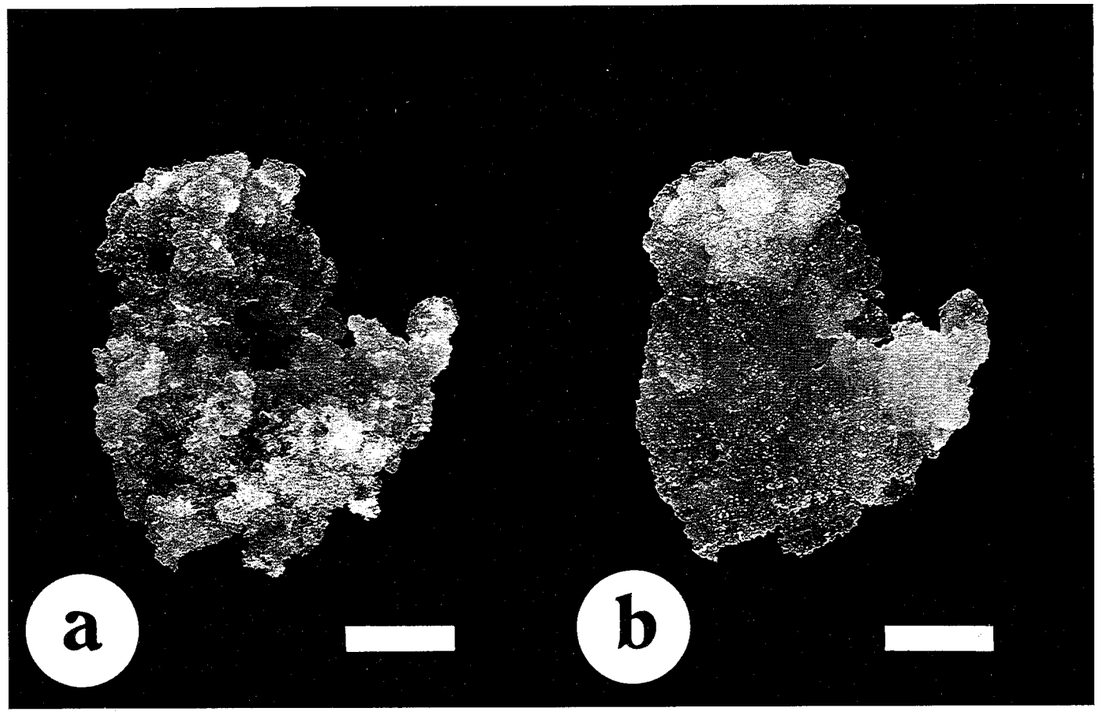

FIG. 1. Tobacco callus (a) removed directly from culture and (b) fixed with formalin-acetic acid-alcohol, infiltrated with polyethylene glycol 400, and stored in 80% polyethylene glycol. The reduced contrast in "b" is due to loss of pigmentation during the fixation process. Scale bars = 5 mm.

JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE 72(3–4):65–72 JULY–OCTOBER 1997

GEOLOGY, WIDTH, AND WEAR OF THE CHICKASAW PATH AND THE OLD NATCHEZ TRACE AT MERIWETHER LEWIS MONUMENT, LEWIS COUNTY, TENNESSEE

RICHARD G. STEARNS

Department of Geology, Box 1615, Station B, Vanderbilt University, Nashville, TN 37235

ABSTRACT—There are three generations of "traces:" the Chickasaw tribe's path of 1800; the Old Trace Road of 1801–1830; a truck road. The Old Trace Road is preserved along 2–27% grades. The path is cut off by the Old Trace Road, and the Old Trace Road is cut off by a truck road. The Old Trace Road lacks expected wagon ruts; perhaps, more numerous walkers and horses obliterated wheel tracks, or ruts were buried or eroded. Wear depth of the Old Trace Road is related to the geologic substrate. On colluvium and residuum from shaly bedrock, wear is 0.9 m. On cherty residuum from the Warsaw limestone, wear is 0.2–0.3 m on grades of 2–5%. Even on steep 24–27% grades on Fort Payne scraggy chert residuum, wear is small (0.2–0.4 m). The Path is ca. 2.1 m wide (range of 1.8–2.4 m, whereas the Old Trace Road is ca. 3 m wide (range of 2.4–3.8 m). This 3-m width of wear is consistent with an original cleared strip 3.7 m wide and a smoothed strip 2.4 m wide as specified in the contract of 1806. The path is significantly narrower than the Old Trace Road, but the Old Trace Road is not significantly narrower than the recent Truck Road.

The Natchez Trace was the early American (ca. 1790–1830) road connecting Natchez, on the Mississippi River, to Nashville, Tennessee, and points north. On it, people returned on foot or horseback, from boat trips down the Cumberland and Ohio rivers. It began as connected trails of the Chickasaw and other American Indian tribes. In 1801, the tribes gave permission for its regular use, and the United States government began to improve it soon after. It stopped being a thoroughfare when steamboats made upstream travel easier and when the "Jackson Military Road" through more populated areas came into use (ca. 1821). Sections were used as local roads, but other sections (including the study area) were abandoned. For a history and descriptions, see United States National Park Service (1941) and Phelps (1962). A portion of the abandoned trace, northeast of the Meriwether Lewis Monument, is the site of this investigation (Fig. 1). The old trace here and elsewhere along the Parkway has been mapped by the Park Service, and sheets showing the Parkway and Old Trace can be seen in the Park Museum in Tupelo, Mississippi.

The study site is typical of long stretches of the trace in Tennessee. It is in a sparsely-populated, infertile oak forest in the Western Highland Rim physiographic province. The trace is worn in soil developed on residuum from cherty Fort Payne and Warsaw formations (Colvin and Marcher, 1964). A mat of oak leaves covers the ground, including the abandoned trace; so, the old worn trace, once bare when it was heavily used, is protected from rain and surface runoff. This part of the trace has not been a thoroughfare for any traffic during the 20th century, as judged by the Columbia 30-min quadrangle (United States Geological Survey, 1902).

I was led to the trace by an interest in geology of the Western Highland Rim as early as 1958 when the Parkway was being built as part of the Park Service's "Mission 66." My research indicated an exceedingly slow erosion rate of the upland (Stearns, 1967, 1970). Erosion is nearly all by solution of soil grains in rainwater. The mineral particles in the upland soils are primarily nearly insoluble quartz and kaolin. I thought that remnants of the trace could be found that had been neither eroded nor buried. I was lead to an interest in the details of location by one of my students who studied military science. During a field trip, he opined that the "Old Trace" as marked by the Park Service at Meriwether Lewis was not likely to be the original Chickasaw path, because it followed the ridge crest; that way, travelers could be seen against the skyline from a distance on both sides. When I asked him to show me where he thought it should be, he soon found a now-unused parallel path. I have no proof that this very path is the Chickasaw trail, but, as a result of this experience, I have continued to explore the old trace, and I have indeed found and measured a segment of a "pre-trace" path.

Natchez Trace is known and preserved over great distances, but other trails are obliterated over much of their length. If possible abandoned remnants of other old trails are discovered, it would be useful to make quantitative comparisons between them and the Natchez Trace. For comparison, we need precise dimensions, but few if any measurements of the trace are published for Tennessee. Measurements reported herein will add to knowledge of the trace.

The trace had at least two "generations," the pre-1801 "Old Trace Path" and the post-1801 improved "Old Trace Road". These two generations are presented here; also, there are newer tracks herein called "Truck Road." Measurements of these are included.

SOME PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS OF WEAR OF TRAILS

Historical and industrial archaeologists have long studied the construction of roads that were improved for use of wheeled vehicles, but most studies of trails have only emphasized the

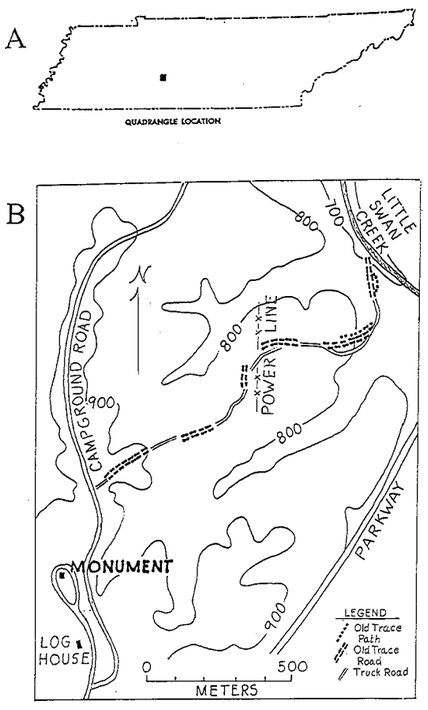

FIG. 1. Location of the study area: A) outline of Tennessee showing the location of the Gordonsburg 7 ½ minute quadrangle. Meriwether Lewis Monument is near the south edge of the map: B) the study area showing preserved parts of the Old Trace Road and the Old Trace Path from the Campground road to Little Swan Creek. Contour lines (in feet) are from the Gordonsville topographic map (Tennessee Valley Authority, 1951).

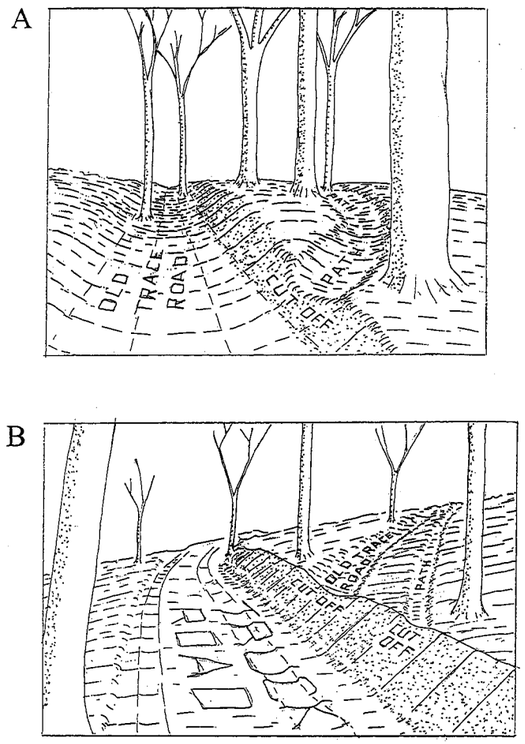

FIG. 2. A) Sketch of the truncation of an older path by the Old Trace Road. The view is northward and down grade. This place is ca. 39.6 m (130 feet) WSW and uphill from Little Swan Creek and is ca. 7.3 m (ca. 24 feet) vertically above the creek. The creek is to the right. This sketch shows the ground in a reasonably accurate way, but trees are selected from many to show perspective. B) Truncation of the Old Trace Road by the Truck Road. This place is about a third of the way up the hill south of Little Swan Creek. The view is upgrade and southward. The grade of the Truck Road is ca. 13%. Uphill is to the right, and downhill to the creek is to the left. Trees are selected to show perspective, and a large tree that has fallen across the path at the cut off is not shown. Note that this path is not cut off by the parallel Old Trace Road and so could be contemporary with it.

route and experiences of travellers. An exception is a recent volume on pre-Columbian road networks edited by Trombold (1991). This volume includes theoretical papers plus field reports on travel routes in the western United States and Latin America. In this volume, Beck (1991:69–70) adapts the geological relative dating method of "cross cutting" to trails in Peru that will be used in this paper. Sheets and Sever (1991:58–62) illustrate an excavated buried path in Costa Rica and describe the process of entrenchment of a path. Width is deemed more important for the purpose of inferring use by Trombold (1991:4). However, Sheets and Sever (1991) consider wear depth to be useful and relate it to duration of use, slope, and rainfall. This paper will present measurements of width and wear.

Measurements and Use of the Old Trace in Historic Records

Indian Paths—Haywood (1823:108) reported on another trail that followed what is now Franklin Road south of Nashville, Tennessee: "This South Fork Road . . . was a broad beaten path made by the buffalos . . . It was worn into the earth one or two feet or more in many places. In some places three or four feet wide." Myer (1971:9) writes "In the wooded or mountainous regions of the central southern United States the Indians were forced to go in single file, and the paths were usually 18 to 24 inches in width." This is close to the widths of 30–70 cm (12–28 inches) reported in Costa Rica by Sheets and Sever (1991).

Natchez Trace After 1801—In February 1803, an order from the War Department said ". . . the road be opened not exceeding sixteen feet in width, and not more than eight feet of the sixteen to be cut close to the ground, and smoothed for passengers . . . in a new settled country there is no advantage in opening a new road very wide, such part as is not actually used in travelling will soon be overgrown with bushes and be more difficult to pass than if the original growth was standing. The great object is to

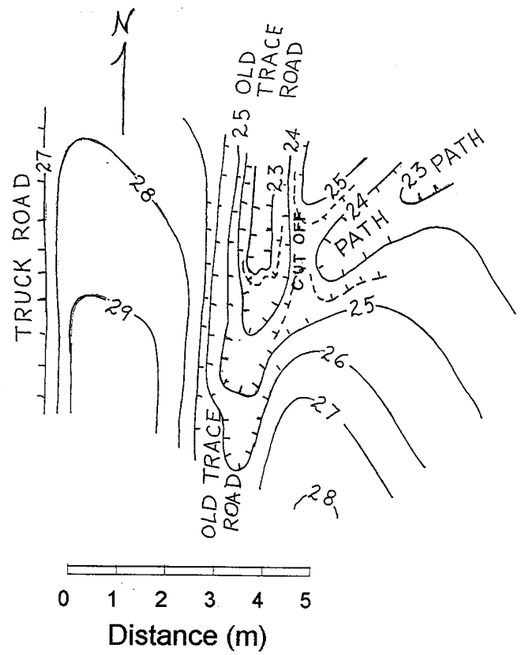

FIG. 3. Sketch topographic map of the area of Fig. 2A. On that figure, the viewer would be standing in the Old Trace Road at the south edge of this map and looking north. Contours are in feet (1 feet = 0.305 m) above Little Swan Creek.

have a comfortable road for horses and foot passengers." (United States National Park Service, 1941:39). In 1806, a report to President Jefferson by the Post Office Department (United States National Park Service, 1941:45) suggested soliciting bids to "repair the routes" . . . "the road through the whole route to be 20 feet wide-all the timber and underbrush to be taken off . . ." In December 1806, newspapers in Tennessee and Mississippi published the proposal (United States National Park Service, 1941:46) including "Note 1-The road to be cleared of all trees, logs, and brush, twelve feet in width and made passable for a wagon. Note 2-The bridges are to be twelve feet broad . . ." More detail comes from a February 1807 contract (United States National Park Service, 1941:47) ". . . clearing the route of trees logs and brush for a width of 12 feet. No stumps were to be left which were more than 16 inches above the surface. In the center of the road everything within a distance of 4 feet was to be cut to the ground so as to facilitate the passage of the post rider. Stumps were to be pared down." I interpret this to mean that the cleared strip was 3.7 m (12 feet) wide, not the 4.9–6.1 m (16 or 20 feet) proposed, and that the smoothed road was 2.4 m (8 feet) wide, 1.2 m (4 feet) on either side of the center.

There are few references to wagons or carriages except near Natchez and Nashville. The United States National Park Service (1941:53) quotes "As the road we were to take to Mississippi was not adapted to the carriages, we sold our little wagon, and procured a pack horse to carry our provisions through the Indian Nation." It was reported that General Jackson had 11 baggage wagons for his returning army in 1813 and six wagons for 3,400 walkers and 800 horsemen in his army returning from the Battle of New Orleans in 1815 (United States National Park Service, 1941:73, 84). The United States National Park Service (1941:54) reported "As late as 1817, . . . from Natchez . . . the wagon was unable to go farther, and . . . transported on horses . . . to the Chickasaw National Council House." Mail riders did not use the trace near Meriwether Lewis Monument after 1819. Rather, they went south from Franklin and through Columbia to cross the Tennessee River at Florence, Alabama, and rejoined the trace in Alabama (Phelps, 1962:215). When Jackson's Military Road was opened in 1821, most wagon traffic going south from Nashville probably followed that route.

We can expect that the pre-1801 Chickasaw path was narrow, 0.5–1.2 m (1.5–4.0 feet). The actual worn Natchez Trace Road of 1801–1819 was originally constructed 2.4 m (8 feet) wide. The limited record suggests that it was worn by a large number of walkers, riding horses and pack horses, and a few wagons in the study area.

Preliminary Field Exploration

The three trace "generations" (Old Trace Path, Old Trace Road, and new Truck Road) were not selected from the measurement of profiles. Rather, I picked them first using trees and truncation relationships. The Old Trace Path and Old Trace Road have 20- to 30-cm (8- to 12-inch) trees growing in them; these indicate disuse during the life of the trees (a long but unknown time). The Old Trace Path is truncated by the Old Trace Road (Figs. 2A and 3), and is in turn truncated by the Truck Road (Fig. 2B). So, the Path is oldest, and the Truck Road is youngest. Also, the Truck Road has wide ruts and no trees growing in it. The Old Trace Road lacks ruts. Narrower ruts that could have been made by wagons might be expected but were not seen.

First, a qualitative examination was made; later, the profiles were measured. The unaltered Old Trace Road begins where the truck road enters the forest ca. 335 m (1,100 feet) north-northeast of the 1843 monument; this point is ca. 61 m (200 feet) past a blacktop road leading to the campground (Fig. 1). From here, the Old Trace Road is nearly continuous for ca. 500 m (0.3 mile) where it is worn into Warsaw residuum. Here and all across the upland, the Old Trace Road is close and parallel to the Truck Road. Farther along, it is overprinted by the Truck Road where wear is less on Fort Payne residuum and the grade is nearly level. The Old Trace Road diverges sharply from the Truck Road where the old road grade is too steep for trucks (27%) as the roads go into the valley of Little Swan Creek. This steep grade must have been difficult for wagons too. On this steep slope, there is a double trace (Fig. 2B). There is a "perched" trace just uphill and parallel to the Old Trace Road. It is possible that this is the older path, but it also is likely that, in wet weather, travelers stepped up out of the more worn trace to keep out of water. In the lower part of Little Swan Creek valley, where the slope decreases, Truck Road and Old Trace Road are deeply cut 0.9 m (3 feet) or so into relatively wet colluvium and residuum from noncherty shaly rock. The Old Trace Path cut off segment is in the lower valley. The Old Trace disappears near the creek. All profiles are south of Little Swan Creek.

The apparent reason why more deeply worn sections of the Old Trace Road are not obliterated by trucks is that the bottom of the Old Trace Road was too narrow. It would be inconvenient to have either your left or right two wheels ca. 0.4 m (1 foot) down in it while driving. An additional reason for trucks to keep

TABLE 1. Data on profiles measured across Old Natchez Trace at Meriwether Lewis Monument.

	Old Trace Road		Old Trace Path		Truck Road				
Location[1]	Width (m)	Wear depth (m)	Width (m)	Wear depth (m)	Width (m)	Rut wear depth (m)	Rut width (m)	Percent grade[2]	Geological information[3]
61	3.4[4]	0.18			4.0	0.21	2.4	2.0	Warsaw Residuum
	3.7	0.20			4.0	0.25			
66	3.4	0.18			4.3	0.27	2.4	2.0	Warsaw Residuum
73	3.7[4]	0.23			4.1[4]	0.23	2.7	5.2	Warsaw Residuum
	3.8	0.26			4.3	0.24	2.9		
					4.4	0.26			
81	3.4[4]	0.25						5.0	Warsaw Residuum
	4.1	0.29							
101	3.2[4]	0.24						4.8	Warsaw Residuum
	3.4	0.25							
	3.7	0.27							
110	3.4	0.15						5.2	Warsaw Residuum
152	3.0	0.20						5.4	Warsaw Residuum
195	2.9[4]	0.30			2.9	0.11	2.4	3.0	Warsaw Residuum
	3.2	0.30			3.2[4]	0.14			
					3.5	0.15			
ca. 450	2.4	0.15						4.0	Top Fort Payne
ca. 990	2.4	0.12						10.0	Fort Payne Residuum
	2.9[4]	0.15							
	3.4	0.19							
ca. 1,130	2.7[4]	0.27	2.0[4,5]	0.09				24.0	Fort Payne Residuum
	3.2	0.31	2.1[5]	0.10					
	3.5	0.35	3.2[5]	0.16					
ca. 1,138	2.6	0.16	1.8[4,5]	0.09	4.0[4]	0.28	2.4?	26.0	Fort Payne Residuum
			2.3[5]	0.11	4.1	0.28			
ca. 1,141	2.3	0.34	1.5[5]	0.08				27.0	Fort Payne Residuum
	2.4[4]	0.35							
ca. 1,310	3.4[4]	0.88	2.4	0.37				12.0	Fort Payne Residuum
	3.7	0.89							
	3.8	0.92							
ca. 1,315			2.0[4]	0.20				12.0	Fort Payne Residuum and Coluvium
			2.3	0.21					
ca. 1,319			2.1	0.13				12.0	Fort Payne Residuum and Coluvium
ca. 1,324			1.8	0.12				6.0	Fort Payne Residuum and Coluvium

[1] Listed from south to north in meters northeast of the blacktop road that leads to the campground.
[2] All grades are northeastward.
[3] In the subsoil.
[4] Preferred width.
[5] Profile with a "perched" less worn path (or road) next to the Old Trace Road with a steep grade.

out of the old Trace Road on the steep decent to the valley is the 25% grade. The apparent reason that the Path was not used and obliterated by the younger Old Trace Road is that the route was straightened when it was improved in 1801–1806.

SURVEYS

Measurements were made on a profile across the trace to estimate width, wear depth, and grade (deviation from level). All except grade were estimated from the profiles (Table 1).

To construct a profile, a tape was stretched across the trace and then the vertical distance from the tape to the ground was measured with a folding rule every 0.2 m (0.5 foot) along the tape. Tape and rule were calibrated in hundredths of a foot. In cases of significant sidling, the tape was not level, so the drop of the tape was estimated by hand level. Uncertainty of 0.03 m (0.1 foot) of drop in ca. 6.1 m (20 feet) along the tape would not cause significant point-to-point error within the profile. These data were corrected for slope of the tape (if any) and height above the ground on the high end. Precision of the data is believed to be within 0.02 m (0.05 foot) point-to-point and within 0.06 m (0.2 foot) end-to-end.

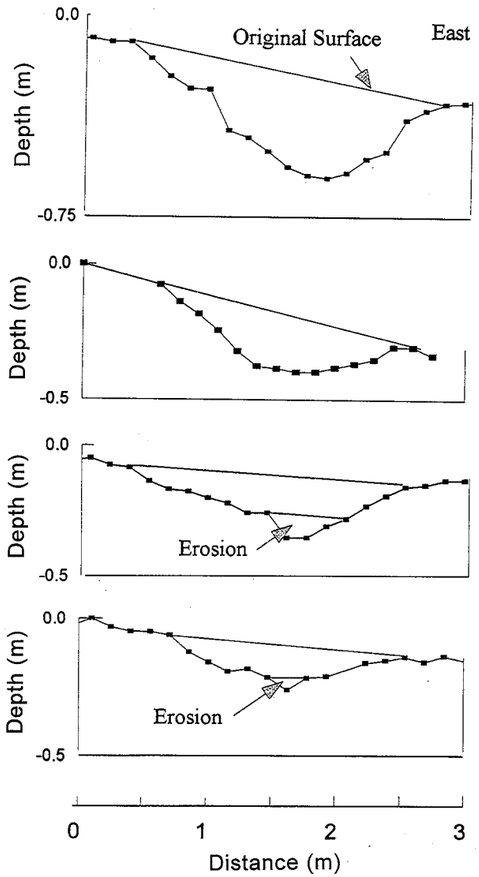

FIG. 4. Four profiles across the Old Trace Path. Top one is close to the cut off shown on Figs. 2A and 3. The bottom one is close to the downhill cut off where the grade is less. A vertical exaggeration emphasizes the depth of wear.

Grade was estimated by walking from a tape stretched across the trace downgrade along the center of the trace until eye level was even with the ground under the tape; then the distance back to the tape was measured by counting paces. Precision for the 2–27% grades measured is ca. 1% (grade = rise/run × 100).

Figs. 4–8 are profiles gathered by type and physiographic position. Fig. 4 shows four profiles of the most ancient Old Trace Path near Little Swan Creek. Figs. 5–7 show profiles of the Old Trace Road (note the lack of ruts): on Fig. 5, it is worn into Warsaw residuum within 500 m of the Campground road. On Fig. 6, it is worn into Fort Payne chert residuum on the steep decent to Little Swan Creek. Fig. 7 shows a profile worn >0.9 m (>3 feet) deep into colluvium and shale residuum. Fig. 8 is the Truck Road; these are extended measurements from three of the profiles on Fig. 5. Note the ruts ≥2.4 m (≥8 feet) wide from outside-to-outside edge.

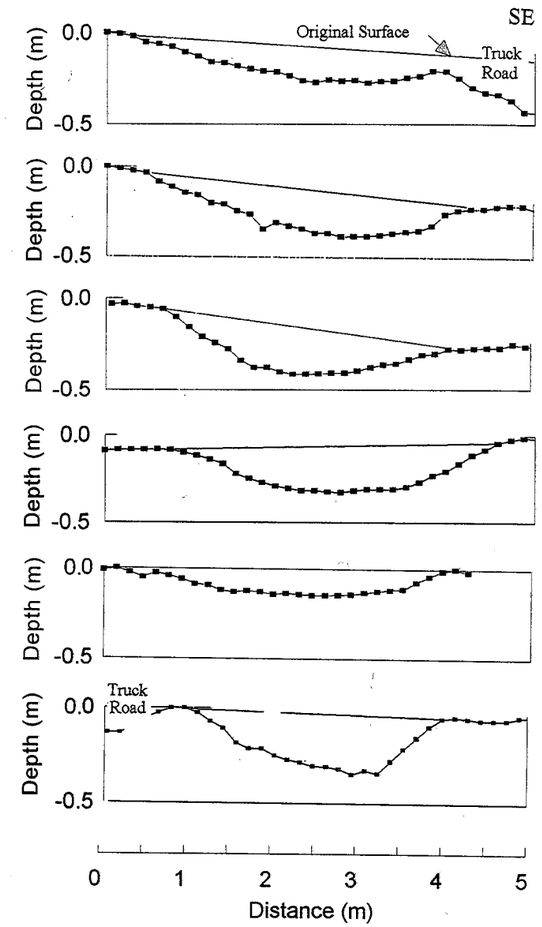

FIG. 5. Six profiles across the Old Trace Road on the upland where it is worn into residuum from the Warsaw Formation. They are presented in order of location from southwest to northeast, and the view is down a 2–5% grade. The top profile is 61 m (200 feet) NE of the blacktop road. The bottom one is 195 m (640 feet) from the blacktop. A 2× vertical exaggeration emphasizes the depth of wear.

The numerical measurements for all of the profiles are presented in Table 1. Except in Little Swan Creek Valley, wear depths are only 0.1–0.4 m (0.3–1.2 feet). Wear does not correlate with grade, except that where grade becomes nearly level the old trace disappears and even truck road ruts become slight or zero. Wear does correlate slightly with width. Width is the parameter used to consider the problem of mistaking a path, or a modern Truck Road, for the Old Trace Road.

Statistics of widths (Table 2) were calculated using the minimum (biases toward narrow width) and maximum (biases toward wide widths) as well as preferred picks for each profile. Some preferred picks were made at an abrupt edge (e.g., third profiles from the top on Figs. 4 and 6). Some are subjective, made at

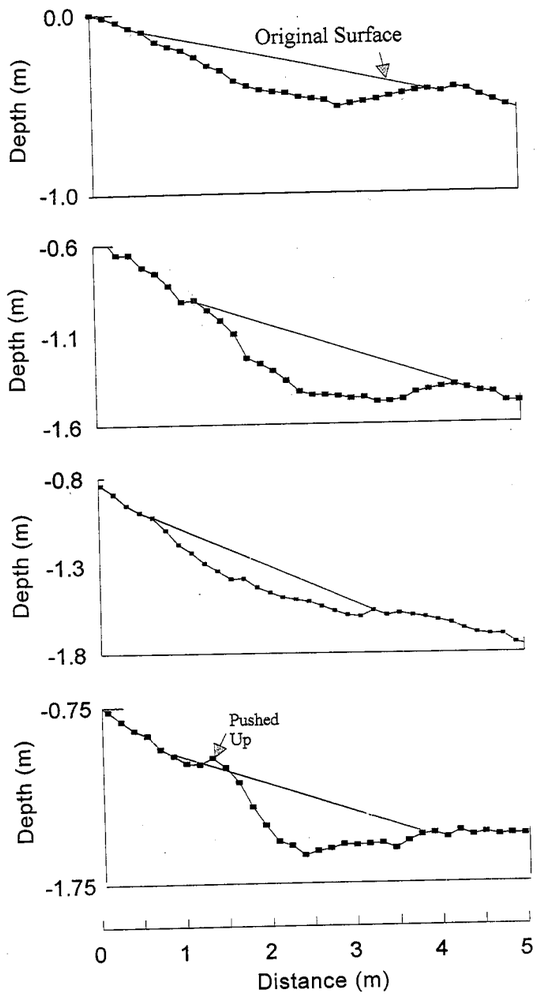

FIG. 6. Four profiles across the Old Trace Road where it decends steeply into the valley of Little Swan Creek and is worn into residuum from the scraggy chert of the Fort Payne Formation. They are presented in order from southwest to northeast, and the view is downgrade. Little Swan Creek is ahead and to the right. The top profile is near the top of the hill; the wear is only 0.15 m (0.5 foot) even though the 10% grade is double that of the profiles on Fig. 5. Wear is not much greater on the other profiles despite the steep grades of 25–27%. A 2× vertical exaggeration emphasizes the depth of wear.

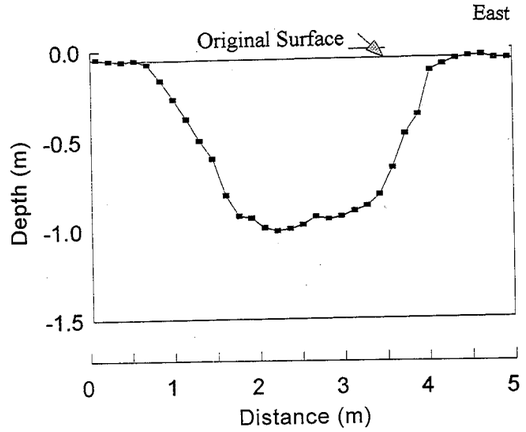

FIG. 7. Profile of the Old Trace Road in the valley of Little Swan Creek where it is worn into colluvium and residuum from shaly bedrock. Wear is triple that on the steep hill above, although the road grade is less than half that on the less worn steep grade. The view is downgrade in the area sketched and mapped on Figs. 2A and 3; so, the creek is ca. 43 m (ca. 140 feet) to the right and ca. 7.3 m (ca. 24 feet) vertically below. A 2× vertical exaggeration emphasizes the depth of wear.

places where the inward slope steepens or in places noted in the field where my eye detected a continuous steepening trending into the profile line. In cases where only one width was picked from a profile, that width was used for all calculations. The results show that the Truck Road is close enough in width to be confused with the Old Trace Road. Using minimum width picks of the Truck Road and maximum width picks for the Old Trace Road, the mean −1 *SD* for the Truck Road coincided with the mean for the Old Trace Road. Although ruts will show that trucks have used any road, a particular road that may have in fact been the Old Trace Road and then not worn wider than it once was by trucks can not be distinguished by its width from a Truck Road that never was the Old Trace Road. The Old Trace Path is distinguishable from the Old Trace Road on the basis of width. Mean width +1 *SD* of the wide set for the Path is still less than the mean width −1 *SD* of the narrow set for the Old Trace Road. Of course, this is true for any path, even a recent one. To qualify as the Old Trace Path it must have other evidence of age, such as being truncated by the Old Trace Road or being occupied by a 160 year-old tree.

POSSIBLE ALTERATION OF THE TRACE BY EROSION AND BURIAL

The answer to the question "has any of the old trace remained unaltered since abandonment" cannot be answered without excavation. The only places measured on these profiles where erosion is certain are the relatively few little gullies (Fig. 4, two bottom profiles; maybe Figs. 5 and 6, bottom profiles). A model for Natchez Trace could be the trail in Costa Rica buried by volcanic ash, and excavated by Sheets and Sever (1991). This trail presumably remains just as it was when in use (Fig. 9D). They interpret the form as a bottom "U" shaped by human use (Fig. 9A) and an upper "V" attributed to erosion promoted by the steep sides (Fig. 9B). Human use keeps the "U" ahead as it wears deeper; the "V" gets deeper and wider as the "U" deepens (Fig. 9C). Costa Rica volcanic ash differs from cherty soil, and this excavated example had no deposit in the bottom (other than the ash that obliterated the path). However, the "V" erosion could have left some redeposited soil in the Old Natchez Trace.

TABLE 2. Mean (meters ± 1 *SD*) widths and range (meters) of widths from profiles measured across the Natchez Trace at Meriwether Lewis Monument.

Method of calculation	Statistic	Trace category: Old Trace Path (n^1 = 4)	Old Trace Road (n = 14)	Truck Road (n = 5)
Minimum	Range	1.8–2.4	2.3–3.7	2.9–4.3
	Mean ± 1 *SD*	2.10 ± 0.26	3.00 ± 0.44	3.84 ± 0.54
Preferred	Range	1.8–2.4	2.4–3.7	3.2–4.3
	Mean ± 1 *SD*	2.10 ± 0.26	3.04 ± 0.39	3.90 ± 0.41
Maximum	Range	1.8–2.4	3.0–4.1	3.5–4.4
	Mean ± 1 *SD*	2.17 ± 0.26	3.29 ± 0.53	4.05 ± 0.35

[1] Number of profiles measured.

Wagon ruts could be buried there (Fig. 9F). Wagon wheels are roughly 1.4–1.5 m apart (4.8–5.0 feet), and ruts would be somewhat wider (maybe 1.6–2.0 m apart). These could fit into the 2.3-m minimum width of the Old Trace Road. Unearthed ruts would prove significant wagon traffic and alteration of the old trace. However, a failure to find deposits or ruts, like Fig. 9F, would not disprove removal of ruts by erosion. Examination and sampling of the surface might (or might not) verify the long uneroded exposure supposed by myself.

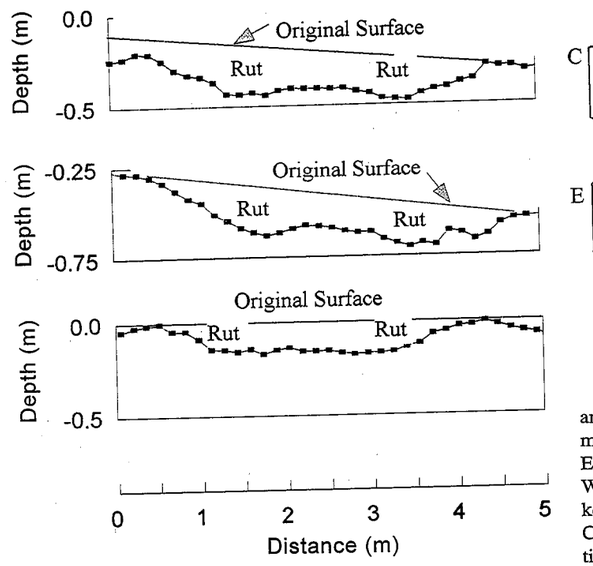

FIG. 8. Profiles across the Truck Road on the upland where it runs parallel to the Old Trace Road. Note that the ruts are ca. 2.4 m (ca. 8 feet) wide. These profiles are measurements extended from profiles across the Old Trace Road shown on Fig. 5. A 2× vertical exaggeration emphasizes the depth of wear.

CONCLUSIONS AND IMPLICATIONS

The Old Trace Path, a short segment of a trail that is dated by truncation as older than the Old Trace Road, was discovered during this investigation. This Old Trace Path is a likely candi-

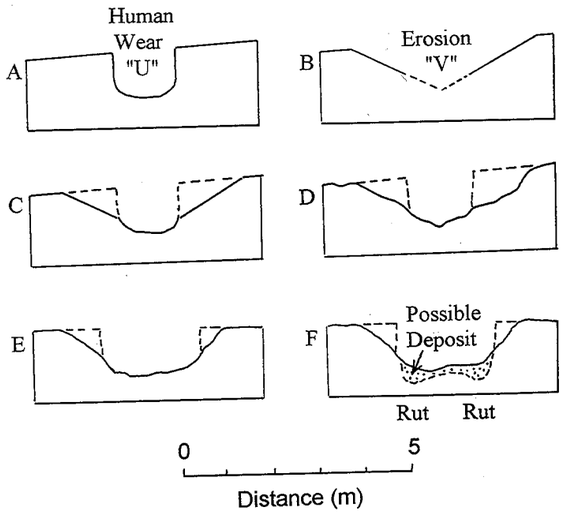

FIG. 9. The development model of Sheets and Sever (1991) and its application to the Old Trace Road. A) First, human wear makes a "U" shaped path, but the steep sides are unstable. B) Erosion widens the path at a lesser slope, the erosion "V." C) With the "U" and "V" combined, human wear "U" is first and keeps ahead of the erosion "V." D) Profile of a buried path in Costa Rica (modified from Sheets and Sever, 1991:fig. 7.6). Continuity of ash layers in both the worn mass and the fill shows no pre-ash fall deposit in this path. E) Profile of the Old Natchez Trace Road from Fig. 7 with the vertical exaggeration removed and interpreted as the "U" plus "V" model. F) Same profile indicating a possible deposit that could have buried ruts since trace was abandoned.

date to be the Chickasaw Tribe's path of 1800. The Old Trace Road, the historic Natchez Trace of the period 1801–1830, lacks even narrow visible ruts; perhaps, it was a foot and horse road used so seldom by wagons that wear by walkers, riders, and pack horses obliterated wagon tracks. However, ruts could be present, but buried by soil eroded from the sides.

Where the Old Trace Road is on cherty residuum weathered from the Warsaw limestone, it is worn 0.2–0.3 m (0.6–1.0 foot) deep on slight grades (2–5%). Where it is on colluvium and residuum from shaly bedrock in the valley of Little Swan Creek, it is worn as much as 0.9 m (3 feet) deep. Wear depth is small even on the steepest grades (24–27%) where it is worn into Fort Payne chert residuum. This wear-resistant residuum is probably the scraggy chert that has long been favored to spread on gravel roads in this region of Tennessee. Measurements of wear depth may prove useful for future comparison with wear of Natchez Trace on other geological substrates. Wear of the modern truck road does not add to knowledge of the Old Natchez Trace, but historical archaeologists are interested in more recent roads too.

The Old Trace Path remnant is ca. 2.1 m (ca. 7 feet) wide (range of 1.8–2.4 m or 6–8 feet), whereas the Old Trace Road is ca. 3 m (ca. 10 feet) wide (range of 2.4–3.8 m or 7.5–13.5 feet). This 3-m width of wear is consistent with an original cleared strip 3.7 m (12 feet) wide and a smoothed strip 2.4 m (8 feet) wide as specified in the contract of 1806. The oldest path is significantly narrower than the Old Trace Road, but the Old Trace Road is not significantly narrower than the recent Truck Road. Estimates of width remain partly subjective. Future interpretation might apply the "U" then "V" model of Sheets and Sever (1991) and attempt to isolate the human-wear width from the total width.

Trenches dug across the Old Trace Road might find that after abandonment, erosion of the steep sides of the worn trace left redeposited soil in the bottom. Maybe wagon ruts, that are not seen on the surface are buried there.

Other segments of the pre-1801 Chickasaw path might be found elsewhere along the Natchez Trace by walking along the Old Trace Road and looking for a path truncated by the Old Trace Road. It would be interesting to get more measurements of width and wear depth of such segments on different bedrock and terrain.

Abandoned segments of other old roads might be found where they extend out narrow ridges and descend steep slopes underlain by Fort Payne bedrock. The Old Natchez Trace Road follows the ridge farther than the newer Truck Road; maybe, so do other old roads. If other old roads date to the early 19th century, their shape in profile should be similar to those presented here.

Literature Cited

BECK, C. 1991. Cross-cutting relationships: the relative dating of ancient roads on the north coast of Peru. Pp. 66–79 *in* New directions in archaeology. Ancient road networks and settlement hierarchies in the New World (C. D. Trombold, ed.), Cambridge Univ. Press, Cambridge.

COLVIN, J. M., AND M. V. MARCHER. 1964. Geologic map of the Gordonsburg Quadrangle, Tennessee. Tennessee Div. Geol., GM 50-SW. 7.5 minutes, Scale 1:24,000.

HAYWOOD, J. 1823. Civil and political history of the State of Tennessee, etc., facsimile copy by Tenase Co., Knoxville, Tennessee.

MYER, W. E. 1971. Indian trails of the Southeast. Blue and Gray Press, Nashville, Tennessee, reprinted from 42nd Annual Report of the Bureau of American Ethnology (ca. 1924).

PHELPS, D. A. 1962. The Natchez Trace Indian Trail to Parkway. Tennessee Hist. Quart., 21:203–218.

SHEETS, P., AND T. L. SEVER. 1991. Prehistoric footpaths in Costa Rica: transportation and communication in a tropical rain forest. Pp. 53–65 *in* New directions in archaeology. Ancient road networks and settlement hierarchies in the New World (C. D. Trombold, ed.). Cambridge Univ. Press, Cambridge.

STEARNS, R. G. 1967. Warping of Western Highland Rim peneplain in Tennessee by ground-water sapping. Geol. Soc. Amer. Bull., 78:1111–1124.

STEARNS, R. G., AND J. M. WILSON. 1971. Hydrology, geology and erosion by leaching in Skillman basin on the Western Highland Rim, Lawrence County, Tennessee. Tennessee Div. Water Resources, Water Resources Research Ser., 3:1–33.

TROMBOLD, C. D. 1991. An introduction to the study of ancient New World road networks. Pp. 1–9 *in* New directions in archaeology. Ancient road networks and settlement hierarchies in the New World. (C. D. Trombold, ed.), Cambridge Univ. Press, Cambridge.

TENNESSEE VALLEY AUTHORITY. 1951. Gordonsburg Quadrangle, Tennessee. 7.5 minute Series, 50-SW, Scale 1:24,000.

UNITED STATES GEOLOGICAL SURVEY. 1902. Columbia Quadrangle, Tennessee. 30 minutes, Scale 1:125,000.

UNITED STATES NATIONAL PARK SERVICE. 1941. Natchez Trace Parkway Survey. 76th Congress, Third Session, Senate Document No. 148, US Government Printing Office, Washington.

JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE 72(3–4):73–84 JULY–OCTOBER 1997

ABSTRACTS OF PAPERS PRESENTED AT THE SPRING 1997 COLLEGIATE MEETINGS

EASTERN REGION

THE UNIVERSITY OF TENNESSEE AT CHATTANOOGA CHATTANOOGA, TENNESSEE

DETERMINATION OF DIGESTIVE RATE AND ASSIMILATION EFFICIENCY IN THE SNAKE SPECIES *ELAPHE GUTTATA GUTTATA*. ***Benjamin Batchelor,*** *Maryville College, Maryville, Tennessee.* Digestive rate and assimilation efficiency were determined for the snake species *Elaphe guttata guttata* during a 3-week study period in summer 1996. Digestive rate was measured in five 1-year-old individuals by periodically inserting an indigestible marker into their food and examining their feces until it was passed. Mean digestive rate was 5 days, comparable to digestive rates reported for other reptiles. To determine assimilation efficiency, two 5-to-10-year-old individuals were fed nine subadult mice each. The caloric value of their food intake and fecal output were determined in a Parr 1341 plain oxygen bomb calorimeter. The digestive efficiency of these snakes was calculated as 95.5%, a value comparable with those reported for other reptiles.

A PHYLOGENETIC ANALYSIS OF THE FAMILY MYRMECOPHAGIDAE. ***Daniel Branham and Timothy Gaudin,*** *The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* This study was conducted to determine the genealogical relationships of anteaters which belong to the family Myrmecophagidae, in the mammalian order Xenarthra. Myrmecophagidae is composed of six undisputed genera: three extinct; three extant. The following project is the first designed to produce a definitive anteater phylogeny by using phylogenetic methodology with an ample number of cranial and postcranial characters chosen specifically for this purpose. The character list for this study was assembled by surveying the primary literature on Myrmecophagidae, through direct examination of different weighting and ordering schemes. While all analyses resulted in the same tree topology, an analysis using ordered characters in which all character states were weighted equally was found to have the best support. This resulted in a single most parsimonious tree with a length of 152 steps, a consistency index of 0.671, and a retention index of 0.645. This tree depicted *Cyclopes* and *Palaeomyrmidon* as sister groups and this assembly as a sister group to *Tamandua* and *Myrmecophaga,* who in turn represented sister groups. The grouping of *Cyclopes* and *Palaeomyrmidon* was the weakest node with only three unique and unequivocal synapomorphies, and the node joining *Myrmecophaga* was the most strongly supported, possessing 23 synapomorphies.

EFFECTS OF ENRICHMENT TREATMENTS ON JAGUAR BEHAVIOR AT THE WARNER PARK ZOO. ***Miranda Cagle,*** *The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* Jaguars at the Warner Park Zoo (one 9-year-old female and one 8-year-old male) were transferred to a new enclosure on 12 November 1995. Prior to that date, they had spent their adult lives in a small, circular cage with a concrete floor. While in the previous enclosure, both cats developed similar stereotypic pacing behavior. Despite the more naturalistic new enclosure and a substantial increase in space, as of May 1996, both cats continued to practice a high amount of pacing behavior in a small amount of space. The idea of an enrichment project for the jaguars was discussed with Mark Graves, assistant director of Warner Park Zoo, with the purpose of decreasing the stereotypic pacing of the jaguars and encouraging more natural, species-typical behavior. A May 1996 enquiry concerning popular or effective forms of jaguar enrichment was sent to zoos in the United States currently holding jaguars. From the suggestions of respondents as well as published articles, an enrichment project for the Zoo was designed. From prelimimary behavioral observations, five categories of behavior were established: pacing; wandering; resting (rolling, sleeping, and bathing); interactive (time spent in physical contact with enrichment forms); inactive (time spent inside the exhibit building once access to the outdoor enclosure was available). Spanning the months from May to October 1996, focal sampling data on each cat were collected using a continuous recording method, resulting in 5 days of data/cat/treatment. There were nine treatments total: initial baseline; herb-spice scent enrichment; animal scent enrichment; meat enrichment; carcass enrichment; live fish enrichment; second baseline; combination of meat and animal scent enrichment; a third and final baseline. All treatments resulted in behavioral patterns that were statistically significantly different from the initial baseline (based on chi-square testing). The cats' reactions to the enrichment items were not the same as those of jaguars at other zoos. Both cats interacted most with the meat and scent enrichment combination. Overall amounts of the female's pacing activity decreased for two thirds of the study and then rose to initial levels. The male's pacing activity increased for most of the study. The observer concluded that the cats pace due to different motivations. While both cats exhibit pacing due to inadequate or inappropriate stimuli, the male also paces as a displacement activity due to stress from overstimulation or inability to cope with environmental changes.

A BIOLOGICAL EXPOSITION OF *PUERARIA LOBATA* (WILLD.) OHWL. ***Luis D. Checo,*** *Southern Adventist University, Collegedale, Tennessee. Pueraria lobata* (kudzu), a member of the family Fabaceae, is a deciduous twine that grows in the southeastern part of the United States. The vine is well known for its fast growth rate which can exceed 0.3 m/day during the summer months. In good soils, growth can exceed 18 m during the season establishing patches measuring ca. 1–2 m in thickness. This Japanese native was first introduced to the United States in 1897 at the Philadelphia Exposition as an exotic and ornamental plant. Later, it became a tool for the United States Soil Conservation Service to stop erosion on farms and along highways.