test of whether the substitution is desirable will be the agreement obtained between the original experimental frequency curve and the theoretical frequency curve corresponding to a given set of corner points.

Finally, a word must be added concerning the procedure necessary for handling possible quadratic factors in the transfer function. A fuller discussion of means for experimentally detecting such factors in the experimental system is reserved for a later paper. One possible approach may be indicated. The presence of a quadratic factor can be detected by observing or recording the transient response of a given system to a step function. Quadratic factors, corresponding to conjugate complex roots, reveal themselves in the transient by damped oscillations. If these can be measured with sufficient accuracy, the damping ratio ζ, and the time constant T_q, can be identified (*2, 7, 8*). The specific db-log frequency curve corresponding to a quadratic with the given ζ and T_q can then be determined by computation, or taken from a chart of nondimensional quadratic frequency curves (*7*). The total curve corresponding to the quadratic can then be subtracted graphically from the over-all frequency response curve, leaving a residual curve devoid of the influence of quadratic factors. The inverse method described above may then be applied.[7]

Once the asymptotic curve has been determined, the process of writing the corresponding transfer function is relatively simple. The frequencies of the various corner points are written along the ω axis in the form $1/T_k$. One now proceeds from the low frequency end of the graph, writing down factors to correspond to successive segments. An initial segment at a slope of 6 m db per octave implies a $(j\omega)$ factor with an exponent equal to m. It is located in the denominator if the slope is negative and in the numerator if it is positive. A time constant factor $(j\omega T_k+1)^n$ is written for each successive corner point, with the appropriate value of T inserted in the factor. The degree of the factor equals n, where the increment in slope of the segment following the corner point is $6n$ db per octave. If the increment in slope is negative, the factor goes into the denominator; if positive it goes into the numerator. In case a quadratic wave-form has been initially subtracted from any part of the experimental frequency curve, a corresponding factor, $(j^2\omega^2T_q{}^2+j\omega 2\zeta T_q+1)$, is inserted in the transfer function, with numerical values for T_q and ζ. A function constructed in the manner described represents the frequency-dependent part of the total transfer function, and may be designated as the function $G(j\omega)$, in the terminology of servotheory. It can be converted into the more general function $G(s)$ by substituting the complex variable s for $j\omega$ in all factors of the transfer function (*4, 6, 8*).

[7] A general estimate of the accuracy attainable with the inverse method, for all types of experimental frequency curves, is not as yet available. For the frequency curves with which it has been tried thus far, curves corresponding to transfer functions with four or five poles and zeros, it was found possible to determine correctly the number and location of factors, in numerator or denominator, and the frequency coordinate of the corner points, with errors of the order of 10% after three or four stages of approximation.

The magnitude of the constant gain coefficient K can be determined by inspection of the initial (low ω) segment of the asymptotic curve (*7, 8*). Its height above the zero db axis (given in db units, and converted into units of gain), at ω equal to one, gives the value of K. The final transfer function, $KG(s)$, thus derived from the experimentally given frequency curve, will be in factored, nondimensional form. From this form it can be readily converted to nonfactored form by multiplying out the various factors; and can then be reformulated as a differential equation (*8*, p. 238). In either form, it can serve as a compact representation of the system, and as a basis for predicting its response to any arbitrary disturbance.

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Some New Finds of Fossil Ganoids in the Virginia Triassic[1]

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In the course of an extensive study of the carbonaceous and bituminous sediments of the Triassic basins in Virginia, a number of heretofore unrecorded fossil fish localities were discovered and investigated.

In October 1942 Martin examined a fresh roadcut along State Route 55 near Thoroughfare Gap in Prince William County and discovered a heretofore unknown or unmapped extension of the nearest Triassic basin (*1*). Along the base of the cut the imprint of a ganoid about 6 in. long, including most of the head and forward fins, was found in an exposure of very soft and

[1] The authors are indebted to David Dunkle and Frank L. Hess for their valuable assistance in preparing the manuscript for publication and to Edward Wagstaff for aid in field surveys.

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moist, finely laminated, buff siltstone. The site was again visited a year later, and a complete impression of Semionotus was obtained. The discovery was brought to the attention of Dr. David Dunkle, associate curator of the Division of Vertebrate Paleontology of the Smithsonian Institution, who secured permission from the state government of Virginia to excavate the outcrop. A number of ganoids previously unknown to this area were discovered, some exhibiting important variations from species found elsewhere in the Newark System.

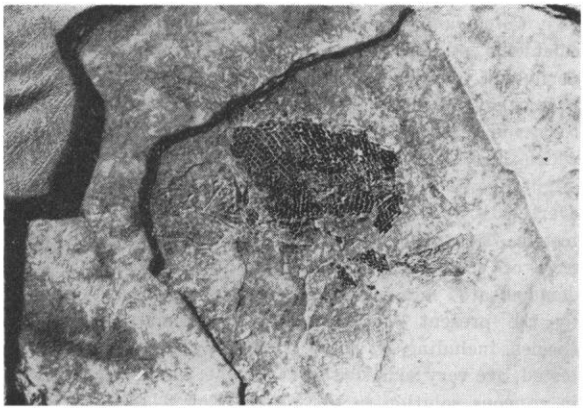

FIG. 1.

On March 6, 1949, further investigation in this district by Edward Wagstaff revealed a small exposure of a highly fossiliferous, dark-gray calcareous shale in the bed of Cotletts Branch, a small brook tributary to Broad Run. The exposure lies roughly one-fourth of a mile northeast of the roadcut. The shale is carbonaceous, very fissile, and considerably indurated. It yielded more distinct imprints and some well-preserved, more or less complete aggregates of scales, fins, and heads. Many of the components of the aggregates appear to be in their original form and proper relationships. The scales are highly polished and jet-black, presenting a marked contrast to the lighter-colored shale.

On July 4, 1946, in a search for agate (*2*), the float along Licking Run in Fauquier County was checked over a considerable distance. About one-quarter of a mile west of a narrow diabase dike a small fragment of dark, carbonaceous shaley limestone bearing jet-black, polished fish scales was found on a dry bar. On April 24, 1949, two years after the abnormally hard freezing and high waters of the winter of 1946–47, many more shale fragments containing fish remains, including one whole fish, were found on the same bar. Black rhombic scales and other parts of various fishes in an excellent state of preservation were fossilized in a dark, very fissile shale similar to that of the Cotletts Branch exposure, but much less indurated and more friable. Intermingled fragments of a coarsely laminated semicrystalline limestone also contained imprints. Some of the fossils were by far the best preserved of all fish found in the Potomac area up to this date. In the float, a large slab showed a nearly intact specimen of Redfieldius, about 9 in. long, with a beautiful mosaic of the scales and harder parts of the fins and head (Fig. 1).

Dr. Dunkle was informed of the discovery and accompanied Baer to Licking Run on May 7, 1949. The outcrop proved to be a veritable mine of fossil ganoids.

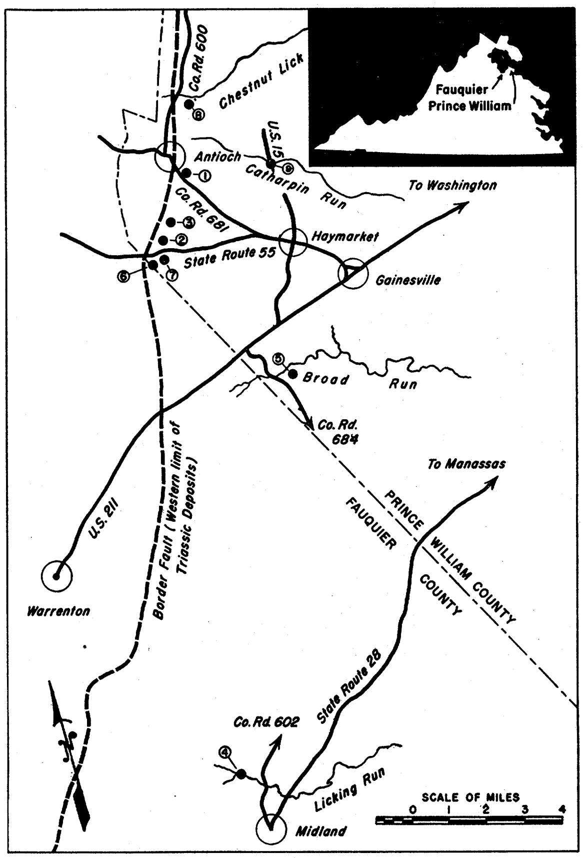

FIG. 2. Sketch map indicating approximate locations of the exposed fossiliferous shales. 1—Exposure in roadcut near Antioch. 2—Siltstone exposure in roadcut on State Route 55. 3—Cottletts Branch. 4—Licking Run location. 5—Broad Run location. 6—Millbrook Quarry. 7—Exposure in small stream near Millbrook Quarry. 8—Chestnut Lick exposure. 9—Exposure in excavation for bridge abutment. 5 ft below surface on U. S. Route 15.

NOTE: The U. S. National Museum has priority at the present time to remove material from the indicated fossil beds. Others must obtain permission to disturb the exposures.

The run was practically at the same stage of flood as on April 24, 1949, but warm enough by this time to permit comfortable wading. An extensive exposure of the fossiliferous shales, entirely submerged in midstream, was easily quarried by hand. Some of the softer layers appeared to be literally soaked with greasy bitumens, and in these the highest concentration of fossils was found, including most of the best preserved specimens.[4]

[4] Nodular lensiform masses, 3–5 in. long, were occasionally observed in the semicrystalline facies of the fossil beds. All specimens examined contained nuclei of nearly complete fossil fish.

About 30 pounds of fossiliferous slabs and fragments were selected and carried to the U. S. National Museum. Specimens of Catopteridae and Ptycholepis were particularly abundant. One large and very interesting impression was later classified as *Diplurus*. Small nodules, possibly coprolites of Triassic reptiles replaced by a phosphoric, carbonaceous material, were much in evidence (*2*).

The following approximate measurements of the exposures on Licking Run were taken under water, beginning with typical Manassas sandstone and extending into Bull Run shale:

8 ft—Pink and yellow shale with a few sandstones.
3 ft—Compact shale, alternating with thinly laminated siltstone.
$1\frac{1}{2}$ ft—Dark, carbonaceous, very fissile shale. } Fossil beds
$\frac{1}{2}$ ft—Dark, carbonaceous, coarsely bedded semicrystalline limestone. } Fossil beds
$3\frac{1}{2}$ ft—Thinly laminated siltstone and compact shale.
10 ft—Buff shale and sandstone.
.... —Typical red shale and sandstone.

This sequence is repeated with some variation in thickness at an exposure on the south branch of the south fork of Broad Run. However, in other exposures along a roadway near Antioch, along Chestnut Lick, in the Millbrook Quarry, in a small stream near by, and in the excavation for a bridge abutment along U. S. Highway 15 at Catharpin Run (Fig. 2), the basal sedimentary strata are concealed and the carbonaceous fossil beds have greater thicknesses (5 ft or more), grading upward into the typical red shale and sandstone. In the Millbrook Quarry, where considerable core drilling has been done, the dark shales grade downward into a dark, arkosic conglomerate having a known thickness of 180 ft. The two easternmost exposures on Licking Run and on Broad Run indicate a thinning-out of the dark shales, and farther eastward the chances of encountering the fossil beds seem small.

Wherever scales occur *in situ*, it is probable that more or less complete preservations of fish exist near by. Therefore, it seems safe to assume that fossil fish may be found in a belt at least 18 miles long and approximately $2\frac{1}{2}$ miles wide near the western Triassic border adjacent to the Bull Run Mountains, where scales are found in numerous exposures at well-spaced intervals. The discoveries outlined in this paper, not to mention the additional collecting possibilities in the entire fossiliferous belt, are significant if only because no ganoid fossils other than isolated scales have, to the knowledge of the authors, been recorded heretofore from the Triassic basins of northern Virginia. Furthermore, the character of the occurrence in siltstone near Thoroughfare Gap appears to be unique in the history of the Newark System.

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Colchicine Poisoning in Relation to Hemerocallis and Some Other Plants

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Colchicum species contain appreciable amounts of colchicine (*4, 5*). According to Blakeslee (*1*) and Levan (*3*), *Colchicum* species they tested were not subject to colchicine poisoning under the conditions of their experiments.

On the basis of these reports, it would seem logical to assume that plants, other than *Colchicum* species, which also contain appreciable amounts of colchicine, might likewise be immune to colchicine poisoning. However, this hypothesis apparently has not as yet been tested. According to Klein and Pollauf (*2*), the presence of colchicine in *Hemerocallis fulva* L. has been demonstrated microchemically; but extensive experiments by the present writer have shown that *Hemerocallis* species, including *H. fulva* L., and various hybrid clones tested, are very sensitive to colchicine, and concentrations in aqueous solution in the range from 0.025% to 0.1%, tested with appropriate application techniques, proved to be quite effective in inducing polyploidy. Concentrations much above 0.1% usually led to the eventual death of the treated plants.

A number of colchicine-induced *Hemerocallis* polyploids have flowered. Their polyploid nature was established on the basis of chromosome counts, and pollen grain and stomate size. One polyploid, Tetra Starzynski, $n = 22$, a tetraploid of the clone Mayor Starzynski, $n = 11$, has been named. Its flowers are larger and finer-colored than those of the diploid form. This removes all doubt about the effectiveness of this compound as a mutagen in this genus. The object of the present note is not to elaborate here on these results, which will be reported in detail elsewhere, but rather to consider very briefly their implication, particularly with reference to the validity of the microchemical method used for determining colchicine.

Klein & Pollauf (*2*) used a microchemical procedure for the determination of colchicine in *Hemerocallis fulva* L. In view of the marked sensitivity to this compound of *Hemerocallis* species, including *H. fulva* L. and hybrid clones, their results require verification. If their report can be verified, then it would appear, in this instance at least, that plants which contain relatively smaller amounts of colchicine could be affected by the application of relatively larger amounts of the compound. It is also desirable to check the reported colchicine content of species in other genera. In this connection, it is of interest to note that *Gloriosa rothschildiana* O'Brien (a plant closely related to *G. superba* L., which is reported to contain colchicine) is subject to colchicine poisoning in the range tested, 0.05%–0.2% concentrations, particularly in the case of small seedling tubers.