as fractional distillation as a means of separation, it is frequently more effective, especially when the substances to be separated possess similar volatilities.

Extensive work has been done on solvent extraction from a practical standpoint, and a wide variety of equipment is now being employed; especially is there a wide variation in the distributing plates or nozzles.

It is necessary to ascertain what factors make a specific nozzle applicable with some solvents, but eliminate its use with others. The smaller extreme of drop size proceeds too slowly up the column. The larger extreme decreases the efficiency of the extraction by producing a small surface area per unit of material; and also tends to break into second, third, and even fourth generations of droplets which behave similar to those of the smaller extreme. Several nozzles were investigated as to drop size, velocity, and stability at varying rates of flow for a selected few commercial solvents in an attempt to determine the effectiveness of the nozzles on an ideal basis.

19. The Effect of Hot Plate Surfaces on Thermal Conductivities.

R. M. Johnston and C. B. Ruehr; *Virginia Polytechnic Institute.*

The hot plate method of determining thermal conductivities is the generally recognized standard. Two different types of hot plate may be used: (1) a built-up, metallic surface plate of either copper or aluminum, (2) a plate made of refractory materials known as an alundum plate. For this reason there is a variation in thermal conductivity values determined for a given sample in two different sets of apparatus, depending on the type of hot plate employed in the test.

Existing equipment of the V. P. I. Engineering Experiment Station was used in an effort to determine the amount of variation which might be anticipated due to differences in surface characteristics of the hot plates. The results of a series of tests show conclusively that, for the sample used, surface variations of the hot plates give a range of thermal conductivities from 0.24 to 0.39 btu per sq. ft. per hr. per deg. F. when the sample is tested under analogous test conditions.

Further investigation in the same field is now contemplated to supplement the preliminary work herein reported.

20. The Torsional Properties of Round Edged Flat Bars.

D. H. Pletta and Frank J. Maher; *Virginia Polytechnic Institute.*

The analysis at non-circular cross sections of bar subjected to torsion cannot be carried out by any convenient mathematical treatment.

This paper describes the results of the Prandtl Membrane Analogy as used to analyze certain sections and the comparison of these results with the results calculated according to a recently published mathmatical treatment.

The mathematical treatment involves the numerical solution of Poisson's Equation by use of the principle of iteration involving only simple mathematics, but consuming considerable time.

The experimental method involves the use of soap bubbles for the determinations. The apparatus and technique differ somewhat from that used by previous investigators, but yield results within one per cent of theoretical values.

Minutes of the Section of Foresty

JOHN W. MCNAIR, *Presiding*

FRIDAY, MAY 2—10:00 A. M.

1. The State Forestry Department.
   F. C. Pederson; *State Forester.* (20 min.)
2. The Work of the Assistant State Forester.
   George W. Dean; *Assistant State Forester.* (10 min.)
3. District State Forestry Work in Southwestern Virginia.
   G. H. Hodge; *District Forester.* (5 min.)
4. District State Forestry Work in the Piedmont Area.
   Berlin Eye; *District Forester.* (5 min.)
5. District State Forestry Work in the Tidewater Area.
   Brantley Henderson, Jr.; *District Forester.* (5 min.)
6. Work of the Extension Service in Forestry.
   Wilbur O'Byrne; *Extension Forester.* (10 min.)
7. Work of the Extension Service in Forestry (Cont.)
   Conner; *Assistant Extension Forester.* (5 min.)
8. Work of the Forestry Department at V. P. I.
   J. B. Grantham; *Professor of Forestry.* (10 min.)
9. The Forestry Department at the U. of Va.
   Chapin Jones; *Professor of Forestry.* (10 min.)
10. Forest Entomology Work of the Virginia Agricultural Experiment Station.
    L. A. Hetrick.

FRIDAY, MAY 2—2:00 P. M.

CHAPIN JONES, *Presiding*

11. Federal Viewpoint on Private Forestry.
    E. I. Kotok; *Assistant Chief, U. S. Forest Service.*

12. The Jefferson National Forest.

    John W. McNair; *Forest Supervisor, Jefferson National Forest.* (15 min.)

13. Forestry Work in the Northern Va. Area of the S. C. S.

    Lawrence T. Small; *Area Forester.* (10 min.)

14. The Virginia Farm Forestry Project.

    A. B. Lyon; *Project Forester.* (10 min.)

15. Forestry Work in the Rockbridge County Conservation District.

    Carl B. Liveley. (5 min.)

16. S. C. S. Forestry Work in the Tidewater District.

    W. A. Phillips; *Soil Conservation Service.* (5 min.)

17. The Work of the Forestry Department of Johns-Manville, Jarrat, Va.

    Ray F. Bower. 10 min.)

18. Education Work in Forestry of the Chesapeake Corporation.

    J. H. Johnson; *Assistant Forester.* (5 min.)

19. Work of the Forestry Department of the Chesapeake Corporation.

    W. L. Gooch; *Forester.* (With Slides.) (15 min.)

20. Work of the Forestry Department of the Chesapeake-Camp Corporation.

    T. N. Barron; *Forester.* (10 min.)

21. Discussion.

The Forestry Section held a joint meeting with the State Senate Committee on Forestry at a hearing on forestry legislation for the State. The talks were given there insofar as possible. The talk by Mr. Kotok was given at an organization meeting which was held after the Senate Committee hearing.

J. H. Johnson was elected Chairman and George Dean Secretary of the Section.

—J. H. Johnson.

Minutes of the Section of Geology

EDWARD C. H. LAMMERS, *Chairman*

RAYMOND S. EDMUNDSON, *Vice-Chairman*

WILLIAM M. MCGILL, *Secretary*

FRIDAY, MAY 2—10:00 A. M.

The Section of Geology met in Room 602 of the old Virginia Hospital Building on Friday, May 2, 1941. Two sessions were held: one from 10:00 to 12:25 noon, and the other from 2:10 to 4:40 p. m. Dr. Edward C. H. Lammers, Chairman, presided at both sessions. Immediately upon opening the morning session the Chairman presented a resolution expressing the deep regret of the Section, in the loss by death, since our 1940 meeting, of last year's Chairman, Dr. E. Ray Casto, of Emory and Henry. This and a resolution extending to the family, the sympathy of the members of the Section, were unanimously passed and ordered recorded in the minutes. More than 50 people attended the two sessions and this was considered a very fine record in view of the heat and attendant discomforts in the room in which the meeting was held. Discussions of each paper added to the interest and success of the meeting. The following papers were presented.

1. James River Project.

(Abstract*)

Dr. M. H. Stow, Chairman of the Special Committee appointed by the Long Range Planning Committee of the Academy discussed briefly the "James River Project" which had been recommended to the Academy as a major project for the Academy to initiate and sponsor as a meritorious long-range project. The objectives of the Academy in initiating and promoting the project would be (1) to supply fields of research in which members of all sections of the Academy would have an opportunity to participate; (2) to encourage and promote thorough correlated scientific, sociological and historical studies of the James River area, publish a monograph on the results of the same, and (3) promote the scientific improvement or betterment of existing conditions in the James River area as a human habitat. It was stated that this area is one of the most historic and beautiful in the country. It was brought out that because of the number of counties wholly or partly within the James River area, the diversified natural resources, industries, and developments in the area, the area itself and the nature of the "project" recommended, the James River project offered an excellent opportunity and medium to unify the various interests, efforts, and fields of research of the Academy membership.

*By Secretary of Section.

2. Some Stratigraphic Variations in Northern Virginia.*

Raymond S. Edmundson; *Virginia Geological Survey.* (Chart, 10 min.)

A comparison of Ordovician formations that crop out on the east and west flanks of the Massanutten Syncline in northern Virginia suggests the following facts or inferences: (a) The Nittany horizon of the Beekmantown is thinner and the Bellefonte equivalent is thicker to the east; (b) the Stones River limestones (Mosheim and Lenoir) show greater variations in thickness to the east; (c) limestone of Athens lithology is absent to the west but the horizon, as suggested by a few fossils, may be repesented in the basal part of the Chambersburg limestones; (d) the Chambersburg limestone is thinner to the east; (e) the Oswego and Juniata formations are present to the west but absent to the east; and (f) the Chepultepec limestone is less fossiliferous to the east.

3. Sedimentary Petrology of Some Atlantic and Gulf Coast Beach Sands.

Robert O. Wilbur and James B. Snobble; *Washington and Lee University.* (Slides, 10 min.)

The mineral composition of samples of beach sands from Westbrook, Connecticut, south along the Atlantic coast to St. Augustine, Florida, and along the Gulf coast from Destin, Florida, to Mobile, Alabama, was determined. The minerals identified were of igneous and metamorphic rock derivation. The most striking feature of the petrology of the sands was their general similarity of mineral content.

4. Mineralogy of Sands from Tributaries of South Fork of Shenandoah River, Virginia.

C. L. Sartor and R. W. Root; *Washington and Lee University.* (Slides, 10 min.)

An examination of stream sands of the tributaries of the South Fork of the Shenandoah River was made to determine their mineral content and source. The minerals found were ilmenite, magnetite, zircon, hypersthene, tourmaline, biotite, garnet, chlorite, apatite, epidote, muscovite, rutile, brookite, quartz and feldspar. Reference to a geologic map of the region showed the source of these streams to be in the Catoctin greenstones and Hypersthene grandiorite of pre-Cambrian age and some lower Cambrian quartzite and conglomerate formations.

From a correlation of the known mineral content of these formations and the evidence found in this study of modern stream sands, it was shown that the mineral content of these streams reflect the petrography of the rocks from which they were derived.

5. Source of Sediment of the Tuscarora Sandstone in Massanutten Mountain, Virginia.

Egmont Horn and H. H. Woods; *Washington and Lee University.* (Slides, 10 min.)

The mineral composition of samples of the basal Silurian, Tuscarora sandstone from Massanutten Mountain, Shenandoah County, Virginia was determined. These minerals indicate that the sediment was derived from sedimentary rocks predominantly, with smaller amounts from igneous

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sources. No material was of metamorphic rock derivation. The results indicate that the Cambrian sandstones and igneous rocks of the Blue Ridge region supplied the sediment for the Lower Silurian formations of this area and that the Blue Ridge arch was in existence at this time and acted as an effective barrier against the westward transportation of sediment derived from **Appalachia.**

6. Outline of the Geology of Smyth County, Virginia.*

Joseph K. Roberts; *University of Virginia.* (Slides, 15 min.)

Smyth County was organized from Washington and Wythe counties in 1832, and the first geological survey made in this section of the state was by William B. Rogers in 1835-41. The county lies mostly in the Appalachian Valley and Ridge province with its southeastern portion in the Blue Ridge plateau. The age of the geological formations involved ranges from the pre-Cambrian complex to Mississippian. The Paleozoic rocks comprise conglomerates, sandstones, shales, limestones, dolomites, and cherts with certain Cambrian rocks metamorphosed. The principal mineral resources are rock salt, gypsum, chemical limestone, and crushed stone with subordinate occurrences of ores of manganese, iron lead and zinc.

The geologic structure is complicated by metamorphism especially so in the southeastern portion of the county. In the Paleozoic section the folds are closed, and overturned, and the faults are of the thrust type. The topography is largely controlled by structure. The three valleys, Rich Valley on northwest, Rye Valley on southeast, and Marion Valley in the central part, are drained respectively by the North, South, and Middle forks of the Holston River. These valleys have a northeast-southwest trend parallel to the Appalachian Highlands. The three streams drain more than 90% of the county, a small portion along the eastern edge being drained by tributaries of the New River. The lowest altitude of the county is around 1,700 feet, and the highest is Balsam Mountain, shown on several maps as Mt. Rogers, 5,720 feet. The geologic map of the Appalachian Valley in Virginia by Charles Butts and assistants, published in 1933 by the Virginia Geological Survey, shows the geology and structure of the county, and represents the latest contribution to the geology of this portion of Virginia.

7. Gallium Content of Some Virginia Rocks.

A. A. L. Mathews and H. D. Ussery; *Virginia Polytechnic Institute.* (Specimens, photographs, 10 min.)

Spectroscopic examination of minerals from the three feldspar belts of the Piedmont area of Virginia, show that the mineral microcline obtained from the Ridgeway-Amelia Court House belt contains the highest percentage of gallium. This mineral contained more than 0.13% gallium. The minerals examined from all of the belts were microcline, albite, oligoclase, andesine, blue quartz, and the rocks aplite and marble. Due to the high value of metallic gallium ($1,388 per pound), certain grades of microcline should be reserved for the recovery of the metal.

8. Virginia's Stone Industry.

Arthur Bevan; *Virginia Geological Survey.* (15 min.)

The raw materials used in recent years by the Virginia stone industry consist chiefly of granitoid rocks, greenstone, limestone, slate, and soapstone, with subordinate amounts of diabase, sandstone, quartzite, conglomerate,

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marble, and shale. Most of the production has been from the Valley and Piedmont provinces. The major product, both in quantity and in value, is crushed and broken stone. Dimension stone, produced at certain favorable localities, include slate, soapstone, greenstone, granite, marble, limestone and sandstone.

The total reported quantity of stone produced in Virginia in 1939 was almost 9,000,000 tons, having a production value of more than $9,000,000, exclusive of rock used in the manufacture of cement. The value is almost one-fifth of the total value of mineral resources produced in the State during 1939. Limestone is the most important raw material. The 1939 production of limestone and lime was 4.2 million tons with a value of more than 4.6 million dollars.

9. Gemology—the Infant Branch of Science.

G. C. Barclay; *Certified Gemologist, Newport News, Va.* (Specimens, 15 min.)

The chief objective of the science of gemology is customer and public protection. The science of gemology was developed by jewelers in England, just before the outbreak of the World War, under the sponsorship of the National Association of Goldsmiths. It deals with the origin of gem materials, their physical, optical, and chamical properties, modes of mining and extracting, fashioning, and marketing.

In 1932 graduates of the English National Association of Goldsmiths and other interested men introduced this movement into the United States; establishing in Los Angeles the Gemological Institute of America. Its work has gone much farther and covers more ground in its teaching and is more complete than the courses offered by the National Association of Goldsmiths in England. From 2 to 3 years are required to complete the course and obtain a certificate of Certified Gemologist. Moreover, to retain his certificate a Certified Gemologist must successfully pass a yearly examination covering new studies, discoveries, methods, findings and activities in gemological work.

The Certified Gemologist must have a broad understanding of mineralogy, geology, chemistry and other fields of science in order to correctly determine and classify unknown minerals, especially those of the gem stone group. He must not only be able to identify, but also to classify and value a gem.

10. Three Items of Virginia Geology.

Roy J. Holden; *Virginia Polytechnic Institute.* (10 min.)

1. A Large Isoclinal Fold

There is an isoclinal fold of unusual size and textbook perfection in Stones River limestones and underlying dolomites in southern Montgomery County and adjacent portion of Pulaski County. The western end of the fold lies immediately to the southeast of the Claytor dam. A stratigraphic thickness of 4,000 feet of rocks has been folded on itself so that both limbs are vertical. The crest of the fold has been completely removed by erosion.

2. The "Black Rock"—Mosheim Unconformity

The "Black Rock"—Moshiem unconformity has been recognized over long distances and is probably widespread. The Mosheim formation is quite lenticular, ranging in thickness from a few to 65 feet and is a source of commercial limestone; the overlying beds are known commercially as "Black Rock" and are quarried locally but yield a lower grade of lime than does the Mosheim. The vaughanitic texture and gray color of the Mosheim

contrast with the dark rather crystalline flinty "Black Rock". The contact between the two is everywhere knife-edged. Locally the contact is irregular and abrupt offsets of as much as six inches occur.

3. A Phosphate Limonite

In Rockbridge County about a mile from Vesuvius is a limonite deposit, formerly operated as the Dixie mine. It is a fault deposit wholly unlike the common type of such deposits. The fault surface is nearly vertical and cuts across the Cambrian quartzite which stands on edge. The width of the ore ranges from 4 to 25 feet and has been mined through to a depth of 175 feet. The quartzite walls are brecciated and weathering has produced a dull luster in the stone. Quartzite fragments completely enclosed in limonite are bright and vitreous. Commercial analyses of the ore show 1.50% phosphorous. A phosphate of iron, dufrinite, occurs in banded sheets standing vertically and lining vertical crevices. The ore is black, non-porous, and has a conchoidal fracture. The Big Ike mine in Warren County and another deposit not far from the Dixie mine have similar ore in a similar structure.

The Dixie limonite deposit is not a product of weathering. It is thought to be a magmatic carbonation product.

11. Diabase Minerals of the Virginia Triassic by Kodachrome.

W. C. Overstreet; *University of Virginia.* (Slides, 10 min.)

Diabase in the forms of dikes and extrusive sheets occurs in the Piedmont, Blue Ridge, and Appalachian Valley provinces of Virginia. As early as 1838 dikes of this composition were reported in the vicinity of Weyer's Cave (Grand Caverns) and in 1839 to the west of Mt. Crawford in Shenandoah County, by Wm. B. Rogers. In the Piedmont region extrusive sheets indicate Triassic age for the diabase, and the dikes may be later than this time. The principal minerals, feldspars and pyroxenes, were recognized about a century ago, but the accessory minerals were not accurately identified much before 1900. The minerals and the texture of the diabase are shown by kodachrome film to a much better advantage than by black and white film. The color is not always natural, but the contrast is such that this technique adds another step in studies of the diabases and other igneous rocks.

12. Mineral Composition of Rocks in the Hudson Highlands of Southeastern New York.

John D. Bates; *University of Virginia.* (Slides, 10 min.)

The area considered is the mountainous pre-Cambrian section in the vicinity of Bear Mountain, New York. The rock units are discussed briefly with reference to their types and their major minerals. They are the Grenville sedimentary series, the Pochuck diorite-gneiss, the Canada Hill granite, the Storm King granite, and basic dikes. Interesting minerals found during studies of these rocks are illustrated by colored (Kodachrome) lantern slides. Those not before found in the area include chondrodite, pleonaste, mizzonite, leucoxene, and diallage. Also mentioned are fluorite, tourmaline, titanite, and basaltic hornblende.

13. Geophysical Investigations in Virginia.

George Woollard; *Princeton, New Jersey.* (Slides, 25 min.)

A brief discussion of the results of detailed geophysical investigations in the Coastal Plain region of Virginia. Illustrated by slides. Instruments, methods and technique used, field and weather conditions, traverses run, and results obtained were discussed.

14. Age Relationships of Certain Metamorphic Rocks in the Vicinity of Lynchburg, Virginia.*

W. R. Brown; *Cornell University.* (Maps, 10 min.)

A preliminary study has been made of the rocks of the Martic thrust block and those immediately to the west in an area lying in a northeast-southwest trending belt between Lynchburg and Rustburg. The rocks in the thrust block have been referred to the Glenarm series and comprise from oldest to youngest: Mt. Athos greenstone, Mt. Athos quartzite, Cockeysville marble, and Wissahickon schist. Certain evidence has been noted which suggests that the reverse sequence may obtain. This is: (1) a decided coarsening of the quartzite toward the marble in most localities; (2) superposition in nosing folds whose synclinal or anticlinal nature is suggested by the pitch of minor drag folds; (3) apparent dip of the Wissahickon formation under both sides of the belt of quartzite, marble, and greenstone; (4) absence of greenstone pebbles in the quartzite; (5) a simpler explanation of structures and regional age relationships. This evidence is admittedly tentative, but further field study is planned to test its correctness and applicability.

15. An Occurrence of Amethyst in Prince Edward County, Virginia.

S. W. Sniffen; *Hampton, Va.* (Slides, 10 min.)

The occurrence of Amethystine quartz is not uncommon in various parts of Virginia. Although some good crystals occur locally, most of the material found is cloudy and of light color. Amethyst of gem quality is, however, rare and the fact that it has been mined in small quantities in Prince Edward County may not be generally known.

Some six or eight years ago, as a result of the investigation of interesting-looking float material, amethyst was found in weathered quartz mica gneiss on the farm of Mr. J. W. Bradshaw at Rice, Virginia. The amethyst occurs in groups or clusters of crystals in quartz stringers or lenses in what has been described as granodiorite and granite gneiss. Trenches, ditches and shallow pits of variable length were dug and crystals of varied quality obtained from pick and shovel operations, to depts of as much as 12 feet. In the portions of the openings now accessible may be seen a large number of thin horizontal sheets or lenses and narrow vertical stringers of quartz. They are much weathered and are distinguished from the decomposed enclosing rock by their darker color and in places by their higher content of quartz. The quartz in the lenses is generally shattered, granulated and stained with iron oxide. The vertical stringers occasionally contain a few crystals of amethystine quartz, but as the stringers cut the lenses they may be the source of the amethyst. It would seem reasonable to suppose that the vertical stringers are apophyses from an underlying mass of quartz or pegmatite in which the best amethyst occurred in vugs or pockets.

16. Field Trip in the Richmond Area.

J. K. Roberts; *University of Virginia.* (20 min.)

A short account of the main features, route, and scheduled "stops" of the annual Geology Section field trip, made this year in the Richmond area. Within the City limits of Richmond are good outcrops of granite, along the Fall Line and in quarries, contacts of granite bedrock and overlying sedimentary (Cretaceous, Eocene, and Miocene) beds, well developed sand and gravel terraces, exposures of the Patuxent sands and gravels, Aquia greensand carrying sharks teeth and the diatomite zone in the Calvert. A few miles west of Richmond in the Richmond Triassic basin are coal mines from which the earliest recorded production of coal in this country was obtained.

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17. Possible Unicoi Tuffs in the Central Blue Ridge of Virginia.

R. R. Bloomer; *University of Virginia.* (Slides, 10 min.)

A red fissile rock that may be an altered tuff occurs as a thin belt near the base of the Unicoi formation in discontinuous exposures on each flank of the Blue Ridge, from a location just east of Buena Vista southwestward to James River.

Several factors have led the writer to conclude that this rock is an altered tuff rather than a sedimentary rock: (1) It is locally underlain by a thin amygdaloidal flow which suggests that the rock in question might also be of volcanic origin; (2) the minerals zircon, apatite, and tourmaline are more consistently present in the enclosing arkose than in the altered tuff; (3) disseminated grains of partially devitrified glass occur in the tuffaceous rock and apparently a relic vitroclastc texture is present; (4) the rock has a felted groundmass which is characteristic of a volcanic rather than a sedimentary rock; (5) the mixture of many large sericitized feldspars and many small anhedral quartz grains suggests that these minerals are respectively of volcanic and detrital origin.

18. Progressive Down-dip Changes in Composition of Artesian Water from the Cretaceous Rocks of Virginia.*

D. J. Cederstrom; *U. S. Geological Survey, Charlottesville, Va.* (Slides, 15 min.)

The data presented summarize the partial results of a cooperative study made by the U. S. Geological Survey in cooperation with the Virginia Geological Survey.

The geology was briefly described. Waters in the water-bearing sands of the Potomac group of sediments of Lower Cretaceous age were discussed in detail. Along the Fall Zone the waters are only slightly mineralized but contain moderate amounts of free carbon dioxide. Eastward the free carbon dioxide is consumed as calcium carbonate is taken into solution as calcium bicarbonate. Still farther to the east these hard waters are softened by base exchange. It is found that the amount of free carbon dioxide taken in the waters along the Fall Zone is not sufficient to account for the high bicarbonate present in many waters and it was suggested that sediments rich in organic matter are liberating carbon dioxide which is converted into bicarbonate.

The distribution of fluoride and chloride waters was also shown and briefly discussed.

19. The Occurrence of Ground Water Along the Fall Zone in Virginia.*

Wm. M. McGill; *Virginia Geological Survey.* (Presented by title.)

A brief preliminary account of incomplete studies by the Virginia Geological Survey and jointly, as a cooperative investigation, by the State and U. S. Geological Surveys, of ground-water conditions along the Fall Zone in Virginia.

The notes or comments presented pertain particularly to the Fall Zone between Richmond on the north and Petersburg on the south, although it is thought that similar general conditions prevail along other portions of the Fall Zone. As was pointed out, however, considerable variations occur locally in both the character and quantity of groundwater, as well as in the depths at which it is or may be obtained.

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The geological formations concerned are unconsolidated sediments of Lower Cretaceous, Eocene, and Miocene age and the underlying crystalline bedrock, Petersburg granite, of pre-Cambrian age. General water-bearing properties and horizons of the different formations, are briefly discussed and data given on depths and yields of wells.

20. Influence of the Core of the Blue Ridge on the Geology of the Buena Vista, Virginia, Quadrangle.*

Robert O. Bloomer; *University of North Carolina.* (10 min.)

The peculiar stratigraphic relations of the Unicoi and Catoctin volcanic series; a rapid pogression in metamorphism across the axis of the Blue Ridge; and the occurrence of numerous thrust faults along the southeastern flank and the relative absence of faults along the northwestern flank of the Blue Ridge in the Buena Vista quadrangle are indicative of a buttress. It is assumed that the hybrid rock called "granodiorite" that forms the core of the Buena Vista anticline and crops out along the Blue Ridge divide, composed a massif-like mass that influenced the geology of the region since late pre-Cambrian or early Cambrian time.

Upon completion of the last paper a brief business session was held at which matters of interest to the Section were discussed and upon recommendation of the nominating committee the following officers were elected for the next year: Dr. R. S. Edmundson, Chairman; Dr. Roy J. Holden, Vice-Chairman, and William M. McGill, Secretary. Dr. E. C. H. Lammers was reelected as the representative of the Section on the Editorial Board of the VIRGINIA JOURNAL OF SCIENCE. The meeting was adjourned at 4:40 p. m.

SATURDAY, MAY 3—8:30 A. M.

On Saturday morning, May 3, about 20 members and guests of the Section assembled at the corner of 11th and Clay Streets and left at 8:30 a. m. in automobiles for a geological field trip under the leadership of Drs. J. K. Roberts and A. A. Pegau and Wm. M. McGill. A mimeographed outline of the trip and brief remarks on exposures examined and features visited proved helpful and added interest. Stops were made to visit and examine exposures of diatomite and clay beds in the Calvert (Miocene) formation, greensand in the Aquia (Eocene) formation from which many sharks teeth have been collected, Patuxent (Cretaceous) sand and gravel beds, Petersburg granite (pre-Cambrian), sand and gravel terraces of Brandywine (Pliocene?) age, falls and rapids along the Fall Zone across James River, after which the party proceeded westward along the south side of James River to the Robious coal mine where the managing-operator, Mr. J. Cogito, met the group and led them to a picturesque shaded wooded area near a spring a short distance from the mine where a picnic lunch was enjoyed by all.

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After lunch Mr. Cogito guided the party through all the workings of the mine, pointed out many features of interest and told us much of the history of mining operations in that vicinity. The trip was concluded at the intersection of the Westham Bridge and River Roads about 4 p. m.

WILLIAM M. MCGILL, *Secretary.*

Minutes of the Section on Medical Science

ROLLAND J. MAIN, *Chairman*

GUY W. HORSLEY, *Secretary*

FRIDAY, MAY 2—10:00 A. M.

1. Studies on Fat Metabolism and Susceptibility to Carbon Tetrachloride.

J. C. Forbes, B. E. Leach, and E. L. Outhouse; *Department of Biochemistry, Medical College of Virginia.* (15 min.)

The significance of the following phases of fat metabolism in regard to the protective mechanism of animals against carbon tetrachloride poisoning will be discussed.

(1) Concentration of liver lipids
(2) Concentration of serum lipids
(3) Rate of ketone body formation
(4) Active fat metabolism

The experimental results to be reported show that the animal's resistance bears no relationship to the fat content of the liver. Animals on low choline high fat diets with fatty livers up to about 30 per cent, starved for 24 hours, have been found to be only slightly more susceptible than normal rats starved for the same period of time.

The administration of fat (filtered butter) by stomach tube several hours before the time of poisoning however, definitely increases the animal's susceptibility. No increased susceptibility follows fat administration if the animals are in a protected state from previously injected xanthine. The concentration of blood lipids of the protected animals does not differ from that of the corresponding control animals. Consequently, the concentration of serum lipids cannot be an important factor in determining the animal's resistance. That the degree of ketonemia likewise is not important is shown by the fact that the ketonemia of starvation is not influenced by subcutaneous xanthine administration.

Since both starvation and the feeding of fat results in an increase in the fat content of the Kupffer cells of the liver, it is suggested that the metabolic state of these cells may be the most important factor determining the resistance of animals to carbon tetrachloride.

2. The Synchronization of Cerebro-Cortical Potentials.

C. G. Holland; *Departments of Physiology and Neuropsychiatry, University of Virginia.* (Lantern, 15 min.)

The electroencephalograph is an amplifying system for recording the voltage from the cortex. This is in the order of millionths of a volt. The oscillographs depict this in the form of an undulating line. Frequencies range from 1 to 40 a second and the potential change from zero to several millivolts. Delta (abnormal) frequences range from 1 to 7 a second; alpha (normal) frequencies from 8 to 14; and beta (normal) from 15 to 40 a second.

By studying the energy output of delta and alpha waves a parallelism between the two may be shown. When the wave forms and frequencies are kept in mind, this parallelism suggests a realignment of energy. This realignment may be further analysed by reducing each wave to an average and comparing them, voltage for voltage and time for time. From this it may be shown there is a proportional correspondence.

3. Study of a Case of Osteosclerosis with Myeloid Leukemia, with Special Reference to the Extensive Extramedullary Blood Formation.

H. E. Jordan and J. K. Scott; *Department of Anatomy, University of Virginia.* (Lantern, 15 min.)

The features of special interest in this case concern: (1) practically complete absence of hemopoietic tissue in the bone marrow, in conjunction with a substantially normal red-cell count; (2) hyperplasia of bone in relation to marrow fibrosis; (3) extensive extramedullary blood formation; (4) "division of labor" as regards hemopoiesis, in that erythrocytes were formed almost exclusively in lymph nodes and liver, and granulocytes in the spleen; (5) evidence that lymphocytes served as common ancestors for both erythrocytes and granulocytes; (6) evidence that the macrophages with erythrocyte fragments in the sinuses of the lymph nodes arose from cells of the reticular stroma.

The histologic evidence from the study of lymph nodes, bone marrow, spleen, lungs and liver, together with the fact of an essentially normal red-cell count, suggests the following interpretation. There was operative presumably some unknown primary factor favoring widespread fibrosis. This factor expressed itself first in the bones where it produced extensive osseous hyperplasia with a concomitant fibrosis of the medullary stroma and a disappearance of hemopoietic parenchyma. Compensation for the disappearance of hemopoietic tissue from the bone marrow was made by the potentially hemopoietic tissues: spleen, liver and lymph nodes.

4. Structure and Function of the Brain of the New-born Bear.

Walther Riese; *Department of Neuropsychiatry, Medical College of Virginia.* (Lantern, 15 min.)

During the past years a great number of observations of the functions of the embryonic nervous system has been reported both in Europe and in this country. The bear (*Ursus arctos* L.) is a mammal the young of which are born with an embryonic nervous system, thus giving the opportunity of studying structure and function of an embryonic brain under natural and physiological conditions. In spite of a pregnancy of 208 days the young at birth are only the size of guinea pig and their body weight is about 300 gr. The histological structure of its brain corresponds to that of a four-month-old human embryo. It is striking that on the other hand the development of other organs corresponds to the average degree of maturity of mammals at the time of birth. In so far as the nervous system participates in certain post partum functions (such as circulation, respiration, heat regulation, metabolism, alternation of waking and sleeping) it would seem essential that it should be correspondingly well developed at the time of birth. However, it is found that the nervous system at the time of birth is markedly embryonic in character. Almost immediately after birth the bear executes side to side movements of the head, alternative flexions and extensions of the fore limbs and synchronic movements of the hind limbs not coordinated with the movements of the fore limbs. These movements represent a motor pattern displayed by other new-born mammals and even by the human fetus and must be considered as at the service of the search for food. This pattern seems to be independent of the developmental stage of the nervous system.

5. The Efficacy of Bacteriophage and Other Bacterial Preparations in the Control of Experimental Friedlander B Infection in Mice.

Leslie A. Sandholzer; *U. S. Public Health Service, Craney Island Laboratory, Norfolk, Virginia.* (Lantern, 10 min.)

A study of the therapeutic and prophylactic efficiency of bacteriophage, heat-killed and phenol-killed vaccines, non-lytic filtrates and peptone water has been made. In all, over two thousand mice were studied and the data obtained evaluated statistically.

Two methods of quantitative evaluation have been employed, (a) the number of eventualities at 24 hours and (b) survival time. The tables of Lowenthal and Wilson were used to determine the statistical significance of the data in the first instance. The significance of the survival time was calculated by dividing the Difference of the Means by the Standard Error of the Difference of the Means.

The results indicate that when bacteriophage, heat-killed or phenol-killed vaccines are administered prior to the onset of the first deaths (about three hours), a significantly large number of the animals survive. Untreated controls or animals treated with peptone water or non-lytic filtrates all died within 24 hours.

When bacteriophage or vaccines were employed prophylactically, the animals were afforded adequate protection even though these agents were administered just prior to the injection of the virulent organisms. Humoral immunity would not seem to be of importance in such protection.

6. A Study of the Antagonistic and Synergistic Relationships Between Members of the Pseudomonas and Escherichia Genera.

Mary V. Ferguson and Leslie A. Sandholzer; *U. S. Public Health Service, Craney Island Laboratory, Norfolk, Virginia.* (Lantern, 10 min.)

A study has been made of the antibacterial and synergistic effects of strains of the genus *Pseudomonas* on members of the *Escherichia* and *Aerobacter* genera in order to determine possible relationships to the sanitary bacteriology of shellfish arising from the interaction of these two groups of organisms.

Seventy strains of *Pseudomonas* and 18 strains of *Escherichia* and *Aerobacter* isolated from oyster meats, oyster liquor and sea water, and 25 strains of *Escherichia* isolated from fecal specimens of laboratory workers have been used in this study.

Antibacterial effects studied by the well method indicated little, if any, inhibition of pyocyanin on the strains of *Escherichia* and *Aerobacter* studied.

To determine the synergistic effects of the *Pseudomonas* organisms growing with either the *Escherichia* or *Aerobacter* strains, equal volumes of each were inoculated into standard lactose broth, and after suitable incubation were subsequently followed through the various standard procedures of water analysis. The lactose broth presumptive tubes thus inoculated revealed no appreciable decrease in gas production as compared with the control tubes of the *Escherichia* or *Aerobacter* strains alone. Upon streak-in the tubes containing the mixed cultures of Eosin Methylene Blue Agar, the typical fecal colon colonies were not present. Instead, these plates revealed a predominance of the *Pseudomonas* colonies plus types resembling *Escherichia-Aerobacter* "intermediates". Studies are now in progress to

determine whether these "intermediate" colony types represent mixtures of the two organisms or represent a fusion of characteristics of the forms employed.

7. Autopassive Local Sensitization and Desensitization.

Oscar Swineford, Jr. and W. Roy Mason, Jr.; *Department of Internal Medicine, University of Virginia.* (Lantern, 20 min.)

The skin of an allergic person is specifically sensitive to certain particular substances known as allergens. The skin is sensitive because it contains specific antibodies or reagins against the allergens. The skin sensitivity of an allergic person may be demonstrated by a local inflammatory process which occurs when a specific allergen is introduced into the tissues. This inflammatory process is the result of a reaction between allergen and specific antibody.

Passive local skin sensitivity is commonly produced by the injection of serum from an allergic person into the skin of a non-allergic person (Prusnitz-Küstner phenomenon). Since allergic antibodies are present only in the globulin fraction of the blood serum protein and since less than 0.1 per cent of the circulating serum globulin reaches the tissue spaces, theoretically the antibody content of the tissues should be locally increased by the direct introduction of an allergic person's own antibody-laden serum into the skin. Hypothetically such an increase in tissue antibodies should result in increased local reaction when the specific allergen reaches antibody containing tissue spaces. Also a local allergen-antibody reaction should use up available antibody at the site and thereby bring about some degree of local desensitization.

Phenomena of this sort, described as autopassivle local sensitization and desensitization, have been produced by us. The sensitization phenomenon has been observed definitely in five cases and equivocally in a sixth. Definite, but by no means complete, desensitization of autopassively sensitized skin sites have been observed in three cases. The reaction cannot as yet be produced at will.

Autopassive sensitization may be of potential value in the diagnostic tests of allergy. Local desensitization has potential therapeutic possibilities. Little is known about the phenomena at present.

Further studies of these phenomena are now in progress, both in the human being and in laboratory animals.

8. The Methylene Blue Lactose Broth Test for Sterility of Glasses and Eating Utensils.

A. F. Meyer; *Sanitary Laboratory, Virginia Military Institute.* (10 min.)

A new and radical method of checking for the presence of bacteria on glassware has been evolved. Basis of the test is the reduction test, known as the Reductase Test, for milk control. Employing the principle that methylene blue, a readily reducible reversible dye, with a narrow electro potential change, will change from the blue to a colorless state under the influence of bacterial growth, the test has adapted the use of regular lactose broth for a basic media, and has been subjected to careful trial, both under field and laboratory conditions.

Methods have been followed to give correlation between time of decolorization of the broth and ordinary agar plate counts. Gross contamination has shown discolorization of the broth in less than eight hours, medium contamination, from eight to twelve, standard ordinance glasses have maintained characteristic blue color for over twenty-four hours. Routine agar

plate test takes twenty-four hours. Time saved is important factor in public health inspections, plus simpilcity of new test over old plate method. Requires only swabs and pipettes, plus broth tubes, whereas old test requires swabs, dilution tubes, agar, petri dishes, and pipettes.

Some interference on part of spore forming air bacteria has been noted, and inhibiting chemicals are being worked on at present to check this.

Added factor in the reduction test is that production of gas by coliforms gives extra check on condition of glassware, and shows presence of dangerous organisms not brought out by routine plate test.

FRIDAY, MAY 2—2:00 P. M.

9. Business Session.

With Dr. Rolland J. Main, Chairman, presiding, there was a free discussion of combining the Section on Medical Sciences with other sections. Dr. J. Shelton Horsley, Dr. James Smith, Mr. A. F. Meyer, Jr., and Dr. Guy W. Horsley were among those taking part in the discussion. Dr. Ernst Fischer made a motion that the Section should not be combined with any other section, and that it should continue to present both scientific and clinical material similar to that of the present program. This was seconded by Dr. James Smith, and the motion was carried. It was also suggested that suitable papers be published in local medical journals, mentioning the fact that they had been been presented on the program of the Section on Medical Sciences of the Virginia Academy of Science. The Nominating Committee presented the slate for election of officers. Dr. J. E. Kindred, of the University of Virginia, was elected Chairman, and Dr. Guy W. Horsley was re-elected Secretary.

10. I. Preliminary Studies: Effects of X-ray on Normal and Injured Liver Cells in Rats.

George Z. Williams; *Department of Pathology, Medical College of Virginia.* (10 min.)

By means of histoincineration, special stains, and administration of colchicine the mineral ash changes, mitotic activity, and degenerative and regenerative changes in rat liver cells were studied. Livers of normal rats are compared with those of animals subjected to carbon tetrachloride poisoning, butter-yellow diet, and 200 KV X-ray irradiation to the liver. These studies are preliminary to and the results are recorded for comparison with effects of irradiation on experimental liver cancer cells to be reported in a subsequent paper.

*The expenses of this study were partly defrayed by a Grant in Aid from the Virginia Academy of Science, which is here gratefully acknowledged.

Symposium on Sulfonamide Drugs

11. Chemistry of Sulfonamide Drugs.

    Alfred Chanutin; *Department of Biochemistry, University of Virginia.*

12. Pharmacology of Sulfonamide Drugs.

    Harvey B. Haag; *Department of Pharmacology, Medical College of Virginia.*

13. Sulfanilamide and its Derivatives in Medical Practice.

    Ernest G. Scott; *Lynchburg, Virginia.*

14. Sulfanilamide and its Derivatives in Surgery.

    I. A. Bigger; *Medical College of Virginia.*

SATURDAY, MAY 3—9:00 A. M.

15. The Relation of Solar Radiation to Cancer Mortality in North America.

    Frank L. Apperly; *Department of Pathology, Medical College of Virginia.* (Lantern, 10 min.)

At this meeting last year a number of graphs were shown which demonstrated an inverse relationship between the total cancer mortality in each of the American and Canadian states and the proportion of these populations engaged in occupations exposed to sunlight. In skin cancer the relationship was a direct one, except in those states with a mean annual temperature of less than 42° F. in which states the relationship followed the general (inverse) rule.

We now present some new graphs showing the relationship of cancer mortality to the total solar radiation as represented by J. H. Smith's "Radiation Index". Again we find that skin cancer varies directly and total cancer inversely as the Radiation Index. In addition our former graphs have been re-drawn after making corrections for differences of age distributions. Some animal experiments supporting these conclusions will be mentioned.

16. The Relation of Arterial Pulse-Pressure to the Arterio-Venous Oxygen Difference in the Blood.

    M. Katherine Cary and Frank L. Apperly; *Department of Pathology, Medical College of Virginia.* (Lantern, 10 min.)

From data obtained from 35 hospital patients with various diseases a relationship was found between the product of pulse pressure and pulse rate and the arterio-venous oxygen difference in the arm, of such an order that

$$(PP \times PR) \times (A\text{-}V\ O_2\ \text{diff.}) = \text{constant}$$

At the lower end of the curve were cases of various kinds of cardiac failure with cyanosis. At the upper end were cases of anemia and high

blood pressure in both of which there was a more rapid blood flow through the arm. From these facts it is concluded that (1) (PP x PR) is a fair indication of blood flow through the arm, but not of cardiac output (2) that the vaso-construction of arterial hypertension is less marked in the arm vessels than in the body generally i.e. is probably more visceral than peripheral.

17. Heparin and Peritoneal Adhesions.

Floyd Boys; *Department of Surgery, University of Virginia.* (20 min.)

Results of numerous experiments in dogs, illustrated with a moving picture in color, show the method of producing adhesions by contaminating the peritoneum. Separation of adhesions at subsequent operation caused further formation of adhesions. Injection of heparin intra-peritoneally following separation of adhesions resulted in only 10% recurrence of adhesions. This solution has been used in several clinical cases with good results.

18. The Mechanism of Shock in Intestinal Strangulation.

Everett I. Evans; *Department of Surgery, Medical College of Virginia.* (15 min.)

Shock has been produced by strangulation of a short loop of terminal ileum in the dog under Evipal anesthesia. Plasma volumes have been determined by the Gregersen dye method which has been found adequate and reliable for these shock studies. After 12-14 hours there has occurred a decrease in plasma volume of approximately 35% and these animals are in varying degrees of shock, with hemoconcentration, rapid pulse, and low blood pressure.

When the fluid free in the peritoneal cavity is examined, it is found to resemble closely blood plasma. When measured, it is found in amounts large enough to account for the decrease in circulating plasma. There was no evidence found to suggest loss of plasma at sites remote from the point of injury. The free peritoneal fluid of these shock animals does not appear to be toxic when given *intravenously* to a normal dog.

Hence, it is suggested that in intestinal strangulation, as in shock produced by trauma (Blalock, Phemister), plasma loss is local, and is the initiating factor in the fall in blood volume and blood pressure in this type of shock.

19. Alcohol Absorption from the Skin.

R. V. Bowers and J. F. Blades; *Departments of Chemistry and Surgery, Medical College of Virginia.* (10 min.)

Severe alcoholic intoxication has been observed in children whose extremities have been in a 95% alcoholic orthopedic preparation for 10-12 hours. Studies were carried out on several children to demonstrate if this intoxication was due to alcoholic inhalation or to absorption from the skin.

Four children, white and colored, male and female, were given this orthopedic preparation for a period of 9 hours. Precautions were taken to exclude any possibility of alcohol fumes being inhaled. Specimens of blood were taken at three-hour intervals and analyzed for alcohol.

When the fumes from alcoholic orthopedic preparations were kept from being inhaled we were unable to detect any alcohol present in the blood, and, therefore, may conclude from these experimens that 95% alcoholic orthopedic preparations will not subject the patient to intoxication if the fumes are controlled.

20. High Altitude Exposure and Drug Susceptibility (Morphine and Sulfanilamide).

Ernst Fischer; *Department of Physiology and Pharmacology, Medical College of Virginia.* (Lantern, 15 min.)

A brief discussion is goven about the relation between high altitude and drug activity with special references to various practical problems brought to light by increased civil and military aviation. Experiments on the influence of single and repeated high altitude exposures upon morphine and sulfanilamide susceptibility of mice and rats are reported. Various types of control experiments have been conducted, the results of which are utilized in an attempt to analyze the mechanism of high altitude influence upon drug susceptibility.

21. An Analysis of Hormonal Influences on Fluid Balance.

S. W. Britton and E. L. Corey; *Physiological Laboratory, University of Virginia.* (Lantern, 20 min.)

The effects of pituitary and adrenal hormones on water balance have been studied in over 400 normal, hypophysectomized and adrenalectomized rats. Water, normal saline, glucose and glucose-saline solutions were utilized in dffierent series. Post pituitary extract and desoxycorticosterone as well as cortico-adrenal extracts were tested under various conditions.

In young normal rats it was observed that desoxycorticosterone, as well as cortico-adrenal extract, produced marked polydipsia and polyuria, while in other cases the reverse conditions were noted under post-pituitary administration. Normal saline solution alone, however, induced an almost similar polydipsia and polyuria, although the chloride output in the urine was markedly increased. Glucose-saline, in comparison, brought about more striking increases in water intake and urine output.

In hypophysectomized animals studied over periods of 10 to 12 weeks after operation, a chronic diabetic condition was observed following a primary acute period which extended over the first 6-8 days. During the chronic phase of increased water intake and urine output, desoxycorticosterone was found to be effective in further augmenting the polydipsia and polyuria. The low chloride levels normally observed in hypophysectomized rats were still more diminished during desoxycorticosterone treatment. Post-pituitary extract was observed to be a specific antagonist to desoxycorticosterone, given simultaneously, in so far as its action on water and chloride balance was concerned. When given alone, the post-pituitary hormone was still more effective. Water intake and urine levels were more greatly influenced in the hypophysectomized rats, nevertheless, by saline and glucose-saline solutions given without hormone.

In adrenalectomized rats results almost similar to the above were observed with desoxycorticosterone and post-pituitary extracts, as well as with saline and glusoce-saline solutions. It is apparent, therefore, that desoxycorticosterone and also whole cortico-adrenal extracts operate under all of the conditions noted to eliminate fluid through the kidneys and at the same time conserve chloride, in direct antagonism to the post-pituitary hormone.

22. Alcaptonuria in a Negro Family.

Lynn D. Abbott; *Department of Biochemistry, Medical College of Virginia.* (15 min.)

Just as we may have hereditary anatomical defects, so may we have defects in body chemistry, so-called "inborn errors of metabolism", which are hereditary and are of great interest not only to the biochemist, but to

the physiologist, to the medical man and to all students of heredity, as well. Alcaptonuria is one of these "biochemical freaks" and is the outward sign of a very rare anomaly of protein metabolism in which homogentistic acid is excreted in the urine. Comparatively few instances of alcaptonuria have been reported in this country. Of approximately 122 cases in the literature in 1929, only 17 occurred in the United States, the majority having been reported from European countries. At the present time only 23 of the total number of recorded cases were reported in this country. Although we know that albinism exists among Negroes, nothing is known of the existence in this race of the other, less obvious, inborn errors of metabolism. A study of a Negro family in which two children have alcaptonuria will be presented. This is the first evidence that this inborn error exists in the American Negro. A brief discussion of the chemistry of alcaptonuria, with a demonstration of the characteristic reactions of the urine will be presented.

Minutes of the Section of Psychology

WILLIAM M. HINTON, *Chairman*

EVELYN RASKIN, *Secretary*

FRIDAY, MAY 2—9:30 A. M.

The Section of Psychology met in Room 500, Old Virginia Hospital, on Friday, May 2 and Saturday, May 3. The Friday morning session was devoted to the presentation and discussion of papers in the fields of experimental psychology and the psychology of learning. The Friday afternoon session was opened with a lecture by Professor Clark L. Hull of Yale University on "The Problem of Primary and Secondary Motivation". Following the general discussion of Professor Hull's paper, the business meeting was held. Reading and discussion of papers continued on Saturday morning, with main emphasis on the fields of abnormal and social psychology and mental testing.

At the Friday afternoon business meeting, Dr. R. H. Henneman gave a progress report of the Committee on Clinical Psychology. The membership passed a resolution continuing the work of the committee and instructing it, upon completion of the survey, to make its findings available to responsible and interested groups. The present officers were re-elected for the year 1941-1942.

Attendance throughout the two days of meetings was unusually good, with more than 40 people present at each of the three sessions.

1. Intensity as a Determinant of the Simple Visual Reaction.

V. Coucheron Jarl; *University of Virginia.*

Previous investigations of the relation between stimulus intensity and the simple reaction time (RT) have given some evidence for a hyperbolic function, with minimal RT being reached at quite moderate stimulus intensities.

In the present experiment, nine subjects gave a total of 1590 reactions to each of three visual stimuli ($A = 170$; $B = 20$; and $C = 0.003$ foot-candles). The strongest light had presumably a greater intensity than any stimulus in the previous studies. In contrast to the traditional procedure, in which a series of successive reactions to one intensity was obtained before changing to another stimulus condition, our stimuli were presented in irregular order. The subjects could never be certain which of the given intensities to expect next. Their degree of preparatory attention could therefore not vary systematically with the sensory adequacy of an expected stimulus.

Under these conditions no subject reached his minimal RT at the "moderate" intensity *B*. When RT is plotted against Log I, there is a somewhat more rapid increase in speed with intensity from *B* to *A* than from *C* to *B*, and the results suggest a logarithmic rather than a hyperbolic function. Apparently the two methods of stimulus presentation are not comparable. It is suggested that with the regular procedure the sensory and attentional factors are both permitted to vary, and that they operate in a reciprocal fashion.

In each of the four previous studies two subjects were used, one being consistently slower than the other and also showing the greatest differential effect of intensity. This would suggest that sensitivity is an important factor even in minimal RT. Our results, on the other hand, gave negative correlations between absolute speed and the degree of change with intensity.

2. The Span of Visual Discrimination as a Function of After-stimulation.

Frank M. du Mas; *University of Virginia.*

Black dots on a brightly illuminated background were arranged in different numbers and patterns and used as a fore-stimulus. The duration and intensity of this fore-stimulus was held constant. Following the fore-stimulus was an after-stimulus of unpatterned white light. The fore- and after-stimulus were separated by dark intervals varying in duration from zero to 425 msec. A group of reports was also obtained for the condition of no after-stimulus. In each case the subject reported the number of dots seen.

The results show that the span of visual discrimination is longest under the condition of no after-stimulus and shortest under the condition of an after-stimulus of high intensity immediately following the fore-stimulus. Between these two extremes there was found to exist a fairly consistent relationship between the number of dots reported and the intensity and tmporal initiation of the after-stimulus.

The results were believed to be due to the "washing out" of the retinal impression of the fore-stimulus by the after-stimulus.

3. Individual Differences in Visual Fusion Frequencies.

F. Gordon Tice; *University of Virginia.* (15 min.)

The flash rate at which perceptual fusion occurs varies greatly from observer to observer. These differences appear to be normally distributed, the extremes often differing by as much as 25 per cent. This difference in response is comparable to that of one individual responding to a tenfold change in intensity. Although these individual differences are large and consistent, in a group of 37 observers they were not found to be highly correlated with similar differences in "persistence time", "action time index", or the differential limen measured at the same intensity and under the same conditions. Nor were the individual differences in fusion frequency found to be significantly related to differences in age, sex, eye color, degree of iridic pigmentation, or verbal reports from each observer rating his day and night vision as compared with that of others, his use of glasses, the amount of trouble he had experienced with his eyes, and stating the nature and approximate degree of any visual impairment which he might have.

The discovery of an almost complete absence of relationship between different measures of an individual's visual sensitivity raises serious questions in connection with visual theory. Since an individual high on one test is as apt to be high, low, or intermediate on another test, any general explanatory principles used to account for differences in sensitivity are relegated to a position of comparative unimportance. These general princi-

ples include: degree of retinal pigmentation, vitamin A concentration, transparency of the optic media, receptor organ density, neural excitability, and Hecht's photochemical theory. Hartline's findings are considered as offering explanations more in accord with the experimental facts. It is suggested that the factors responsible for individual differences in the various visual functions investigated are, like the factors underlying differences in other behavior, often highly specific to the conditions and processes involved, and that, in the majority of instances, individual differences are to be explained in terms of specific, not general factors, and for specific, not general situations.

4. The Duration of Sleep Movements.

M. Morgan Jackson; *University of Virginia.* (Slides, 15 min.)

Results of a study upon an aspect of sleep movements that has been given little consideration previously are summarized. By using a high-speed kinetograph determinations were made not only of the frequency of movements but also of the amplitude and duration of each separate movement. Twelve adult male subjects were used in the experiment. One of these was studied over a long period of time. All sleep movements were classified into major or minor movements and the duration values of these are given separately. Figures are given for the total duration of movement during sleep and also for the average duration per movement for the different classes. In addition to this, the trends in respect to the time consumed in movement and in the average duration per movement for the different parts of the night's rest are discussed.

5. A Projection Technique for the Laboratory Demonstration of Color Mixing.

Huntington W. Curtis; *College of William and Mary.* (10 min.)

Color mixing in the laboratory by the usual method—rotating disks on a color wheel—has several defects. Both saturation and brightness of colors of pigment-coated disks differ for various hues, thus rendering invalid any comparisons in terms of per cents of component colors in the mixture. Also the perceived color of a given mixture varies with the intensity and hue (daylight or tungsten) of the source of illumination. Color mixing by means of projecting lights on a screen in a dark room is a superior technique, but until recently the cost of lanterns and filters provided a serious obstacle.

The technique to be demonstrated makes use of three small 35 mm. projectors, which with appropriate colored filters and a variable transformer and switching mechanism, will give excellent results with colored lights mixed on a white screen. Several of the more difficult mixtures on the color wheel are strikingly produced with this set-up: yellow and blue = white; purple and green = white; red and green = yellow (an especially good effect); red, green, and blue = white.

Apparatus: 100-watt projectors
"Acro"—$6.98 at Lafayette Radio Co., 100 Sixth Ave., New York.
or "Vokar"—$9.95 at Central Camera Co., 230 South Wabash Ave., Chicago.
Filters (gelatine, unmounted)—1¾" square @ 30c from Eastman Kodak Co. or free as samples from theatrical supply companies.
Transformer (variable)
"Variac"—$10.00 at General Radio Co., 30 State St., Cambridge, Mass.

6. Anesthetization of the Albino Rat during the Delay Interval of a Delayed Alternation Habit.

Gloria Ladieu; *University of Virginia.* (15 min.)

Albino rats were trained in an alternation habit and the delay interval gradually increased from 30 seconds to 15 minutes. Even with the longest interval per cent of alternation was well beyond that which might be accounted for by chance. There was some indication that a longer delay might be imposed.

When the animals had reached a five-minute delay, ether anesthetization during the interval was attempted. Alternation was just as frequent during the anesthetic as during the non-anesthetic trials. As a consequence, bodily set cannot be invoked to explain immediate memory. Also no confirmation is found here for any explanation in terms of some continuing activity or self-rehearsal. A third hypothesis still to be tested is that of retroaction inhibition. However, this must wait upon the establishment of some limit to the delay interval.

7. An Attempt to Condition the Galvanic Skin Response to a Sub-Vocal Stimulus.

Elliot Mitchell; *College of William and Mary.* (10 min.)

Following the same hypotheses as those guiding the experiments of Hudgins on the conditioned pupillary light reflex and the work of Menzies on conditioned vasomotor responses, this reasearch was designed to discover if the galvanic skin response could be successfully conditioned to a verbal stimulus, "spoken subvocally" by the subject. Successful conditioning of this response would tend to reinforce the claims of these previous investigators as to the existence of a conditioned response process involved in the development of voluntary control over previously non-voluntary reflex adjustments.

A Wheatstone bridge set-up and sensitive galvanometer were used to record the galvanic skin response. Electric shock was employed as the unconditioned stimulus and spoken words (nonsense words) as the conditioned stimuli. The first step was to establish a conditioned galvanic skin response to a word spoken alound by the subject. Eight of fifteen subjects were thus successfully conditioned to the self-initiated verbal stimulus (spoken aloud). These C. R.'s showed in most cases considerable resistance to extinction.

In the second part of the experiment, the subjects were merely to "think" of the stimulus word, or to say it to themselves on a signal from the experimenter. Indication of successful conditioning was shown by three of the six subjects used in this type of training.

8. Some Factors Affecting the Acquisition of Verbal Expectations.

Jeannette Hughes and Nancy Phillips; *Randolph-Macon Woman's College.* (15 min.)

Lloyd G. Humphreys has suggested that equal acquisition of conditioned responses under 50% and 100% reinforcement is due to the fact that subjects act according to their expectations of the unconditioned stimulus, but because the unconditioned stimulus is noxious they may make responses so as to avoid it. Several of his experiments show that subjects do form expectations, and it was the purpose of the present study to investigate the effect of a noxious stimulus on acquisition of verbal expectations in a situation analogous to conditioning.

Sixty college women divided into groups of twenty were required to

write, at the appearance of a light on their left, an X if they expected a light on their right to follow the left one, a zero if they did not. Two of these groups were given 48 acquisition trials, in which the right light followed the left light on only half the trials, in unpredictable order. On trials when the subjects did not expect the right light and it did appear, they were given a slight electric shock. Group I were instructed to write their expectations about the light and told nothing about the shock, while Group II were instructed to try to learn to avoid the shock and to avoid it. This could be done by writing X's on every trial. In Group III, the right light followed the left light on each of 48 trials. These subject were instructed to learn to avoid the shock.

It was found that in Group I there was some tendency acquired to write X's to avoid the shock, despite the instruction to write expectations. In Group II there was a strongly pronounced avoidance reaction, and in Group III, even more avoidance was shown than in Group II.

Since the introduction of a noxious stimulus in the situation analogous to conditioning causes verbal expectation curves to be similar to conditioning curves, Humphrey's hypothesis remains tenable.

9. Dominance Behavior in Monkeys.

James H. Elder; *University of Virginia.* (10 min.)

Green monkeys were used in a situation where food was delivered by means of a lever operated at several feet distant from the food box. Subjects thoroughly trained to secure food in this situation were used in pairs and in groups of three. Dominance scores were determined by the amount of food secured and the number of times the mechanism was operated by a given subject.

Dominance relationships were found to be quite stable from week to week. Except in one pair there were no prolonged struggles for maintenance of dominant status. In this respect monkeys seem to differ from rodents. Various degrees of hunger produced only temporary reversals in the form of tentative challenges on the part of the subordinate animal. The applicability of the method for use with other animals and human children was discussed.

10. Behavior of Children in Pubertas Praecox.

M. R. D. Singer; *University of Virginia.* (15 min.)

The average age at puberty for 59 female and 48 male cases of uncomplicated pubertas praecox was found to be 26.5 months. Sixty-four per cent of the cases reached puberty at or before the second year of life and since the instances of precocious puberty decreased in frequency when plotted against age of onset of puberty it is apparent that precocious puberty is not merely the lower end of the distribution curve of normal puberty.

Overt sex behavior ranging from auto-eroticism and genital manipulation to coition and attempted rape was reported for 60% of the male cases. Apparently all of the components of the sex drive were present.

There is scanty evidence for similar sex behavior in female cases. Modesty was shown to have its onset at about 5 years of age even when puberty had been reached some 3 years earlier.

Precociously pubescent children showed a prevailing level of activity above that of the normal child.

Approximately twice as many female PP's showed normal social behavior as did males. Conversely twice as many male as female cases reported problem behavior such as aggression, resentment of authority, and temper tantrums. No female but several male cases were reported as engaging in anti-social actions.

Various degrees of withdrawal up to complete self-isolation were reported for PP cases in response to teasing about the gross anatomical differences between the subject and age-mates. Other cases, separated from their age-mates by their own physiological maturity, rejected their child companions and sought adult recognition. Some even aped adult habits of smoking and drinking.

Adult personality, poised and serious, was reported for some cases in which neither rejection of child companions nor the seeking of adult recognition was mentioned.

The social behavior displayed by PP cases would appear, then, to be intermediate between that of adults and that of immature children of the age of PP cases.

It was found that the occurence of PP within the first two years of life had no effect upon the onset of walking.

11. The Rôle of Hysterical Fugues in Systematized Amnesia.

D. Maurice Allan; *Hampden-Sydney College.* (15 min.)

The usual interpretation of hysterical fugues as escape reactions from trouble situations needs to be broadened to include other types of motivation such as romantic fantasy goals, regressive desire for past security and habit-systems based upon specific emotional conditioning. As evidence of the last type, two recent fugues of the case "Norman S." are presented in detail. The events of these fugues have been reconstructed partly from eye-witness accounts, partly from the subject's recall in hypnotic trance. This World War I veteran suddenly leaves home, headed for a former army camp at which he had his first memory lapse in 1918. He displays remarkable endurance and resourcefulness in attempting to reach the goal. However, perception of changes of date, roads and automobile models soon convinces him that he is disoriented in time and the fugue terminates with his getting in touch with relatives. An amnesic hang-over of several days duration and minor personality changes are further features of the case. Each fugue shows a pre-stimulus pattern of frustration, inferiority feeling, severe headaches and seems to be conditioned upon an initial traumatic episode in army camp. Suggestion treatment and discussion therapy have greatly reduced the frequency of the fugues.

12. A Critical Analysis of Sub-Tests in the Terman-Merrill Revised Stanford-Binet Intelligence Scale, Forms L and M.

Cora L. Friedline and A. B. Berman; *Randolph-Macon Woman's College* and *Brooklyn, N. Y.* (15 min.)

The purpose of the study is a critical evaluation of certain sub-tests of the Terman-Merrill revised Stanford-Binet Intelligence Scale, Forms L and M, from the points of view of (1) clarity of expression, (2) adaptability, and (3) practicality. The report is the result of the experiences of the authors in testing children in the outpatient department of a large non-sectarian hospital (Brooklyn, N. Y.), and in a mental clinic in Lynchburg, Virginia. Such observations and recommendations as are made in the article, are presented "for the purpose of improving an already exceedingly valuable instrument for measuring intelligence".

13. An Experimental Evaluation of the Chicago Non-Verbal Examination.

Richard H. Henneman; *College of William and Mary.* (15 min.)

This study was planned to evaluate the Chicago Non-Verbal Examination as an instrument for measuring the intelligence of culturally retarded groups. Two group of school children, one white, one colored, 120 children

in each group, age range between eight and fifteen years (median age of each group eleven years, one month), were selected for testing. Three tests were given to each group of children: (1) a "verbal" group test of general intelligence (National Intelligence Test, Scale A, Form I); (2) the Chicago Non-Verbal Examination; (3) the Pintner-Patterson Performance Scale, Short Form. M. A.'s and I. Q.'s were computed for both groups of children on all three tests, and the data examined to ascertain whether the results of the Chicago Non-Verbal more closely approximated those of the language test or those of the performance test. For the white children, the language test showed the highest scores, the performance test was a close second, and the Chicago test were the lowest. For the colored group, the Pintner-Patterson scores were slightly ahead of the language test while the Chicago test was again lowest. The greatest amount of colored overlapping of the white group was shown for the performance test, while there was little difference between the language and Chicago tests in this regard. Test intercorrelations revealed a higher degree of relationship between the C. N. V. and N. I. T. ($r = .73$) than between the P.-P. and either of the other two ($r = .50$). The results suggest that the Chicago test is probably not truly a "non-cultural" intelligence test.

14. An Investigation of the Relation Between "Verbal Facility" and "Success" in College.

Dean D. McKinney; *College of William and Mary.* (10 min.)

Claims have been advanced from time to time that verbal fluency is highly indicative of success in a large variety of occupations in life. However, besides the obvious fact that "verbal ability" is an important component of tests of "general intelligence", there seems little direct evidence for such claims. The study reported here is part of a preliminary survey of this problem, which seems to divide itself logically into two aspects: (1) criteria and measures of "verbal facility"; and (2) definition and measures of "success". It was decided to distinguish between verbal facility and "articulations" (speech proficiency) and to study only the former in this preliminary experiment, it being measured by the three "L-score" subtests of the 1937 edition of the American Council on Education Psychological Examinations. An attempt was made to get at "success" in college by three types of measurement: (1) academic grades; (2) general intelligence test scores (scholastic aptitude); and (3) degree and extent of participation in extra-curricular activities.

As subjects, 103 college seniors (45 men and 58 women) were selected as having indicated by prospective graduation successful accomplishment of careers in college. Correlation coefficients indicated significant relation between verbal facility and both academic grades and intelligence ratings; also between extra-curricular activities and both intelligence and verbal facility. Relation between grades and activities was negligible.

15. A Study of Sisters in College.

M. Boyd Coyner; *Farmville State Teachers College.* (15 min.)

Over a period of years, measures have been obtained of a large number of sisters at the Farmville State Teachers College. The table below shows correlations of some of these measures. If there were perfect one-to-one relationship between the scores the correlation would be 1.00; if no relationship occurred the correlation would be 0. The size of the figure indicates the degree of relationship.

	No. Pairs	*Correlation*
Otis Intelligence Test	123	.581
First yr. academic record	96	.500
Second yr. academic record	74	.556
Height	45	.601
Otis of one sister and academic record of other sister: 1st year	150	.269
2nd year	156	.426

Considering the first four correlations it is seen that one can tell from the Otis Test or the academic record of one sister about as well what the other sister would do in these functions as one could tell what the height of one sister will be if that of the other is known. The latter two correlations show that the Otis score of one sister predicts only slightly what the academic record of the other sister will be.

16. A Comparison of Freshmen and Seniors in a Liberal Arts College in Respect to Their Understanding of Social Issues.

Evelyn Cantey and Helen K. Mull; *Sweet Briar College.* (10 min.)

Gundlach's questionary on certain social issues of special current interest (see *The Psychological Bulletin* for October 1940) was given to all the members of the freshman and senior classes at Sweet Briar College and the answers selected by these students were compared with Gundlach's results for psychologists and Berkeley students. Sweet Briar seniors approach the psychologists much more closely in the kind of answers they give than do the freshmen, thus showing more enlightened and liberal attitudes. More factors than one, undoubtedly, are responsible for this marked difference between the two classes, but it seems reasonable to believe that the liberal arts curriculum is one important cause of the greater liberality of the seniors.

17. Student Belief on Certain Selected Social Issues.

William M. Hinton and John G. Martire; *Washington and Lee University.* (15 min.)

In 1940 an original survey was made by Ralph Gundlach to discover Psychologists' and student belief on certain social issues such as race, sex, and class discrimination; educational handicaps; and social reconstruction. The results of this survey have been compared to the results obtained from a group of Washington and Lee students.

The questionnaire was made of 16 multiple choice questions and the consensus of the A. P. A. members was the criterion for marking "right" and "wrong". A high total score of 16 was possible and comparisons were made by the use of the median and percentages.

In an attempt to find further relationships, the students were divided into four academic classes and their scores were compared. Economic divisions were made and certain questions were correlated with these groups. There was a division made between those students who had taken either Psychology or Sociology and those who had not. Finally, an attempt was made to see if any differences could be found which were due to the section of the country from which a student comes.

While it was shown that in most cases our students were in general agreement with the expert opinion of the A. P. A. members, the agreement was not always strong. The additional data showed that the higher the class of students, the higher the agreement with the A. P. A.; that students with Psychology and Sociology range higher than those without these subjects; and that regarding either economic conditions or sectional status, there were no significant differences. An elaboration of these points was made.

18. The Development of Stereotypes Concerning the Differences Between Negroes and Whites.

Robert Blake; *University of Virginia.* (15 min.)

In this study, a "stereotype" has been defined as a trait regarding which there exists at least 75% agreement within a given group in assigning the trait to either the Negro or the White.

The data upon which this study is based was collected at McIntire School, a consolidated grammar and high school near Charlottesville, Virginia. The total number of subjects examined was 324. For purposes of anaysis, grade groups were divided into grades 4-5, 6,7, 8-9, 10-11. The number of subjects in each group is about equal.

The test form was composed of sixty questions as "Who is the more ———?"; each question was followed by four alternative answers, the Negro, the White, no difference or don't know. The subjects were instructed to underline the answer which most clearly showed what they believed.

The following is a list of the stereotypes and the grade groups in which they first appeared:

I. Stereotypes about Negro characteristics:
   - Grades 4-5—None.
   - Grades 6-7—"Loud-mouthed", "Better servant".
   - Grades 8-9—"Lazy", "Superstitious", "Inclined to fight", "Fond of flashy clothes", "Moves more slowly", "Sleepy-natured", "Ignorant", "Easily frightened", "Stupid", "Able to do hard work", "Afraid of the dark".
   - Grades 10-11—"Sense of rhythm", "Easily pleased", "Laughs more", "Happy-go-lucky".

II. Stereotypes about White characteristics:
   - Grades 4-6—"Clean".
   - Grades 6-7—"Neat".
   - Grades 8-9—"Better manners", "Trustworthy", "Intelligent", "Worries more", "Wide-awake".
   - Grades 10-11—"Thrifty", "Ambitious".

(Each stereotype listed in a given grade group also appeared in each subsequent grade group except "Trustworthy" and "Inclined to fight".)

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An Analysis of the Contrast Values and Biological Application of Microscope Filters and New Filter Materials

LEWIS W. WEBB, JR. AND FREDERICK F. FERGUSON

The purpose of this paper on microscope contrast filters is to acquaint the average microscopist with the optical qualities of a set of good color filters. In the use of the microscope the resolving powers of a lens may be greatly aided by the development of color and tone contrast in stained materials. While monochromatic staining of materials has obvious contrast values over unstained materials counterstaining may be said to be advantageous over either. Generally, contrast is developed by the use of colored light passing through a stained preparation. The light falling upon a microscope mirror may be colored by using a colored lamp, a colored fluid before the light source or one of many types of transparent filter materials. The most commonly used colored lamp is the so-called day light bulb which has advantages over an ordinary one. A weak solution of copper sulfate in a Florence flask is greatly used while more efficient formulas such as Zeitnow's fluid are available. Many exacting microscopists use the trick of matching the filter color with that of the contrast or background stain so as to throw into sharper contrast the desired features. The Bausch and Lomb Company have developed an interesting set of filters which gives contrast between the stained preparation and a colored background. This paper deals only with the development of color contrast by using colored filters before the microscope lamp.

The function of a colored microscope filter is to stop light of certain wave lengths. Certain rays pass freely through the filter while others are (partially or wholly) absorbed. Generally, red filters appear red because they absorb green and blue light and transmit red light easily. Filters which absorb red and green light appear blue. Using such a filter red and green objects appear dark, i.e., show contrast, while blue objects appear light. A filter which absorbs blue and red is green; one which absorbs only blue appears yellow since it transmits green and red light and these affect the eye as yellow. Many trained microscopists have neglected a very useful tool because of insufficient knowledge of filter contrast value and unwillingness to pay the price of an expensive set. In this study an effort

has been made to develop specifications for a more ideal set of contrast filters. These filters should give maximum effectiveness at a nominal cost.

Nearly one hundred different light filters have been obtained and tested.* These are of seven types including a number of new materials: "Differential" (Bausch and Lomb Co.), "Cellophane" (E. I. Dupont de Nemours and Co.), "Wedge" (Harrison and Harrison Co.), "Plastacele" (E. I. Dupont de Nemours and Co.), "Plexiglas" (Rohm and Haas Co.), "Wratten" (Eastman Kodak Co.), and others.

The transmission spectrogram of each filter was first determined by a grating spectroscope. This was done as a means of determining and specifying the general color characteristics. The type of material, thickness, resistance to scratching, uniformity, and other physical properties were noted. The percentage of transmission of tungsten light was obtained by means of a photoelectric photometer.

These filters were then tested for the contrast they produced when used with each of the prepared biological slides made with the following stains:

1. Heidenhain's Hematoxylin (*Hydra*)
2. Delafield's Hematoxylin with Eosin (*Amphioxus*)
3. Borax Carmine (*Diphyllobothrium latum*)
4. Reynold's (*Ancylostoma caninum*)
5. Wright's (Frog Blood)
6. Giemsa's (Bone marrow of cat)
7. Harris's Hematoxylin with Eosin (Cerebellum of man)
8. Light Green with Eosin (*Tilia*)
9. Mallory's Triple (*Zea maize*)
10. Gentian Violet (Crystal violet) (*Allium* mitosis)
11. Goodpasture's with Stirling's (*B. welchii* in abdominal wall of man)
12. Acid Fast (*B. tuberculosis*)
13. Weigert's Elastica with Van Gieson's (Pancreas of man)
14. Sharlach R (Sudan IV) with Orange G and Harris' Hematoxylin (Fatty tissue in heart of man).

The microscopic equipment used included, Bausch and Lomb binocular research microscopes with apochromatic lenses and research microscope lamps. The grades of A, B, C, and D have been used to give every filter a contrast rating with each of the 14 stained preparations, as indicated in the following sample data sheet:

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*The authors gratefully acknowledge the cooperation and interest shown in this study by the following persons: Mr. William Clift, Phipps and Bird, Inc., Mr. D. S. Frederick, Rohm and Haas Co., Mr. W. F. Jenson, E. I. Dupont de Nemours and Co., Dr. L. V. Foster, Bausch and Lomb Optical Co., Mr. W. H. Harrison, Harrison and Harrison Co., and Dr. W. S. De Loach.

Those filters with contrast values of A and B grade were checked with the Coleman Regional Spectrophotometer to gain a more accurate transmission spectrogram or percentage of light transmission for the visible color bands. This instrument has a

Figure 1. Table showing contrast ratings of a set of effective filters.

General Color	Transmission Spectrum	Ratings for Contrast Produced when used with Standard Stains														% of Light Trans.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Red		A	D	D	D	D	D	C	D	D	D	D	D	D	D	33 to 58
Flame Red		A	D	D	D	C	D	B	C	D	C	D	D	D	D	42 to 60
Blue		B	A	B	B	A	B	A	A	A	A	A	A	A	A	14 to 52
Purple		C	D	D	D	C	D	B	C	D	D	C	D	D	D	42 to 62
Green		B	A	B	A	A	A	A	A	B	A	A	A	A	A	22 to 51
Yellow		C	D	D	D	D	D	D	C	D	B	D	D	D	D	76 to 86

These ratings were given to a set of Harrison and Harrison "Wedge" filters.

spectral range of from 340$m\mu$ to 1000 $m\mu$. For example of the graphs obtained from the machine, see Figures No. 2, 3, and 4.

From experience derived in using and testing many filters of various types the following criteria will be useful when selecting filters. No discredit to any filter manufacturer is intended or implied in this criticism; it being the unbiased opinion of the authors.

The "Cellophane" filters were improved by mounting them between two pieces of optically ground glass in a transparent cementing medium (balsam). This removes the wrinkles in the wavy surface which are objectionable. When properly mounted, "Cellophane", obtained from any 5 and 10 cent store, makes a fairly good filter.

The plastic materials, "Plastacele", "Plexiglas", "Pyralin", and others can be readily cut to fit any size holder. They scratch rather easily but if properly handled, this will not be objectionable. These filters are relatively inexpensive, yet effective.

One of the best sets of filters tested was the Harrison and Harrison "Wedge" type. These filters are made by laminating two pieces of optically flat glass together with a dyed cementing medium which is hardened under heat and pressure. The filters were ¼ in. thick, 1½ in. wide, and 12 in. long. Due to the wedge formation, the medium varies in density from one end to the other, By sliding a filter of the desired color under the condenser of the microscope, varying intensities of the color can be obtained.

The well known "Wratten" filters are very good if of the proper color. Keep in mind that all companies make filters that are of no value in microscopic contrast work. Select those filters which are fairly close to the specifications given (Figures 2, 3 and 4). "Wratten" filters have defects which need to be given consideration by microscopists. First, their size and shape make them awkward to handle; second, they tend to form bubbles around the edges as they age, third, they have a low resistance to heat.

After careful study of the various materials, the following conclusions were drawn:

1. Colored plastics and gelatin are not inferior as filter materials if used in front of the condenser.

2. Although the plastics tend to scratch easily, surface scratches cause no appreciable distortion. These scratches can be removed in most cases by application of "Simonize" cleaner.

3. Filters of purple, brown, orange, smoke, and various shades are of little if any value in contrast development when used with the common stains.

4. Filters of amber or yellow shades have slight contrast value in some cases but are not recommended. They are considered of value when used with crystal violet.

5. Red filters give good contrast with a few stains but their use will not be frequent.

6. An effective green filter will be used oftener and give the best contrast with the majority of stains.

7. A good blue filter will also find wide application and is of definite value.

Therefore, for the average microscopist, a good green and a good blue filter are all that is essential for improved microscopic contrast work. The following specifications are given for an effective green, blue and red filter.

A *green filter* should not transmit over 20% of any band below 450$m\mu$. The maximum transmission should be near 70% at 520$m\mu$ and should drop to 20% or below at 620$m\mu$. There should be no appreciable rise in the region beyond 620$m\mu$.

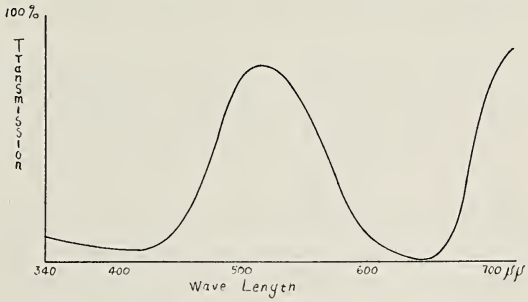

FIGURE 2

Transmission spectrogram of a light green filter ("Plastacele" No. C 10075-10).

A *blue filter* should transmit at least 20% of the 380$m\mu$ band, increase to a maximum of about 50% at 450$m\mu$ and decrease to about 20% at 580$m\mu$. It should not rise above 20% for bands from 580$m\mu$ to 720 $m\mu$.

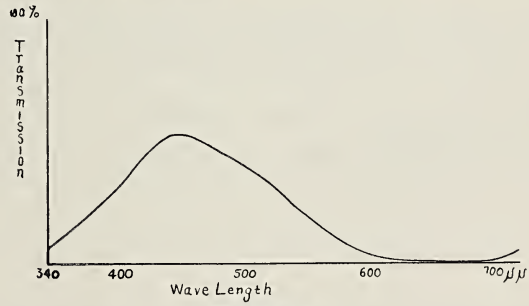

FIGURE 3

Transmission spectrogram of a light blue filter ("Wratten" No. 38A).

A *red filter* should be a flame red. Transmission should begin at 560$m\mu$ and rise abruptly to a constant value of about 80% at 600$m\mu$.

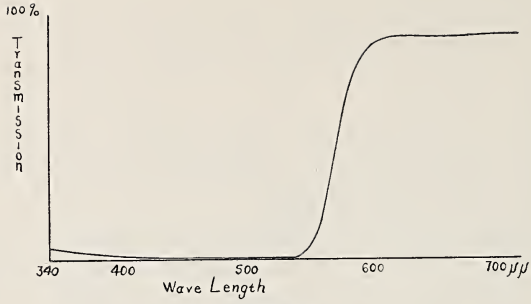

FIGURE 4

Transmission spectrogram of a flame red filter. (Harrison and Harrison. "Wedge").

Our general knowledge of color contrast would be enhanced by a study of the correlation of the transmission maxima of microscope filters with the absorption maxima of dyes. These maxima have been obtained for the simple analine dyes in plain aqueous or alcoholic solutions. They cannot be given definitely for natural dyes like hematoxylin and carmine, nor for compound stains like Wright's, because of the amount of variation or the indefinite nature of the figures obtainable. Another paper is planned, giving several methods and simple devices which can be constructed to facilitate handling these filters.

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Mineralogy of Sands from Tributaries of South Fork of Shenandoah River, Virginia[1]

C. L. Sartor and R. W. Root

Recently we had reference to an unpublished Master's thesis by Mr. R. D. Rogers, Jr., of Cornell University, in which the results of a petrographic study of some Silurian sandstones of Pennsylvania were recorded. In this paper Mr. Rogers reported the presence of minerals of igneous and metamorphic rock derivation.

It was suggested that a comparable study of some Silurian rocks in Virginia be made[2] and that this study be correlated with an examination of some stream sands derived from areas of known rock types in order to determine how accurately these sands reflect the petrography of their parent rocks.

Samples of stream sand were obtained from every stream flowing down the western slope of the Blue Ridge in the South Fork of the Shenandoah River between Luray and Front Royal, Virginia. No attempt was made to take mathematically accurate samples, but care was taken to secure material which would be reasonably representative of the sediment being transported by the stream.

After collection the samples were first washed in water to remove organic material and other foreign matter and then boiled in dilute hydrochloric acid to remove calcite and limonite from the sand to facilitate identification. The sands were then sieved through fine meshed bolting cloth to eliminate those grains too large for microscopic study. A bromoform separation divided the remainder into two fractions; a light fraction consisting of minerals of specific gravity below 2.8, and a heavy fraction of minerals with a specific gravity greater than 2.8. Both light and heavy separates were mounted in Canada Balsam on regular petrographic slides. Mineral identifications were made from these slides.

Examining the minerals identified from the stream sands as a group, we find ilmenite and magnetite range from common to flood in relative frequency. In general, they may be considered abundant. Zircon and epidote were present in all samples, ranging from rare to abundant, and may be considered essentially common. Chlorite and chloritic material occurred in much the same fashion. Garnet was absent in some samples only to appear abundant in others. It too may be considered as common to the sediments. Hypersthene was found in most samples but in relatively small amounts. Tourmaline occurred in the same manner,

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[1]Presented before the Geology Section of the Virginia Academy of Science, May 2, 1941.
[2]See Horn and Woods, *Source of Sediment of the Tuscarora Sandstone in Massanutten Mountain, Virginia*, this issue Virginia Journal of Science.

being relatively rare. Biotite occurred in about half the samples and was considered relatively rare. Its absence is probably accounted for by its lack of resistance to weathering. Apatite was found in two samples despite the fact that they were all boiled in acid. Muscovite and rutile occurred as a few grains and brookite was identified in one sample.

In the light separate quartz appeared in flood proportions with varying amounts of feldspar. Of the latter both plagioclase and orthoclase were distinguished.

This suite of minerals is doubtless derived from igneous rocks and not from metamorphic ones. No minerals of direct metamorphic rock derivation were found in any streams in this area. Doubtless much of the zircon, tourmaline and possibly garnet represent second cycle material although some may be of immediate crystalline derivation. If a geologic map of the area drained by these streams is consulted it will be seen that the rock types within the area consist of the Hypersthene Granodiorite and the Catoctin Greenstone of pre-Cambrian age and a group of lower Cambrian basal quartzites and conglomerates. From these rocks feldspar, hypersthene, quartz, epidote, biotite, apatite, magnetite, ilmenite, zircon, titanite, pyrite and rutile have been reported, thus establishing a direct relationship between the sediments examined and their possible source.

From this study of modern stream sands derived from source rocks of known mineralogic composition, it has been demonstrated that the minerals of the stream sands definitely reflect the petrography of the provenance from which they were derived.

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Observations on Some Virginia and West Virginia Plants

H. A. Allard

In extensive collecting, the following plants have been found in Virginia and West Virginia, constituting records new for these States, and in some instances greatly extending the previously known range of several far northern species into the high southern mountain areas. Specimens have been deposited in the U. S. National Herbarium and some in the Herbarium of the National Arboretum. An examination of the collections of the U. S. National Herbarium revealed no material from Virginia or West Virginia. The Cyperaceae listed were identified by Dr. F. J. Hermann of the United States Department of Agriculture.

Virginia

Dianthus prolifer L. Abundant in an open pasture on the west slope of the Pond Mountain area just south of Highway 55 at Thorofare Gap. No material from Virginia in the collections of the U. S. National Herbarium. *Allard,* June 8, 1941, *8889.* Naturalized from Europe.

Filipendula rubra (Hill) Robinson. In swale west of wooded slope of Pond Mountain, just south of Highway 55 at Thorofare Gap. No material in the collections of the U. S. National Herbarium from Virginia. *Allard,* June 29, 1941, *8995.*

Sphenopholis filiformis (Chapm.) Vasey. The writer found this growing in moist, rich woods near Halfway, Fauquier Co., Virginia, in the Bull Run Mountain area. It is chiefly confined to the drier soils of the Coastal Plain from North Carolina to Florida, Tennessee and eastern Texas. This grass has not previously been recorded from Virginia. *Allard,* May 30, 1939, *6650.*

West Virginia

Carex leptonervia Fern. The following collections of this *Carex* have been made by the writer: *6895,* July 2, 1939, Big Cove in the Canaan Valley, Tucker Co., in dense woods on the east slope of Brown Mountain about 10 miles east of Davis; *8733,* May 30, 1941, in low swamp thicket on Little Blackwater River in Big Cove at 3200 feet; *6895,* July 2, 1939, on the west slope of a knob of the Cabin Mountain range east of Glade Run in the deep shade of a maple-beech wood near 3300-3400 feet.

This species has not before been reported from West Virginia.

Scirpus rubrotinctus Fern. The writer has made two collections of this species in the Canaan Valley as follows: *9064,* July 8, 1941, on or near Glade Run, Tucker Co., near the west slope of Cabin Mountain, east of Davis about 10 miles; *9224,* July 15,

1941, along a brook flowing into Glade Run, near its confluence with Little Blackwater River.

These records are far south of the known range given as Newfoundland to Assiniboia, south to Connecticut, New York and the Great Lakes. However, owing to the high altitude of the Canaan Valley, and the more or less northern affinities of its distinctive flora, such range extensions are probably to be expected.

Scirpus atrocinctus Fernald. The writer made two collections of this species in the Canaan Valley, West Virginia as follows: *9159,* July 11, 1941, on the highest point of a knob of Cabin Mountain just east of Glade Run, among sandstone conglomerate boulders, at 3700 feet; *9194,* July 12, 1941, in a bog on Glade Run just east of Cabin Mountain at 3200 feet. This, too, is a northern *Scirpus,* ranging from Hudson Bay, Newfoundland and Saskatchewan south to Connecticut, Pennsylvania, Michigan and Iowa, and the writer's finds constitute a rather interesting record for West Virginia.

This interesting region has almost the facies and atmosphere of far nothern Maine. In the swamps the veery sings everywhere, and in the cool, dark rock maple-beech second growth woodland, or in remnants of the primeval forest of rock maple, beech, yellow birch, and hemlock, which still survives in Big Cove, the tranquil song of the hermit touches one's moods with a profound loneliness.

It is in this far northern atmosphere, amidst the ghosts of spruce and fir, *Abies balsamea* (L.) Mill., represented only by huge decaying stumps and logs, that one finds abundant *Polemonium Van-bruntiae* Britton, *Almus incana* (L.) Moench., *Caltha palustris* L., *Carex leptonervia, Scirpus rubrotinctus, Scirpus atrocinctus,* and *Arisaema stewardsonii* Britton. The writer has found the last named plant locally abundant in certain swamps on the Little Blackwater River, and it is to be remembered as one of the most beautiful and distinctive jack-in-the-pulpits, with prominent bright green and pure white longitudinal stripings of the slender, strongly fluted spathes.

U. S. Department of Agriculture,
Washington, D. C.

A Forest Fire Prevention and Suppression Program for Virginia

Part I

F. C. Pederson,

State Forester of Virginia

Virginia has about fifteen and one-quarter million acres of forest land which is subject to recurring periods of high forest fire hazard during the spring and fall of each year, and in the drier years also to some extent during the summer months. A reasonable degree of protection against fire during these hazardous periods is absolutely essential if this vast forest and potential forest area is to be productively managed and if its recreational and economic potentialities are to be developed to the fullest extent. As a matter of fact, adequate forest fire control is basic and fundamental to any sound program of forest land use, whether the object of management is timber or pulpwood production, the prevention of erosion, the reduction of flood levels, the conservation of game and wildlife, or scenic and recreational developments. Adequate forest fire control has been aptly and correctly expressed as the common denominator of all conservation activities.

Leadership by the State is Necessary

Experience, past and present, clearly indicates that organized effort is necessary to secure any real control of forest fires which will safeguard the interests of the private owners and of the public. In order to formulate and carry out a definite, comprehensive and well outlined policy of forest fire protection, and in order to maintain the necessary machinery for impartial, equitable and yet vigorous law enforcement, it is essential that the State assume the leadership and responsibility for the conduct of the work. It should also be recognized that the land owners are responsible for only a small percentage of the fires which occur on their properties; they are largely caused by carelessness on the part of brush burners, smokers, campers and the general public, and it certainly becomes a public duty and function to prevent, as far as possible, the occurrence of such fires and to extinguish them after inception. Again, it is proved by experience in Virginia that State leadership stimulates activity by private owners of timberland. The activity is manifested by four Timberland Owners' Forest Fire Protective Associations which are now organized in the State.

By far the greatest part of the acreage in Virginia in need of protection from fire is privately owned, less than eleven per cent belonging to the Federal Government and the State. In size

these private holdings range all the way from a few acres in the case of farm woods to tracts of about 75,000 or more in the case of certain corporations. Altogether there are probably at least 350,000 individual and corporate timberland owners in the State. This diversity of ownership, and the consequent diversity of the interests represented, seriously complicates the problem of protection. It also precludes the possibility of successful private effort except in the case of small isolated tracts or of large compact holdings in the hands of interested corporations or individuals. For this reason, therefore, as well as from the standpoint of public interest in the protection of the State's present and potential forest resources, State effort is essential to make protection from forest fires effective.

The Administrative Organization As It Is

The fact that periods of great fire danger in Virginia are usually of relatively short duration within the spring and fall months makes it necessary that the fire control organization be a flexible one and that the personnel who are charged primarily with the suppression of fires be employed on an hourly basis. At the same time, it is of the utmost importance that the skeleton organization so created be sufficiently permanent to insure prompt action when the need arises. In view of these considerations, the Virginia Forest Service has gradually developed the following plan of organization, which is varied slightly when necessary to meet local conditions.

At the present time the organized territory in the State is divided into five administrative units, each in charge of a district forester, who, in addition to the conduct of other forestry work in his assigned territory, has general supervision and control of the forest fire organization within his district. Funds available for forest fire protection from the State, federal government and private owners jointly are entirely insufficient to protect all the forest land in the State where the need of protection is urgent and is recognized. It has, therefore, been the policy of the State Forest Service to carry on systematic work only in the counties where substantial cooperation, financially and otherwise, can be secured. For this reason the fire control organization in Virginia has been subdivided into county units, the object being to make each unit thus established complete in itself, and competent in itself, except in cases of extreme emergency.

In each organized county a chief forest warden is placed in charge of all the fire prevention and suppression work. He selects local forest wardens upon whom dependence is placed for leadership in the actual suppression of fires. The chief warden also posts notices, inspects land-clearing operations before actual brush burning takes place, examines sawmill sites and railroad

rights-of-way, visits schools, and takes every practical means in the short time allotted to him for such work to mobilize all the forces in the various communities which are capable of assisting in the prevention and suppression of forest fires. In addition to this warden organization, which by the first of the year comprised a total personnel of 1,640 men, registered or listed fire fighting crews, who work under the direction and supervision of the local wardens, have been organized in the counties in which provision has been made for the employment of fire fighters.

Only 79 out of 100 Counties are Protected

The spring season of 1941 closed with seventy-nine of the one hundred counties in Virginia organized for forest fire control by the State Forest Service in cooperation with county officers in accordance with the provisions of Section 541 of the Virginia Code, and with the Federal Government under the terms of Section 2 of the Clarke-McNary Act. Within these counties protection is afforded to 10,922,500 acres of privately-owned timberland. In addition, intensive protection is given, by the U. S. Forest Service or by the National Park Service, as the case may be, to about 1,557,500 acres of forest lands that are federally owned. Thus on about 12,480,000 acres, or approximately 82 per cent of the forest land in the State which it is recognized needs protection, provision has been made for systematic fire control work.

Such protection, however, aside from that given to the federal lands, is not as intensive as the values at stake demand or as more liberal State appropriations and federal allotments would make possible. The remaining 2,727,000 acres of forest land in Virginia receive no organized forest fire protection whatsoever except as individuals may have occasionally arranged for extinguishing fires on their own properties.

Organization and Expenditures Called For in Recently Proposed Budget

At the present time no one can say positively what organization will insure adequate forest fire control in Virginia on a State-wide basis or just what it will cost. By adequate protection I have in mind a reduction of the fire loss to such an extent that the average annual burned acreage will not exceed one-fourth of one per cent of the total area protected, or will be so small that insurance companies will ordinarily insure at a rate which the forest owners can afford to pay. However, based on experience with the problem in Virginia and the results secured in other states, a detailed budget has been carefully prepared which calls for an annual expenditure of approximately $450,000.00, and which represents the estimated cost of adequately

protecting all the State-owned and privately owned forest lands in the State. The outstanding features of this budget are provisions for:

1. Employment of an assistant forester to plan, direct and coordinate forest fire control work on a State-wide basis.
2. A protective organization of about 3,000 forest wardens, adequately equipped to handle the normal fire situation and to organize and direct protection work effectively during emergency periods.
3. A state-wide detection system of 140 steel towers with sufficient telephone construction so that information on fires may be promptly relayed to the fire fighting personnel.
4. An adequate fund for the employment of fire fighters and emergency patrolmen as needed during critical periods.
5. The establishment of thirteen fully organized and equipped administrative or protective districts, each in charge of a district forester.
6. The employment of chief forest wardens on a monthly basis for an average of about five or six months in the year.

Division of Costs Between Different Agencies

Virginia is not yet spending one-fourth of the estimated amount needed for a thorough job. During the fiscal year ending June 30, 1941, a total of $125,216, exclusive of payments made for the maintenance of CCC improvements, was expended on the fire control project. Of this amount the State provided 58 per cent; the federal government, 27 per cent; the counties organized for fire control, 13 per cent; and the balance, 2 per cent, was paid out of private funds.

To find means for a State-wide fire control system on approximately the scale outlined, with financial and other responsibilities assumed by all beneficiaries—owners, county, State and nation—is the primary forest problem. Because of the large number of forest owners in Virginia and the fact that the bulk of the forest land in the State is in relatively small holdings, it is believed that the individual landowners' responsibility for financial support of the fire control program can be most effectively met by payment of small percentage of the total costs involved being paid for by the counties out of the general property tax fund. Where land ownership is in relatively large units contiguously located, it is feasible and desirable from the standpoint of more intensive protection to form protective associations in which the cooperating members voluntarily pay for the cost of necessary improvements and for special protection work. With the smaller holdings, however, it is not feasible from an administrative standpoint to attempt to consolidate them into association units.

Dollars and Cents Unsatisfactory as a Gauge of Damage

From a financial standpoint, damage is the proper basis for judging the seriousness of the fire situation. Unfortunately, damage figures are the least satisfactory and the least dependable of all fire statistics, due to the lack of uniformity in the method of estimating damage and to the marked difference of opinion as to damage done. What the losses from woods fires in Virginia were prior to organized protection in the State no one can say, and it would be useless to estimate. But what they are today is a matter of vital concern to each and every one of us for it represents a preventable loss and an economic waste for which the present generation and posterity will suffer. The best available estimates, based on reports submitted over a period of years by forest wardens in the counties organized for forest fire control, indicate that the direct tangible property loss caused by forest fires in Virginia averages at the present time between one-half and one million dollars a year. This, however, represents an ultra-conservative estimate, as the forest wardens' appraisal of damage makes no pretension of taking into consideration such intangible losses as the destruction of reproduction, substitution of less valuable for more valuable species of forest trees, reduction of the productive power of the forests, adverse effects upon stream flow, stimulation of soil erosion, killing of game animals and other wildlife, and destruction of recreational and scenic values. Moreover, as a rule, the wardens' appraisals give little, if any, weight to the potential value of young growth. If all these losses could be accurately gauged and converted into terms of dollars and cents, it is probable that the average annual fire bill for Virginia would run into several million dollars.

Causes of Forest Fires

Forest fires in Virginia are more than ninety-nine per cent man-caused. They are, therefore, largely preventable. Fires from lightning or other natural causes are extremely rare—practically all are due to carelessness, indifference or ignorance. Among the classified causes, as reported by the forest wardens for the past five-year period (1936-1940), smokers lead with a total of 658 fires per year on the average, or 33 per cent of the total number. Brush burning operations accounted for the origin of 25 per cent, 9 per cent were of incendiary origin, railroads were responsible for 6 per cent, campfires for 5 per cent, and lumbering operations 2 per cent, while 5 per cent were due to miscellaneous causes and 15 per cent were of unknown origin.

(To be concluded in a later issue.)

Source of Sediment of the Tuscarora Sandstone In Massanutten Mountains, Virginia[1]

EGMONT HORN AND HENRY H. WOODS

A petrographic study was made of the Massanutten Sandstone near Passage Creek at the north end of Massanutten Mountain in Shenandoah County, Virginia. The purpose was to determine the source of the sediments and thus to shed light on some phases of the paleogeography of early Silurian time and the extent and effects of the Taconic Revolution.

The Massanutten Sandstone lies at the base of the Silurian. It is a pink siliceous quartzitic sandstone, fine grained to conglomeratic, and is about 800 feet in thickness, thoroughly indurated and very resistant to weathering.

Fifteen samples were collected at intervals of 75 feet from a moderately dipping outcrop. These samples represent the lower 400 feet of the formation. About 2 pounds of each sample were chipped from points within a 5-foot radius of each sampling station. In the laboratory the preparation of the samples followed the usual procedure of sedimentary petrology.

The following minerals were found:

Quartz was the only mineral found in the light separates. Although a few grains were rounded, most were sub-angular.

Zircon was by far the most abundant heavy mineral. Euhedral crystals were more prevalent than rounded grains. This mineral may be of either igneous or sedimentary derivation. In general it was "abundant".

Leucoxene was white or stained brown or yellow. The grains were irregular or rounded in shape. It probably is derived chiefly from decomposition of ilmenite. It frequently was in "flood" proportions and always at least "common".

Tourmaline was present, in various colors, as rounded grains.

Ilmenite was recognized by its sub-metallic luster and deep purplish-black color. It was usually present, but "rare". Basic or ultrabasic igneous rocks are the chief sources of derivation.

Magnetite was usually "rare", but persistent. Basic and ultrabasic rocks are the main sources of derivation.

Hematite was "rare" in the many samples in which it was found.

Rutile was found as rounded and sub-angular grains of dark yellow-brown color. It was present in most samples but was "rare" in frequency. It is often derived from the decomposition of ilmenite, however all of these grains probably are detrital.

One grain of *Augite* was found in each of three slides. Its presence indicates a crystalline rock source.

[1]Presented before the Geology Section of the Virginia Academy of Science, May 2, 1941.

A few irregular and sub-rounded grains of pink and colorless *Garnet* were found in two samples.

Pyrite was in "flood" proportions in one slide, but was not observed in any others. It is doubtless of authigenic origin.

Muscovite was found in one sample; it may be derived from many rock types.

The coarse clastic material of this formation indicates a source topography of considerable elevation. The mineral suite just described shows no indication of derivation of the sediment from metamorphic rocks. It consists predominantly of grains derived from pre-existing sedimentary formations, and as indicated by euhedral zircon and augite, from some igneous rocks.

Rogers[1] found minerals of metamorphic rock derivation in the same stratigraphic position as the basal Massanutten Sandstone (Tuscarora Sandstone) in Pennsylvania. This indicates that some of the Tuscarora Sandstone in Pennsylvania probably came from Appalachia, far to the east. Hence this would be a source quite different than that of the sediment at Massanutten Mountain, Virginia. The latter did not come from metamorphic rocks of Appalachia, but was derived from Cambrian sandstones and igneous rocks probably located in the Blue Ridge area. Thus we have another unit in the accumulating evidence that the Blue Ridge was elevated before early Silurian time and acted as an effective barrier against the westward transportation of sediment derived from Appalachia.

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[2]Unpublished Master's Thesis at Cornell University, "A Petrographic Study of the Bald Eagle, Juniata, and Tuscarora Formations in Central Pennsylvania", 1939.

Native Grapes of Virginia

A. B. Massey

Few genera of our native plants have yielded the wealth of economic varieties and hybrids as have certain species of the genus *Vitis*—the grapes. Of the 30 species native to North America the greater part of the cultivated American grapes have come from the fox grape *Vitis labrusca.* This species occurs naturally from New England to Georgia and west to southern Indiana. Such familiar varieties as Isabella, Catawba, Concord, Champion, etc. have been developed by selection or hybridization from the fox grape.

At least eight of the North American species of grapes are native in Virginia. These differ markedly in their habit of growth, leaf shape and texture, the date of ripening of their berries, and the value of the berries for culinary purposes. Certain species make excellent jelly and beverages. The muscadine and its varieties, the scuppernong, Thomas, etc., are favored fall fruits in the south. The fruit of all are valuable food for birds and other forms of wildlife, hence, are valuable food and cover plants for wildlife refuges and for use on the farm to encourage farm game. They thrive along fence rows, field borders, stream banks, and out of the way places, hence occupying those areas the farmer rarely uses.

It is not uncommon to find native grapes which do not bear fruit. This is due to the fact that the vines are functionally male or female. An examination of the flowers of the grape will reveal the fact that both stamens (male) and pistils (female) are present. The flowers on some plants have erect robust stamens which produce pollen in abundance and a diminutive functionless pistil. On other vines the characters of the flowers are reversed. The stamens are small and turned down while the pistil is fully developed and potent. The pollenization of the latter results in the formation of berries. In the first type, since the pistil is functionless, no fruit is formed. Hence the vines with pistils and reflexed stamens are "female vines" and bear fruit if the flowers are pollenized from vines having erect stamens. All of the grapes native to Virginia are either male or female hence we cannot expect fruit from a vine growing alone unless it is a "female" vine which receives pollen from others vines in the surrounding country. When propagating native grapes by cutting or grafts it is essential to give attention to the type of plant which is propagated so that both male and female vines, with a predominance of the female, occur in plantings. The situation is different with the cultivated varieties and hybrids as the majority of these have functional male and female flowers on the same plant. However, the scuppernong and other cultivated varieties

of the muscadines are unisexual. Hence, wild male vines of muscadines must be present in the neighborhood in order to have fruit on scuppernong, James, Flowers, or Thomas varieties. All of these have been developed from the wild muscadine—*Vitis rotundifolia.*

The recognition of native plants is commonly based upon flower characteristics and to a less extent upon the characteristics of the other parts of the plant. The species of grapes, however, are recognized primarily upon fruit, leaf, young shoot, stem and tendrils characteristics. It is, therefore, important to give thought to the type of material taken when collecting specimens for identification. Information as to the distribution of grapes in Virginia is incomplete. The writer would be glad to receive specimens from all sections of the state. Duplicates are desired so that one may be retained and the second returned if the collector desires.[1]

Virginia Species

The summer grape—*Vitis aestivalis* Michx. occurs naturally from New York to Missouri, Florida and Mississippi. It grows vigorously in moist but well drained soil in sunny situations in thickets and hedge rows. The fruit is available through the fall and is relished by various birds. The vine is browsed extensively by deer.

Blue leaf grape—*V. aestivalis* var. *argentifolia* (Munson) Fernald. *Rhodora* 38:428 (*V. bicolor*, LeConte in Gray's Manual 7 Ed.). Distributed from New England and Illinois to North Carolina and western Texas. In Virginia it is more frequent in the mountain province. It is a vigorous high climbing vine in sunny or partially shaded situations. The lower side of the older leaves are glaucous giving them a bluish appearance, hence the common name. The lower leaf surface is much less pubescent than is the species. The petiole is usually glabrous. The small fruit ripens in September and hangs on the vine into late fall.

'Possum grape—*Vitis Baileyana* Muns. (With *V. cordifolia* Michx. in Gray's Manual 7th Ed.). This is a species of limited distribution occurring in West Virginia, Virginia, North Carolina to Tennessee and Georgia. It is a slender, climbing, much branched vine. It is distinguished from *V. vulpina* by the pubescent petiole and lower leaf surface, especially along the veins. The berry cluster is compact due to the short pedicel fruits. The species was first described by Munson from plants received from Roanoke County, Virginia. The fruit ripens in August and September.

Frost grape—*Vitis vulpina* L. (*V. cordifolia* Michx., in

[1]The writer is planning to extend the study of the grapes to include the southern Appalachian region. Herbarium material fully labeled, and preferably unmounted, will be gladly checked or labeled. Duplicates will be appreciated where possible.

FROST GRAPE—*Vitis vulpina* L. (*V. cordifolia* Michx., in Pennsylvania to Florida, eastern Kansas and Texas. In Virginia it is frequent over the state especially in the mountains and Piedmont. It is a large, vigorous, high climbing vine. The leaves are thin bright green on both surfaces and rather glossy. The fruit ripens in October though it is sometimes available earlier, especially to wildlife. It grows on limestone on sandy soil and is tolerant to very low temperatures.

FOX GRAPE—*Vitis labrusca* L. Occurs from New England to Georgia, Tennessee and southern Indiana. In Virginia it is well distributed over the state but more frequent in the Blue Ridge mountains and Piedmont provinces. It is conspicuously infrequent in the Alleghany Area. Leaves are thick dark green above, heavy tomentose underneath. Berries large in small clusters.

FOX GRAPE—*Vitis labrusca* var. *subedentata,* Fernald (*Rhodora* 42:462-463, pl. 637. 1940). ". . . . . var. *subedentata* has the margins of leaves accompanying inflorescences with only obsolescent teeth, the subuli at the ends of the stronger veins relatively short, the shoulders usually poorly developed and rounded or broad and subhorizontal, and the dense felt of the lower surface very close and fine, its component hairs scarcely discernible under slight magnification (Plate 657, Fig. 3). In fact the lower surface glistens as if varnished . . . ." Distribution, southeastern New York to Virginia.

SAND GRAPE—*Vitis rupestris* Scheele. This species is a low form often appearing to be more of a bush than a vine. It is not recorded as being frequent anywhere in Virginia, but more in the west. The name, sand grape, has been applied to it since it is found in sandy ravines and hillsides, especially near streams.

FROST GRAPE—*Vitis raparia* Michx. (*V. vulpina* L. in Gray's Manual, 7th Ed.). The most widespread of the native North American species. It occurs along woodland borders, in fields, along roadsides, along river banks, New Brunswick and Quebec to Manitoba south to Tennessee, Texas and Colorado. In Virginia it is not as frequent as some of the other species.

ASHY LEAVED WINTER GRAPE—*Vitis cinerea* Engelm. This is a Coastal Plain species which reaches its known northern limit in southeastern Virginia. It is not so abundantly distributed in Virginia as is the variety.

RUSTY WINTER GRAPE—*Vitis cinerea* var. *floridana* Munson. Frequent in rich low grounds in southeastern Coastal Plain. Differs from the species in the rusty color of the tomentum.

MUSCADINE—*Vitis rotundifolia* Michx. A very vigorous vine climbing high in trees, along fences and over thickets. Common in the Piedmont and the Coastal Plain. The scuppernong is a variety of this. This species is easily distinguished from others. The bark is tight not shredded, tendrils are not branched, the berries, which form small clusters, are large, thick skinned and the pith is continuous through the nodes.

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Further Genetical and Cytological Studies on a Sea-side Ecotype of Aster multiflorus Ait.

Albert L. Delisle and Mary Rebecca Old

Introduction

Since the summer of 1937, the senior author has been conducting some genetical observations on a sea-side ecotype of the widespread *A. multiflorus*.[1] This specimen was collected at Montauk, (Plate 2), Long Island, in June, 1937, from a large group of similar plants growing in that vicinity. The location of these plants was at a distance from the shore, well within the line of demarcation separating the vegetation from the shore sand. A few plants, however, were found growing on the shore sand and these were not different in growth habit from the others.

From Table I, and Figures 1 and 2, Plate 1, it will be noticed that the most conspicuous difference between the type specimen and the variety is found in the mode of branching. The type species is very much branched (Delisle, 1937) and bushy and its branches are ascending or spreading. The variety, however, though much branched and bushy, has very stiff and wiry, descending lateral branches. There are minor differences also, in habitat, form of involucral bracts, and in size of achenes. In the variety, the involucral bracts have thick herbaceous tips (not whitish and squarrose as in the type) and are rather mucronate at the top.

Breeding experiments conducted on *A. multiflorus* and *A. multiflorus* var. *depressa* over a period of two years have shown them to be self-sterile. Repeated controlled pollinations[2] from the same plant have consistently failed to produce achenes. However, cross-pollination is effected easily and results in good sets of seeds.

For comparison with the type species, *Aster multiflorus,* specimens of which have been grown for 5 or 6 generations and are very constant in their morphological characteristic, the Montauk variety, *depressa,* was grown from seed obtained under controlled pollination, for 2 consecutive years. The resulting plants were planted side by side with the original stock of the variety, *depressa.*

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1. The name *A. multiflorus* is used here because of its occurrence in Gray's Manual, 7th. edition, and other floras, instead of *A. ericoides,* which, according to Mackenzie, antedates it and under which the original description was made. (Mackenzie 1926; Blake 1930). In Small's Manual of the South Eastern Flora, *A. multiflorus* Ait., is described as *A. ericoides* L.
2. The same pollination technique was again followed as was used and reported in an earlier paper (Wetmore and Delisle, 1939).

Table 1

Comparison of Some Vegetative Characters in *Aster multiflorus* and *A. multiflorus* var. *depressa*.*

Characters	*A. multiflorus*	*A. multiflorus* var. *depressa*
Stem	Pale or hoary, slender with minute, close to hirsute pubescence. Usually low (0.3-1.0m.).	Hoary, with minute, close to hirsute pubescence. Low, close to ground. Branches with very marked tendency to spread. Tendency to root at nodes.
Degree of Branching	Very much branched and bushy. Branches ascending or spreading.	Very much branched and bushy. Branches very stiff and wiry. Branches descending. Heads on upper side.
Branchlets	Conspicuously pubescent with appressed hairs, pale or hoary, wiry.	Conspicuously pubescent with appressed hairs, pale or hoary, very wiry.
Rhizome	Perennial and spreading.	Perennial and spreading.
Habitat	Dry sandy soil.	Dry, sea-side beach sand.
Time of Flowering	August to October.	August to October.
Heads	Very crowded, small, racemose.	Very crowded, small, racemose.
Involucre	Imbricated, outer part bristly ciliate, not glandular.	Imbricated, outer part bristly ciliate, not glandular.
Involucral Bracts	Herbaceous tips whitish, squarrose or spreading, 2.7-2.9mm., gradually passing into leaves on branchlets bearing the heads.	Herbaceous tips thickish, deep green, mucronate, 2.7-2.9mm., gradually passing into leaves on branchlets bearing the heads.
Corolla		
Ray florets	White.	White.
Length	4.0-4.4mm.	4.0-4.4mm.
Breadth	0.65mm.	0.65mm.
Number	10 to 20 (13)	10 to 20 (13)
Disc florets		
Length	3.5mm.	——
Breadth	0.6mm.	——
Number	9 to 10	9 to 10
Pappus	Single, uniform.	Single, uniform.
Achenes		
Form	Flattened, ribbed, weakly pubescent with short hairs.	
Length	1.3-1.6mm.	1.3-1.6mm (based on 50 seeds).
Breadth	0.58-0.61mm.	0.35-0.45mm. (based on 50 seeds).
Weight	2.0mg.	1.0-1.5mg. (based on 50 seeds).

*All measurements except height of plants and achene size are based on data obtained from samples of 100 or more.

For cytological studies, heads of the proper stage of development were fixed in acetic-alcohol—3 parts glacial acetic acid and 7 parts absolute alcohol—and transferred to 85 per cent alcohol, there to remain until examined.

Because of the small size of the chromosomes, smearing techniques were found not too satisfactory. The capitula were, therefore, embedded and sectioned in celloidin (Jeffrey, 1928) according to the technique and schedule outlined by Wetmore (1932).

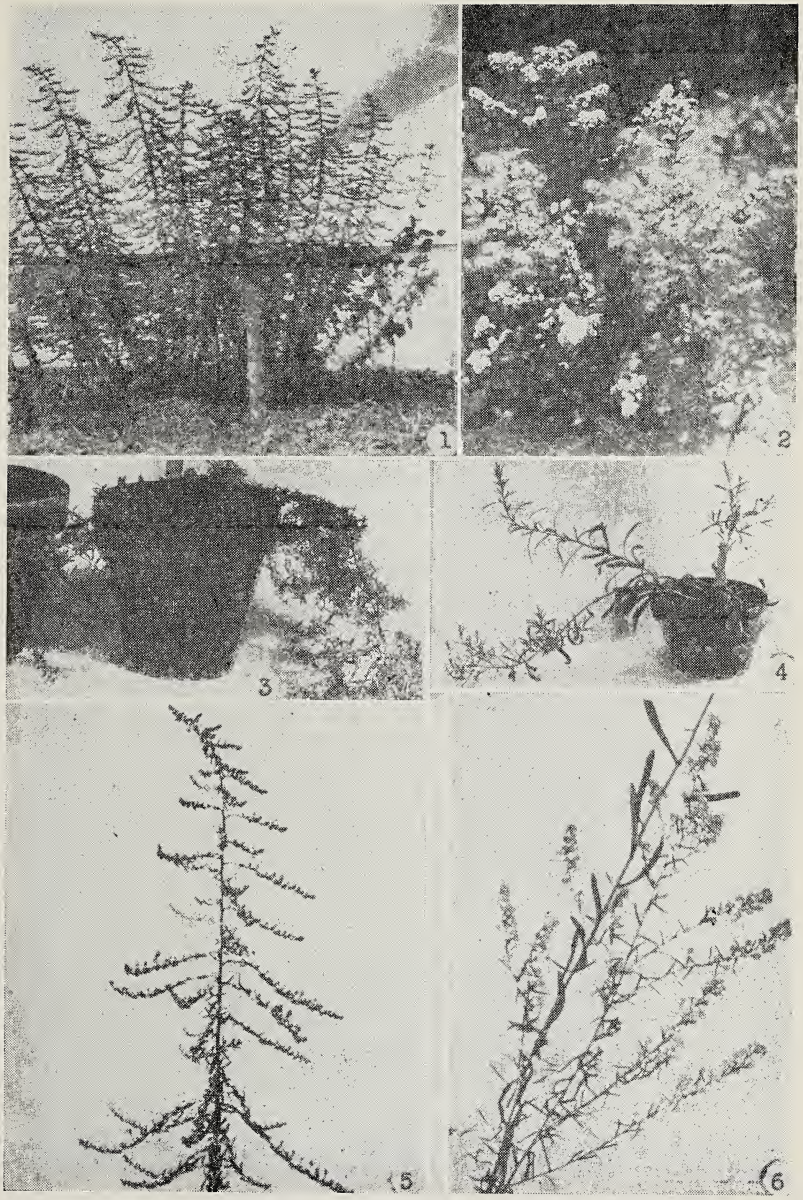

PLATE 1

Fig. 1. Mature plant of *A. multiflorus* v. *depressa*, grown from seeds obtained from plants similar to that in Fig. 3. Fig. 2. Normal, type specimen of *A. multiflorus*. Fig. 3. Original plant collected at Montauk, L. I., (later planted in the field and indistinguishable from specimen shown in Fig. 1). Fig. 4. Second generation plant from original Montauk stock. Figs. 5 and 6. Details of branches from plants in Figs. 1 and 2, respectively.

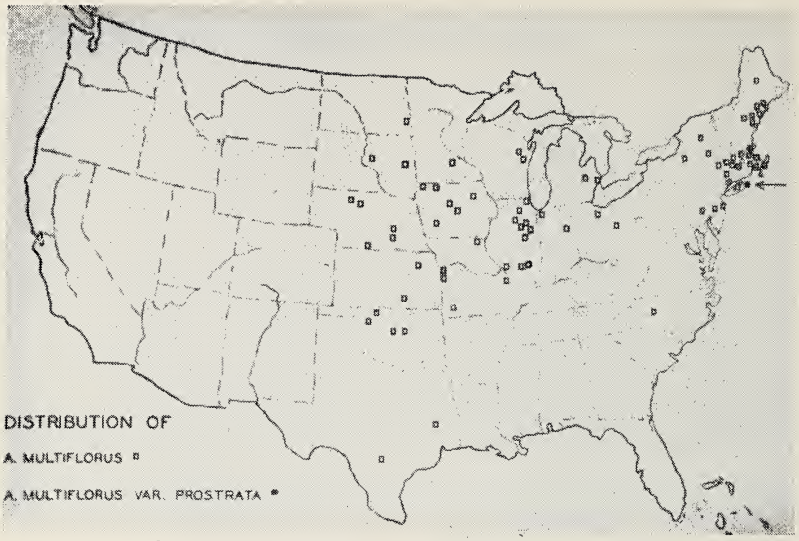

PLATE 2

Map showing distribution of *A. multiflorus*, from specimens examined at the Gray Herbarium. Arrow indicates location of the variety, *depressa*, when found.

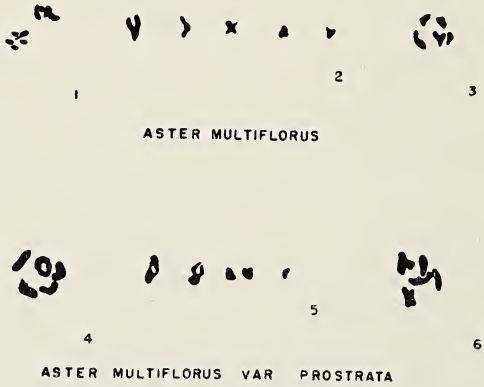

PLATE 3

Fig. 1. Late anaphase, showing 5 chromosomes at each pole. Fig. 2. Each pair of chromosomes in relative size. Fig. 3. Diakinesis. Figs. 1, 2 and 3, *A. multiflorus*. Figs. 4 and 6. Two views of diakinesis. Fig. 5. Each pair of chromosomes in relative size. Fig. 4, 5 and 6, *A. multiflorus* v. *depressa*. Note chromosome size differences between the type and the variety.

Observations

a. *Genetical.*

The specimens of the Montauk variety, *depressa,* transferred to the field and growing alongside *A. multiflorus,* have retained their peculiar branching. In fact, the wiry, stiff, descending characteristic branches of the variety have become accentuated under cultivation. It will be apparent from Figures 1, 3 and 4, that the Montauk variety has retained its characteristic branching even under cultivation over a period of 4 years.

The first and second generation offspring, obtained by controlled pollination, show no marked difference from the original mature Montauk, L. I. stock of the variety, *depressa,* of *A. multiflorus.* Plants of the second generation have not as yet been brought to maturity, however. They exhibit the same characteristic of wiry, descending lateral branches as their parents.

No developmental nor anatomical study of the seedlings have as yet been completed, though work of that nature is now in progress.

It is felt from preliminary evidence that the morphological variation from the type specimen, as reported in the Montauk variety of *A. multiflorus,* is probably in the nature of a mutation. Present evidence seems to indicate that it will breed true. Further genetical work is contemplated, especially, in studying the results of pollinating the variety with pollen from the type species.

b. *Cytological.*

The chromosomes of *A. multiflorus,* as previously reported, (Wetmore and Delisle, 1939), show much regularity in the behavior of all five pairs. Fig. 3, pl. 3 shows a view at diakinesis. One chromosome pair, as seen in Figure 2, is considerably larger than the rest. In addition to the large chromosome pair, there are two medium-sized, and two smaller pairs. The size ratio between the largest and the smallest pair at diakinesis, is approximately 2.5:1. The somatic chromosome number is 10.

In the Montauk variety, the meiotic chromosome number is also 5, (see Figures 4 and 6). There is no apparent difference in chromosome morphology between the type species and the variety. In Figure 5, the five pairs of meiotic chromosomes, at diakinesis, are drawn side by side to illustrate their morphology and relative sizes, for comparison with a similar arrangement in the type species. (See Figure 2.)

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Distribution and Duration of Meristematic Activity in Leaves of Smilax

BERNICE M. SPEESE

Introduction.—This is a brief report on the distribution and duration of meristematic activity, as determined by a study of mitotic frequencies, in leaves of *Smilax* L. The leaf-sampling method described in the first paper (Speese, 1939) of this series was used. The approach is direct and mathematical.

Meristematic Distribution.—Six species of *Smilax* were investigated with regard to comparative spatial occurrence of leaf mitoses. The species are listed in Table 1; specimens have been deposited in the United States National Herbarium. From leaves of the sizes in figures 1-6, at levels A, B, and C, one-millimeter-in-diameter samples were punched dorsiventrad from beside the midrib and from along the margin, and the number of dividing nuclei (arbitrary limits of mitosis were established) counted in each sample when smeared in iron-aceto-carmine. It is clear that six samples were taken from each leaf. (Figs. 1-6.) Since the six

TABLE 1

SPECIES OF *Smilax* INVESTIGATED AND THE NUMBER OF MITOSES COUNTED IN SAMPLES FROM ALONG THE MARGINS AND FROM BESIDE THE MIDRIBS OF LEAVES OUTLINED IN FIGURES 1-6; ALL THE LEAVES WERE FIXED AT 4:00 P. M.

Collection No.	*Species*	*Geographic Source*	*Fig. and Level*	*Mitoses at Margin*	*Mitoses at Midrib*
134	*S. glauca* Walt. var. *leucophylla* Blake	Keysville, Charlotte Co., Virginia	1A	55	18
			1B	207	61
			1C	264	83
133	*S. laurifolia* L.	Wilmington, New Hanover Co., North Carolina	2A	84	85
			2B	164	146
			2C	236	225
119	*S. lanceolata* L.	Wrightsville Beach, New Hanover Co., North Carolina	3A	108	53
			3B	284	173
			3C	360	210
135	*S. Bona-nox* L.	Myrtle Beach, Horry Co., South Carolina	4A	631	640
			4B	912	882
			4C	1532	889
114	*S. rotundifolia* L.	Clarke Co., Virginia	5A	722	556
			5B	977	940
			5C	1289	1064
110	*S. hispida* Muhl.	Clarke Co., Virginia	6A	523	607
			6B	1136	1198
			6C	1321	1226

TABLE 2

NUMBER OF MITOSES IN MARGINAL SAMPLES FROM FOUR LEVELS OF LEAVES OF *S. Bona-nox* AND OF *S. lanceolata;* BOTH LEAVES FIXED AT 10:00 A. M. IN *S. Bona-nox* A DECREASE IN MERISTEMATIC ACTIVITY IS CORRELATED WITH SINUS FORMATION; IN *S. lanceolata,* WITH THE DEVELOPMENT OF A TAPERING LEAF BASE.

Collection No.	*Species*	*Geographic Source*	*Fig. and Level*	*Mitoses at Margin*
135	*S. Bona-nox* L.	Myrtle Beach,	7A	55
		Horry Co.,	7B	80
		South Carolina	7C	68
			7D	121
119	*S. lanceolata* L.	Wrightsville Beach,	8A	19
		New Hanover Co.,	8B	142
		North Carolina	8C	200
			8D	127

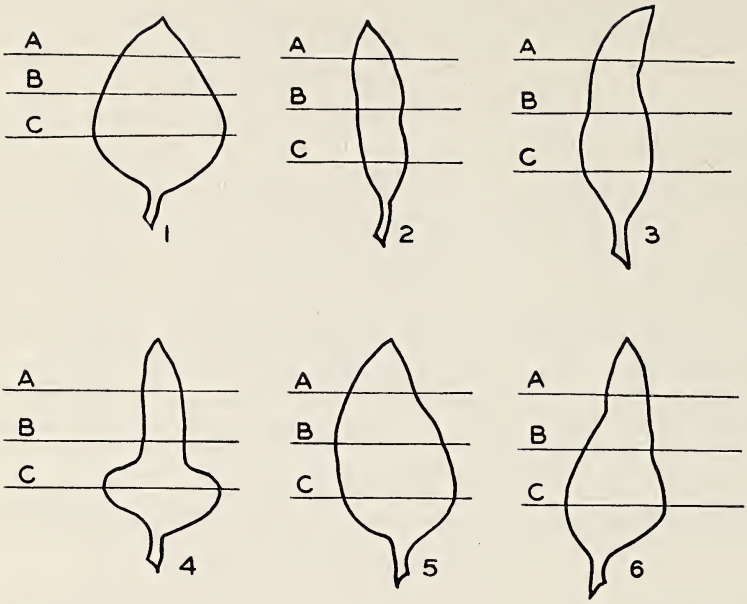
TABLE 3

NUMBER OF MITOSES IN SAMPLES FROM THE MID-POINT OF THE GREATEST LONGITUDINAL AXIS OF LEAVES OF DIFFERENT SIZES OF A CLONE OF *S. rotundifolia.*

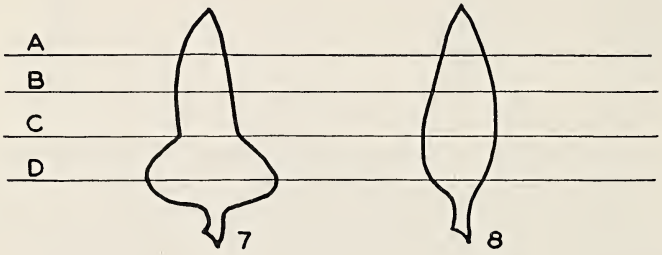
Leaf Size		
Length	*Width*	*Number of Mitoses*
12mm	5mm	1998
14mm	7mm	1703
22mm	10mm	1609
35mm	22mm	475
46mm	31mm	56
55mm	43mm	38
68mm	62mm	4
82mm	65mm	0

species are consistent in their indications, it may be considered that the observations are replicative. The results, presented in Table 1, show in these leaves a basipetal cessation of mitosis and a longer-continuing meristematic activity at the laminal margin than toward its center. (Table 1.) A compensatory reduction in mitotic frequency occurs near the leaf margin where a sinus is formed—as in *S. Bona-nox* L., and where the leaf base tapers —as in *S. lanceolata L.* (Figures 7 and 8; Table 2). The observations reported here are in accord with Avery's (1933) interpretation of leaf development of tobacco and with Myers' (1940) of *Coleus.* (Table 2.)

Meristematic Duration.—To discover the relative mitotic frequencies at various developmental stages of a leaf, nuclear



FIGURES 1-6.—Natural size outlines of the *Smilax* leaves investigated and the levels designated at which samples were taken from along the margins and from beside the midribs. Data in Table 1.



FIGURES 7-8.—Natural size outlines of leaves of *S. Bona-nox* and *S. lanceolata* with levels designated at which marginal samples were taken. Data in Table 2.

divisions were counted in samples from beside the midrib and at the mid-point of the greatest longitudinal axis in leaves of different ages. Eight leaves were so studied; they were fixed at 4:00 p. m., each being the fifth leaf above the base of a shoot from a clone of *S. rotundifolia* L. (Speese No. 95). The data for those leaves are recorded in Table 3. The division rate regularly lessens with increase in leaf size, and, therefore, in age, until, in the central area of the leaf of this plant, mitosis will have ceased when the length-width relation of the leaf is 82:66mm. Divisions continue near the margin until a greater leaf size is attained.

Summary.—As determined for six species of *Smilax*, there is a basipetal gradient for the mitotic rate in leaves, and divisions cease earlier in the central part of the leaf than at the margin. Increase in size, and accordingly in age, of a given leaf area is regularly correlated with decrease in mitotic frequency, until divisions cease.

Acknowledgments.—The author expresses her appreciation to Dr. O. E. White for the hospitality of The Blandy Experimental Farm, to Dr. J. T. Baldwin, Jr., for criticisms and for assistance in writing this report, and to Dr. C. V. Morton for identifying the plants investigated.

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Observations On Virginia Plants, Part II

F. R. Fosberg

II. On Certain Phytogeographically Significant Species

Fernald has remarked (conversation 1938) that the Piedmont region of Virginia does not contain much of sufficient interest to justify botanical exploration. The types of significant distribution outlined and illustrated by maps in his paper on the Inner Coastal Plain (Rhod. 39:321-366, 379-415, 433-459, 465-491, 1937) are all characterized by absence of the species in the Piedmont, at least from southern Virginia northward. Even a short collecting trip in the Piedmont region in southern Virginia in 1938, during which conditions for collecting were unfavorable due to floods and bad weather turned up a number of stations for some of these plants that are said to be absent from the Piedmont. More critical study of the grasses and sedges of the region might well yield many more.

These species from the Piedmont are listed below with several others of those mentioned by Fernald whose ranges are extended into the blank areas characterizing his types of distribution. They are arranged in the classes suggested by Fernald (l. c. 475-484).

Ia. **Hedyotis nuttalliana** Fosberg (*Houstonia tenuifolia* Nutt.). Clarksville, Mecklenburg Co. *Fosberg 15441* (UP, USNA) is definitely a Piedmont station for this species.

IIa. **Coreopsis verticillata** L. *Fosberg 15578* (UP) from 1 mile south of Zion, Louisa Co., and *Fosberg 15518* (UP) from 2 miles north of Wylliesburg, Charlotte Co., Va., as well as a number of collections in the New York Botanical Garden Herbarium, and several cited in Sheriff's monograph are from the Piedmont and break down the discontinuity between the Coastal Plain and Appalachian Upland areas of distribution for this species.

IV. **Elephantopus nudatus** Gray. A single Piedmont locality for this species is 12 miles east of Danville, Halifax Co., Va., *Fosberg 15393* (UP). Group IV is in Virginia supposed to occur on the "Sea-Island Half of the Atlantic Coastal Plain."

V. Several species of this group, supposedly occurring, in the Atlantic States, only on the Sea-Island half of the Coastal Plain, actually occur in the Piedmont or Piedmont and Uplands.

Pinus echinata Mill.

A good stand of this species occurs on a slope along Hyco Creek, north of Prospect Hill, North Carolina, in a typical Piedmont locality. *Fosberg 17634, 17636* (USNA). Munns (U. S. D. A. Misc. Pub. 287:26, map 22. 1938) indicates the range of this species as including the entire Piedmont, from southern New York south, and a large part of the Appalachian region. I have recently collected it in the Piedmont near Falls Church, Virginia. *Fosberg 18611* (USNA).

Amianthium muscaetoxicum (Walt.) Gray.

Found throughout the Appalachians from at least northern Pennsylvania, where I have seen it growing and where it has been collected (Herb. U. P.), to Lookout Mountain, Ga. (*Ruth 136* (US)). It is plentiful in the Blue Ridge of Virginia. Collections from Shenandoah Park are to be cited in a paper on the Park flora. Various specimens from the mountains are in the herbarium of the U. S. National Arboretum and in the U. S. National Herbarium. (See also R. S. Freer, Claytonia 4:49. 1938.)

Dioscorea quaternata (Walt.) Gmel. var. **glauca** (Muhl.) Fern.

This variety is abundant in the Shenandoah National Park in the Blue Ridge of Virginia as is shown by numerous specimens that I am citing in a paper on that region. This seems to be the common *Dioscorea* there. Numerous collections are in the U. S. National Herbarium and the U. S. National Arboretum from the Appalachians, from North Carolina (*Standley 5645, Standley & Bollman 9963, 10125, Townsend* in 1897, etc. (US) as far north as southern Pennsylvania (*Tidestrom 7315, 7386, Rose & Painter 8123* (US)) and western Maryland (*J. Donnell Smith* in 1878 (US)), and from the Blue Ridge on the east as far west as the Cumberland Plateau in Tennessee (*Weatherby 6260* (US)), and West Virginia (*Steele & Steele* in 1893 (US)). On the Piedmont there are a number of collections from at least the outer edge, as in the vicinity of Baltimore and Washington in Maryland and Virginia and near Durham, N. C.

Quercus phellos L.

Observed to be fairly common north of Clarksville, Mecklenburg Co., Va., in 1938, but being sterile, was not collected. Also found near Falls Church, Fairfax County, *Fosberg 18605* (USNA).

Chionanthus virginicus L.

Common at Plummers Island and found at several other Piedmont localities in the Potomac Valley, in Virginia and Maryland. There are many collections of it in the U. S. National Herbarium from the Appalachian region from Alabama to southern Pennsylvania.

Scutellaria integrifolia L.

I found this in two Piedmont stations in southern Virginia, 6 miles north of Clarksville, Mecklenburg Co. *Fosberg 15499* (UP), and 12 miles east of Danville, Halifax Co., *Fosberg 15638* (UP). Numerous other collections from the Piedmont of Virginia, Maryland, Pennsylvania and New Jersey may be found in the herbarium of the University of Pennsylvania and the U. S. National Herbarium. Epling has annotated most of those in the National Herbarium as ssp. *typica*.

Salvia lyrata L.

Also occurs at the locality 12 miles east of Danville. *Fosberg*

1535 (UP). Other Piedmont collections from Virginia, Maryland, Pennsylvania, and New Jersey are represented in the U. S. National Herbarium and at the University of Pennsylvania and New York Botanical Garden. There are also collections from the mountains of North Carolina (*Vasey* in 1878 (US), *Standley 5612* (US)) and West Virginia (*Martin 531* (USNA)).

Diodia virginiana L.

This species seemed fairly common in rather disturbed ground along Lawson Creek, southwest of South Boston, Halifax Co., Va. *Fosberg 15415* (UP) and 6 miles north of Clarksville, Mecklenburg Co., Va., *Fosberg 15479* (UP). It has also been collected in the Piedmont near Monroe, Union Co., N. C., *McQuilkin 55* (USNA).

Va. Of this class, supposedly absent from the Piedmont region, the following eleven species have been collected in the Piedmont.

Castanea pumila (L.) Mill.

The chinquapin has been found in at least two localities in the Virginia Piedmont: 1 mile south of Zion, Louisa Co., *Fosberg 15572* (UP); Palmyra, Fluvanna Co., *Eggleston 17757* (US). Also, two in Chester Co., Pa.; Nottingham, *Pennell 2260* (US, UP); West Town Farm, *Maris 134* (US), *Smedley 139* (US).

Quercus marilandica (L.) Muench.

From the Piedmont in Virginia, Mecklenburg Co., 6 miles north of Clarksville, *Fosberg 15503* (UP), and various collections from the Piedmont of southeastern Pennsylvania. (UP). It has also been observed to be not uncommon in the Piedmont of Maryland.

Ulmus alata Michx.

Fernald's map (No. 54) shows the distribution of this species, in Virginia, to be strictly limited to the Coastal Plain. It was seen in some abundance in several localities in the southern Piedmont counties of Virginia. One collection was made 6 miles north of Clarksville, Mecklenburg Co., *Fosberg 15449* (UP). This seems merely a northern extension of its Piedmont occurrences further south in North Carolina.

Phoradendron flavescens Nutt.

Allard has collected this species in the Bull Run Mts. in the Virginia Piedmont (No. *8306* (US)) and I have seen several clumps along the highway between Washington and Charlottesville.

Clitoria mariana L.

Fernald's map (No. 55) shows this species in Virginia to be common on the Coastal Plain and more rare in the mountains of the southwestern part of the State, but absent from the Piedmont. It is present, but rare, in Halifax Co., 12 miles east of Danville, east of the Dan River, *Fosberg 15400* (UP).

Rhus quercifolia (Michx.) Steud.

Barkley's map (Ann. Mo. Bot. Gard. 24:421. 1937) shows this species absent from the Piedmont. I found it in two Piedmont localities, in neither of which it was common. Louisa Co., 1 mile south of Zion, *Fosberg 15575* (UP); Prince Edward Co., near Kingville, 5 miles south of Farmville, *Fosberg 15541* (UP). These collections seem fairly distinct from the common *R. toxicodendron* in their erect habit and hairy, cut leaflets.

Obolaria virginica L.

This has been found in the Piedmont 1 mile northeast of Birchrunville, Chester Co., Pa., *Fosberg 1624* (UP), and on the Virginia side of the Potomac River above Georgetown, *Palmer & Morris 129* (US).

Campsis radicans (L.) Seem.

On the Virginia Piedmont along Lawson Creek, southwest of South Boston, Halifax Co., *Fosberg 15425* (UP). I have also seen it on Plummers Island, Montgomery Co., Md., in the Potomac.

Diodia teres Walt.

This has been found on the Virginia Piedmont along the Pigg River, Pittsylvania Co., *Fosberg 17595* (USNA), and in Pennsylvania at Easton, *Porter* in 1895 (US).

Elephantopus carolinianus Willd.

Extends into the Piedmont along the Potomac at least as far as Great Falls, Fairfax Co., Va., *Fosberg 16665* (USNA), and Great Falls, Montgomery Co., Md., *Hermann 9861* (USNA).

Chrysopsis mariana (L.) Nutt.

Also found extending into the Piedmont along the Potomac above Georgetown on the Maryland side, *J. D. Smith* in 1880 (US). It is also in the Virginia Piedmont along the Pigg River 8 miles west of Gretna, Pittsylvania Co., *Fosberg 17617* (USNA).

VI. Members of this category are supposed to be absent from both the Piedmont and the Appalachian Upland, though found on the Coastal Plain and in the interior of the Continent.

Iresine rhizomatosa Standl.

The type locality of this species is Plummers Island, Md., in the Potomac above Washington, D. C. This island is a large mass of rock, typically Piedmont. I do not know of the species from elsewhere east of the lower Mississippi drainage.

Magnolia tripetala L.

This species is found scattered along the eastern side of the Appalachian system. Virginia: Bedford Co., *Curtiss* (US); Rockingham Co., Swift Run Gap, *Fosberg 18245* (USNA); Madison Co., near Nethers, seen but not collected. Pennsylvania: York Furnace, York Co., *Crawford 6192* (US). West Virginia: In at least two places—Perryville, McDowell Co., *Morris 1131* (US), and Procius, Clay Co., *Palmer 35528* (US).

Gillenia trifoliata (L.) Moench.

This species is common throughout the Appalachians from Canada to North Carolina, and this is evidently its main area of distribution. Judging from material in the National Herbarium it is absent, or practically so, from the interior of the continent west of the Appalachian system.

Cephalanthus occidentalis L. var. **pubescens** Raf.

This form is represented from the Virginia Piedmont by one specimen from Prince Edward Co., *J. D. Smith* in 1880 (US).

Triosteum angustifolium L.

Two collections of this may be recorded, one from the Piedmont at Ellicott City, Howard Co., Md., *Arsene 703* (US), and one from the Blue Ridge of Virginia on Trayfoot Mountain, Rockingham Co., *Fosberg 17411* (USNA). It has recently been reported from West Virginia by Gilbert (Castanea 3:83. 1938).

VII. **Symphoricarpos orbiculatus** Moench.

In the Virginia Piedmont along Lawson Creek, southwest of South Boston, Halifax Co., *Fosberg 15419* (UP), and along the Pigg River 8 miles west of Gretna, Pittsylvania Co., *Fosberg 17267* (USNA). There are also various collections of this in the U. S. National Herbarium from the Piedmont and mountains of Virginia, North Carolina, West Virginia and Tennessee. It is frequently a component of the existing vegetation, seemingly quite at home, but I would certainly hesitate to say where its natural range ends and where it has been introduced since European settlement.

Conclusion

It seems likely that, in many of these cases of broken ranges, at least two other factors besides the physiographic history of the region are of importance. First is the lack of detailed knowledge of the actual extent of their occurrence in the blank places on the distribution maps; and second, the presence or absence of suitable habitats. This, of course, is related to the history of the region, both physiographic and human. When the likely habitats are examined in the intervening regions, many more of these plants may be found where they are not now known. Also, examination of material already in various herbaria may fill out some of the gaps. It seems altogether likely, in a continental area with no serious barriers to the spread of plants, that any species may be found wherever the proper combination of environmental factors permit it to become established. What these conditions are, however, is scarcely known for most species of plants, excepting one or two factors such as acidity and temperature.

Bureau of Plant Industry,
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Washington, D. C.

GENERAL NOTES

TWO VIRGINIA FERN RECORDS.—While the Netvein Chainfern, *Lorinseria areolata* (L.) Presl, is common on the Coastal Plain, it is rare in the uplands. On May 23, 1940, an extensive colony of it was discovered in a swamp along U. S. Highway #15 about 3 miles southwest of Fork Union, or a mile north of the new bridge near Bremo Bluff, in Fluvanna County.

The Daisy-leaf Grapefern, *Botrychium matricariaefolium* A. Br. ex Koch, has never been definitely recorded south of Maryland. On May 28, 1941, G. R. Fessenden, F. R. Fosberg, and the writer were collecting plants along the brook which runs northwest from Swift Run Gap, opposite the Spotswood Wayside Spring, in Rockingham County. Quite unexpectedly, Fessenden discovered a plant of this fern, and our combined search disclosed a colony of 10 individuals, on a wooded slope. In the interest of scientific record, five of these were collected for distribution to as many herbaria.—EDGAR T. WHERRY, University of Pennsylvania.