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FOSSIL FOOTPRINTS FROM THE GRAND CANYON: THIRD CONTRIBUTION

(WITH FIVE PLATES)

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INTRODUCTION

A third visit to the Grand Canyon in the late spring of 1927 enabled me to collect additional fossil footprints, some of which are undescribed species. Since there is no immediate prospect of acquiring further specimens, it seems important that these, together with a specimen presented to the Museum by Mr. G. E. Sturdevant, naturalist of Grand Canyon National Park, should be described, in order to perfect as far as possible the record of the ichnites of this region. While the above mentioned specimens from the Hermit and Supai formations form the basis of the present paper, attention is also given to a fourth ichnite fauna recently found in the Tapeats sandstone of the Bright Angel section. These materials are fragmentary and do not warrant systematic description. All are trails of invertebrate animals, probably trilobites, a conclusion reached by the late Dr. Charles D. Walcott from his study of similar trails from this same formation in other parts of the Grand Canyon.

I wish here to express to Dr. John C. Merriam and his associates of the Grand Canyon Exhibit Committee of the National Academy of Sciences my appreciation for the financial assistance which made this third trip possible. I also wish to acknowledge again the help given by various members of the Park organization. Superintendent M. R. Tillotson furnished equipment and assistance of personnel; Mr. James Brooks, chief ranger, detailed ranger assistants; and Mr. G. E. Sturdevant, Park naturalist, as on previous visits, contributed freely of his time and energy to the successful outcome of the work in hand.

NEW OBSERVATIONS ON THE GEOGRAPHICAL DISTRIBUTION OF TRACKS IN THE GRAND CANYON

The geographical range of fossil tracks in the Grand Canyon was considerably extended through the opportunity offered of exploring new localities. It would seem that on the south rim of the Grand

Canyon, tracks can be found in the Coconino, Hermit, and Supai formations wherever local conditions permit of search being made for them.

In the Coconino, footprints were found in débris at the base of the Coconino cliff on the west side of the Bright Angel Trail, and were also noticed by Dr. E. F. Miller of the Marlin Oil Company, on the Grand View Trail where he was engaged in measuring the geological section. Their presence here is further substantiated by a specimen (No. 2367, U. S. N. M.) collected in this same locality in 1903 by the late Dr. Charles D. Walcott. This is some 20 miles east of the nearest known fossil footprint locality, and thus considerably extends their previously recorded range.

Accompanied by Dr. David White and Mr. G. E. Sturdevant, I visited the Dripping Springs locality at the head of Hermit Gorge and, although only a short time was spent there, we observed tracks in great abundance on the sloping ledges immediately to the north and east of the spring, thus fully verifying earlier reports of their occurrence.

Considerable time was spent in searching the track-bearing horizon in the Coconino formation where it is crossed by the Yaki Trail, and although numerous tracks and trails were found, with one exception their preservation was so poor that none was thought to be of sufficient value to collect.

In the Hermit formation, Dr. David White discovered tracks of extinct animals in association with fossil plants in two distinct and widely separated localities—on the Bright Angel Trail and on the Yaki Trail. In both of these localities the preservation of the plants was far superior to that of plants found in Hermit Basin, but the animal tracks were inferior in that only a few imprints were found, never a trackway of any extent. Neither of these places, therefore, seems to be a promising locality for further work, their chief interest being in extending the known geographical distribution of the Hermit ichnites.

In the Supai formation Mr. Sturdevant, as previously mentioned, found a slab of well preserved tracks on the Bright Angel Trail, and numerous footprints were observed by us on blocks that had fallen down from the more or less perpendicular face of the track-bearing bed of sandstone on the point which projects into the Canyon immediately below Yavapai Point.

Several days prospecting in the Supai formation along the western side of O'Neill Butte on the Yaki Trail disclosed a considerable abun-

dance and variety of tracks. Those found were on blocks lying on the hillside, though a few were preserved *in situ*. That this formation has a large undescribed ichnite fauna is plainly evident, but it is difficult to obtain specimens for study because of the inaccessibility of the perpendicular track-bearing cliffs, and because the tracks usually occur in massive blocks of sandstone that do not readily cleave into layers. If adequate study specimens are to be secured, specially trained stone workers with proper equipment must be employed.

In the Coconino on the south rim of the Grand Canyon, tracks are now known at Dripping Springs on the west, and on the Grand View Trail to the east, an extent of about 29 miles. In the Hermit and Supai, tracks have been found from Hermit Basin on the west to the Yaki Trail on the east, a distance of about 11 miles. That further exploration will greatly extend these ranges is now plainly evident. Tracks have not yet been found in the rocks of the north rim of the Canyon, but it is confidently expected that their discovery there will be one of the early announcements.[1]

SYSTEMATIC DESCRIPTION OF GENERA AND SPECIES

Under this heading are included notes and new observations on described genera and species as well as descriptions of a few that are new to the ichnite faunas of the Grand Canyon. They are discussed in the same order as in the preceding papers on this subject, commencing with those from the Coconino formation and following successively with the Hermit, Supai, and Tapeats footprints.

ICHNITES FROM THE COCONINO FORMATION

Genus LAOPORUS Lull

Mention was made in my previous paper[2] of the similarity existing between the tracks of *Laoporus* and those figured by Hickling[3] from the British Permian. Further study and comparison deepens my conviction that these tracks are congeneric. Their close similarity in size, number, relative lengths and arrangement of the digits is clearly indicated in the illustrations (compare figs. 1 and 2). The

[1] Under date of Dec. 14, 1927, a letter from Mr. G. E. Sturdevant announces the discovery by him of fossil tracks in both the Supai and Coconino formations on the north rim of the Grand Canyon.

[2] Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 17, footnote.

[3] Manchester Lit. and Philos. Soc., Memoirs, Vol. 53, 1909, Art. 22, pl. 2, figs. 10 and 11.

British tracks are referred by Hickling to *Chelichnus ambiguus* Jardine, but examination of Jardine's original figures of this species[1] leaves much doubt as to the correctness of this assignment. If correct, it is of interest to note Hickling's observation that in Jardine's

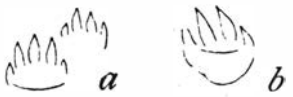


FIG. 1.—Footprints from the British Permian which can be properly referred to the genus *Laoporus*. *A*, fore and hind tracks; *B*, manus. All after Hickling. About ½ natural size.

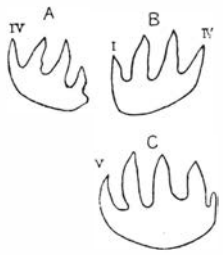


FIG. 2.—*Laoporus noblei* Lull. *A*, outline of manus track. Paratype. No. 8422, U. S. N. M. *B*, *C*, manus and pes track of No. 11,122, U. S. N. M. All about ½ natural size.

specimen, "the fifth digit is nowhere shown," and it is a condition often observed in the trackways of the American *Laoporus*.

OCTOPODICHNUS DIDACTYLUS Gilmore

Octopodichnus didactylus Gilmore, Charles W., Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 31, pl. 10, fig. 2, text fig. 13.

Recently in bringing together all of the miscellaneous fossil footprint materials in the U. S. National Museum, the accumulation of many years, a small slab (No. 2367) was found on whose surface there was a trackway that is clearly referable to the genus *Octopodichnus* and provisionally to the species *O. didactylus* Gilmore. The specimen is of interest as being the third recognizable specimen found of this species and also from the fact of its coming from a new locality for tracks, thus greatly extending their known geographical range.

The specimen was collected by the late Dr. Charles D. Walcott from the Coconino sandstone on the Grand View Trail, Grand Canyon National Park, Arizona, in 1903. This discovery antedates by 12 years the finding of quadruped tracks in the Grand Canyon by Schuchert and by nearly a quarter of a century the discovery of the type specimen (No. 11,501 U. S. N. M.) on which the above genus and species was established.

The considerably smaller size of the trackway and slight differences noted in some of the individual imprints suggest the possibility of

[1] Ichnites of Annandale, 1853, pls. 6 and 11.

the specimen representing a distinct species, but more perfectly preserved material is needed to determine that point. The trackway shows two parallel lines of imprints arranged as in the type in groups of four, the groups of the two sides alternating. These groups have the usual arrangement of a row of three regularly spaced tracks with the fourth offset inward.

After a study of the type specimen, it was my conclusion that the trackway was probably made by some Permian crustacean. In confirmation of the probable correctness of that conclusion, Mr. Remington Kellogg, of the U. S. Biological Survey, calls my attention to a considerable similarity between these tracks and trails made by the living sand crab *Ocypoda albicans,* recently observed by him in the sands on Hatteras Island, North Carolina.

ICHNITES FROM THE HERMIT FORMATION

Genus HYLOIDICHNUS Gilmore

Hyloidichnus Gilmore, Charles W., Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 51.

Generic characters.—Quadrupedal, semi-digitigrade. Both manus and pes have five digits. Manus smaller than pes and placed in front of hindfoot. Toes either terminated with pellets or having bifurcated ends.

HYLOIDICHNUS WHITEI, new species

Plate 3, fig. 1

Type.—Catalogue number 11,692, U. S. N. M. Consists of a small slab on which are four imprints. Collected by Dr. David White, June, 1927.

Type locality.—Yaki Trail ("Cedar Ridge" 500 feet west of trail), Grand Canyon National Park, Arizona.

Geological occurrence.—Hermit shale, 30 feet above Hermit-Supai contact, Permian.

Description.—Stride estimated to be about 106 mm., width of trackway about 45 mm. Forefoot slightly smaller than hind and placed almost directly in front of it. *Hindfoot:* Length about 24 mm., width about 22 mm. Five toes. The toes are long and especially slender, fourth longest, others growing progressively shorter toward the inside of the foot. First only faintly impressed, but apparently about the same length as the fifth. Digits II to V having terminations slightly enlarged, the first apparently having bifurcated ends. The toes have the following lengths: I=7.5 mm., II=11.1 mm.,

III = 13 mm., IV = 16 mm., V = 8 mm. Sole not sufficiently impressed to show its outline; it seems to be short and broadly rounded behind. *Forefoot:* Length about 18.5 mm., width from tip of first to tip of fifth digit 17 mm. Five digits which increase in length from first to fourth. Fifth about one-half as long as the fourth, but longer than first. First and fifth directed strongly forward and outward respectively from the median digits. Digits I and II terminated by pellets; III

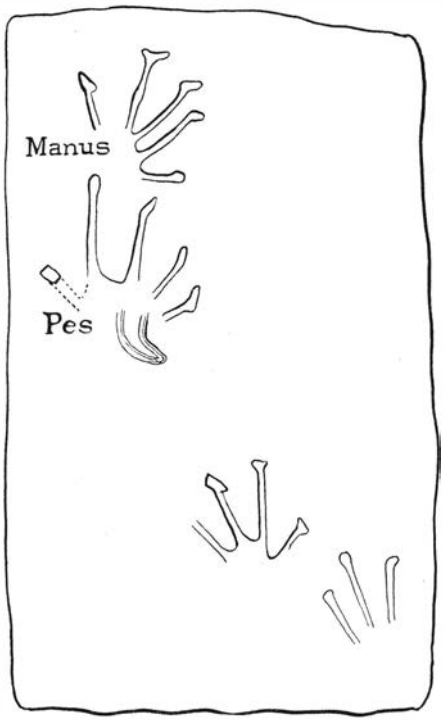


FIG. 3.—*Hyloidichnus whitei,* new species. Type. No. 11,692, U. S. N. M. Diagram of trackway. About natural size.

and IV by asymmetrically bifurcated ends resembling those of the pes in *H. bifurcatus.* All toes especially slender. The digits have the following measurements: I = 6 mm., II = 12 mm., III = 13 mm., of the manus. *Forefoot:* Length about 30 mm., width about 30 mm. IV = 13.5 mm., V = 5 mm. The palm failed to leave a distinct impression and thus its size and contour are unknown.

The general resemblance of the foot plan, the same relative length of toes, and the presence of both bifurcated and pellet toe terminations as in the feet of *Hyloidichnus bifurcatus* Gilmore from this same

formation, indicates that its affinities fall within that genus. Its specific distinctness, however, is shown by its much smaller size, in having the bifurcated toes on the manus, and the more slender form of the toes as a whole.

The species is named in honor of Dr. David White who collected the type specimen.

PARABAROPUS COLORADENSIS (Lull)

Plate 1

Megapezia ? coloradensis Lull, R. S., Amer. Journ. Sci., Vol. 45, 1918, p. 341.
Parabaropus coloradensis (Lull), Gilmore, C. W., Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 53.

On the track covered surface of a large slab (No. 11,707, U. S. N. M.) of impure Hermit sandstone of the collection of 1927, obtained from the fossil track locality one-fourth mile west of the sign "Red Top" on the Hermit Trail, is a trackway identified as *Parabaropus coloradensis* (Lull). This trail, the most perfect yet discovered, shows the trackway to have a width of about 190 mm.

On this same slab are numerous trails of *Holopus hermitanus* and a single trackway of *Collettosaurus,* probably *C. pentadactylus.* The large size of this slab, with its undulating surface covered with footprints, presents an interesting section of the old mud flat over which these animals walked and which has preserved a plain record of their ramblings. A view of this specimen is given in plate 1.

The stride of the *Parabaropus* tracks varies from 260 to 340 mm., whereas in specimen No. 11,598, described in my previous paper,[1] the stride is about 240 mm., and it is quite apparent from the measurements of the foot impressions that the two animals were of about the same size.

In the specimen now before me, the pes impressions lack the elongated sole which is such a distinctive feature of the hindfoot in the tracks previously referred to.[2] The difference noted is due, as is clearly apparent from a comparison of specimens, to the difference in depth to which the feet impressed themselves into the mud. In the specimen under discussion, the posterior part of the heel did not register, whereas in the trackway previously described, the whole foot sank deeply into the muddy surface. The proportions of the feet, number of toes, their form and close similarity of arrangement, leave no

[1] Fossil footprints from the Grand Canyon, Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 57.
[2] *Op. cit.,* p. 56, fig. 27.

doubt as to their being cospecific. The differences noted in a comparison of these two specimens illustrates the need of an abundance of material in the study of fossil tracks if an investigator is not to be led astray by differences that are more apparent than real.

In the normal relationships of the tracks, the forefoot is placed in front of the hind, but in the trackway now before me the forefoot is occasionally found in the rear of the hindfoot.

COLLETTOSAURUS PENTADACTYLUS Gilmore

Plate 1

Collettosaurus pentadactylus Gilmore, C. W., Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 60, text fig. 32, pl. 19, fig. 1.

A trackway 1300 mm. in length, on slab No. 11,707, U. S. National Museum (see pl. 1) seems to be clearly referable to the above genus and species. While this specimen adds nothing to our knowledge of the feet impressions, the presence of a deep, continuous, but slightly undulating, tail drag is of interest, since the type specimen (No. 11,527, U. S. N. M.) showed none. A second specimen (No. 11,710, U. S. N. M.) identified as pertaining to the same species, although 530 mm. in length, gives no evidence of a dragging tail. Study of these three specimens confirms my previous conviction that the presence or absence of a tail drag has but little significance as a diagnostic character for distinguishing fossil tracks.

ICHNITES FROM THE SUPAI FORMATION

Genus AMMOBATRACHUS, new genus

Generic characters.—Quadrupedal. Five digits in pes, four in manus. Forefoot smaller than hind, with the latter placed in front of the former. Digits of both manus and pes widely separated, outer toes of both much reduced in size, fifth of pes widely divergent.

Genotype.—*Ammobatrachus turbatans,* new species.

AMMOBATRACHUS TURBATANS, new species

Plate 2

Type.—Catalogue number 11,691, U. S. N. M. Consists of a slab of sandstone 380 mm. long having a trail traversing its entire length. Collected by G. E. Sturdevant, 1927.

Type locality.—Bright Angel Trail, Grand Canyon National Park, Arizona.

Geological occurrence.—Supai formation, Pennsylvanian.

Description.—Stride about 80 mm., width of trackway about 115 mm. *Hindfoot:* Length about 40 mm., width about 40 mm. Five digits. The first toe is short. Third slightly the longest while second and fourth are subequal. All three acuminate. The second and third curved slightly outward. Fifth toe, short, stout, with bluntly rounded

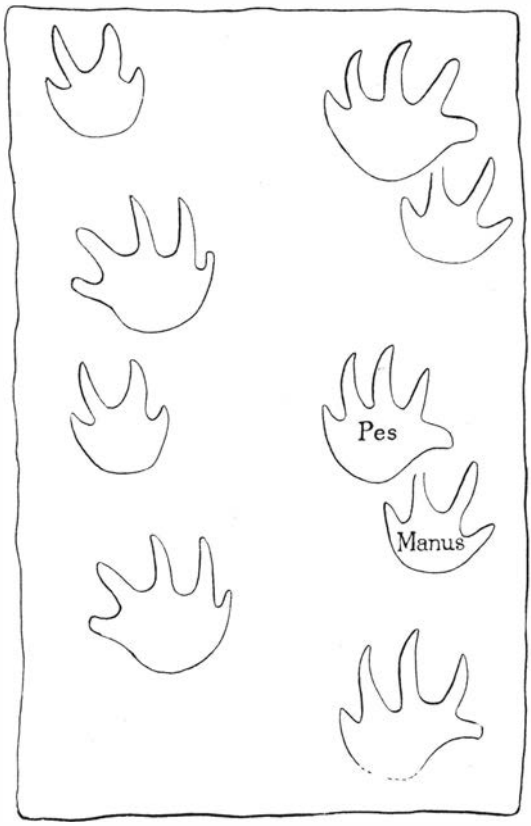


FIG. 4.—*Ammobatrachus turbatans,* new genus and species. Type. No. 11,691, U. S. N. M. Diagram of trackway. About ½ natural size.

extremity. This digit is directed strongly outward, its longer axis standing nearly at right angles to those of the other toes. In the imprints of the pes on the left side the fifth toe is longer, more slender, and directed more forward than on the right side. The imprint of the second toe is lacking in most of the tracks of the left side. The sole of the foot is relatively long, exceeding the length of the toes, is rounded behind, and had palmar pads. The toes have the following

lengths: II = 15 mm., III = 17.5 mm., IV = 15 mm., V = 7.5 mm. Hindfoot regularly placed in front of fore, but usually clear of the toes of the manus. *Forefoot:* Length about 30 mm., width about 30 mm. Four toes. Toes lengthening toward the outside of foot, the outer and inner being short and subequal in length. The outer toe originates well backward on the side of the palm, and is directed forward and outward. Median toes widely separated and divergent anteriorly. All of the digits of the manus have subacute terminations (see fig. 4). The foot as a whole is much smaller than the pes. Sole relatively short, being broader than long and broadly but regularly rounded posteriorly. Length of toes as follows: II = 7.5 mm., III = 12.5 mm., IV = 14.5 mm., V = 7.5 mm. The digital formula of five and four at once distinguishes this genus from all described forms of the Supai ichnite fauna. *Batrachichnus* of the Hermit, *Laoporus* and *Agostopus* of the Coconino, have a similar number of toes, but here their resemblance to *Ammobatrachus* largely ends. The intermediate size of the footprints under discussion, the wide spreading of the toes, and differences in length and other proportions effectually distinguish these from all other Grand Canyon tracks.

Hickling [1] figures a pes track from the Permian of Corncockle Muir, Scotland, which bears certain resemblances to the pes, but his details of foot plan are uncertain and thus a closer comparison is of little importance.

INVERTEBRATE TRAILS FROM THE SUPAI FORMATION

During the field work of 1927, a considerable number of trails evidently made by invertebrate animals, were observed in the track-bearing horizons of the Supai formation. Owing to the lack of proper facilities, only a few of these were collected. Although many of them clearly show that the impressions were made by animate creatures, their details are not sufficiently clear to depict their principal characteristics, and on that account they seem unworthy of generic and specific designation, but in order to advance our knowledge of the Supai ichnite fauna as far as is consistent with the character of available materials, a few of these specimens are briefly described and illustrated.

In figure 1, plate 4, is illustrated a trail (No. 11,740, U. S. N. M.) found lying on the slope west of O'Neill Butte. A second specimen found later on a massive block of sandstone at the base of the track-

[1] Manchester Lit. and Philos. Soc., Memoirs and Proc., Vol. 53, 1909, Art. 22, pp. 6 and 7, pl. 3, fig. 20.

bearing sandstone in the middle Supai appears to be identical, but the extreme hardness of the sandstone resisted all attempts to collect it. These were the only trails of this particular kind observed in many days of prospecting in this formation. The trail illustrated (see fig. 5) is impressed on the surface of a pinkish sandstone and has a length of approximately 370 mm. The specimen, which is the positive slab,

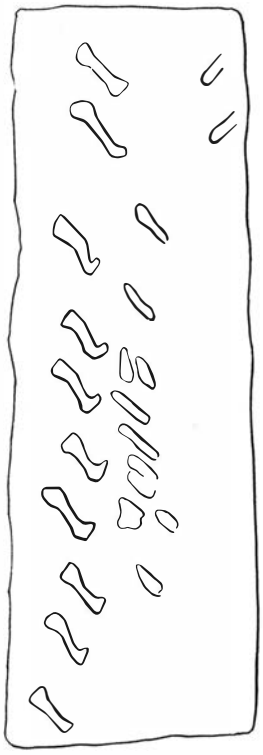


FIG. 5.—Invertebrate trail from Supai formation. No. 11,740, U. S. N. M. About ½ natural size.

has been cast, and the replica affords all the evidence of the original. The trackway as a whole is asymmetrical, brought about, it would seem, by the failure of the appendages of the right side to leave their imprints. Two faint impressions on the right side near the midlength lend support to this view. (See pl. 4, fig. 1.) These are elongated depressions set diagonally to the line of movement, and in nearly every way conform to those forming the outer row on the left side of the trackway. If this supposition is correct, the normal trail would have a width of about 46 mm. The longitudinal row of tracks of the left

side consists of a uniform series of elongated depressions that stand diagonally to the line of direction. These are quite regularly spaced, averaging about 15 mm. apart. The outer ends of the diagonal tracks are somewhat enlarged backward, whereas the inner end gives off a sharp spur that is directed forward and inward. Over all, these diagonal impressions have an average length of about 27 mm. A second, and supposedly median row of elongated impressions, but less clearly registered, parallels those just described. They also have a diagonal trend, paralleling in direction but usually alternating with those of the outer row.

This trail seems to be undescribed and when more perfect examples are found, there will be little difficulty in fully characterizing it. The character of the trackway points clearly to its invertebrate origin, though at this time I have no suggestion to offer as to the particular group of animal life to which it may be attributed.

A second trail, No. 11,693, U. S. N. M. (see pl. 4, fig. 2), collected by Mr. G. E. Sturdevant in 1927, from the uppermost track-bearing horizon of the Supai formation, on the west side of O'Neill Butte, represents another undescribed trackway of peculiar kind, the details of which, as in the preceding, are not altogether clear. This trackway has a total length of 330 mm.; width about 65 mm.; length of stride about 25 mm. It consists of two parallel rows of curved, pointed, finger-like markings, between which are irregularly shaped, subround impressions of spasmodic occurrence. The tracks of opposite sides seem to alternate, although in some few instances they are opposite. The finger-like impressions stand diagonally to the line of movement and seem to be directed forward, though from this specimen alone one cannot be sure of the direction of movement. The irregularity of the impressions (see fig. 6), especially of the two rows, does not permit of a satisfactory diagnosis, and for that reason I refrain from naming it, though it undoubtedly represents a form new to this ichnite fauna.

In plate 3, figure 2, is illustrated a kind of track that has been observed on numerous occasions in the Supai formation, but which has not yet been found in the form of a definite trackway. While this type of track may be easily recognized, none of the examples found gives any idea of a continuous trail, the individual tracks being placed here and there and apparently without rhyme or reason. Occasionally two and three will be found, one placed behind the other.

Some of the imprints are tridactyle, others didactyle. The toes are usually sharply pointed and widely divergent. These tracks vary from 14 to 16 mm. in length and from 9 to 12 mm. in width. They

FIG. 6.—Invertebrate trail from Supai formation. No. 11,693, U. S. N. M. About ½ natural size.

give every evidence of having been made by an invertebrate animal to whose identity we have no clue at this time. It is anticipated that sooner or later well-defined trails of this animal will be discovered.

ICHNITES FROM TAPEATS SANDSTONE

Plate 5, figs. 1, 2, 3, and 4

In a previous paper[1] mention was made in a footnote of the discovery by Mrs. G. E. Sturdevant on the Bright Angel Trail of a small section of a trackway which at that time was thought to come from the Bright Angel shale. More extended search of this locality by Messrs. G. E. Sturdevant and Edwin D. McKee has brought to light several additional specimens, and Mr. Sturdevant writes me that all of these specimens, including the one previously found by Mrs. Sturdevant, are from the Tapeats sandstone.

The correctness of his observation is fully confirmed by comparison of the specimens with trails figured by the late Dr. Charles D. Walcott[2] from the Tapeats sandstone of other parts of the Grand

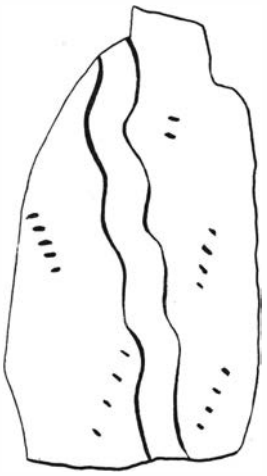


FIG. 7.—Trilobite ? trail from Middle Cambrian; Tapeats sandstone on Bright Angel Trail. About ½ natural size.

Canyon, several of which are identical in character. That there was an extended ichnite fauna in this formation is abundantly shown by the many different kinds of trails figured by Walcott, and by the specimens more recently collected.

Walcott attributes all of the various kinds of trails illustrated by him as being made by trilobites. He points out that the known genera and species of trilobites from the Middle Cambrian give a wide varia-

[1] Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 9.

[2] Smithsonian Misc. Coll., Vol. 67, No. 4, 1918, pls. 37 to 42.

tion in size, and in ventral appendages, quite sufficient perhaps to account for most of the trails found.[1]

While I have no intention of giving a detailed description of these recently discovered trails, a few of the more characteristic specimens are illustrated here, especially those that differ from the trails published by Walcott, and these figures tell the story of the kinds found.

The discovery of these trails in the Tapeats of the Bright Angel section is especially interesting as recording a fourth track-bearing horizon in this one geological section.

A CORRECTION

In the faunal list of the Coconino, Smithsonian Misc. Coll., Vol. 80, No. 3, 1927, p. 4, a third species of *Agostopus*, *A. robustus* is listed. This name was inadvertently included, but it has no standing and should therefore be dropped from further consideration, as a *nomen nudum*.

Attention is also called to the misspelling of the species *Hylopus hermitanus* in the same publication. In the list of Hermit ichnites, page 7, *H. hermitus*, and on page 78, *H. hermitensis* both should be *Hylopus hermitanus* Gilmore.

[1] *Idem*, p. 175.

EXPLANATION OF PLATES

PLATE 1

PAGE

Large track-covered slab (No. 11,707, U. S. N. M.) from the Hermit shale, showing trackways of *Parabaropus coloradensis* (Lull) (large track forming the diagonal trail across left side of slab); *Collettosaurus pentadactylus* Gilmore (trail with distinct tail drag to right of center); and *Hylopus hermitanus* Gilmore (all other tracks on the slab). This slab has a greatest transverse diameter of 6 feet and 5 inches; a greatest vertical diameter of 3 feet and 10 inches 7

PLATE 2

Ammobatrachus turbatans, new genus and species. Type. No. 11,691, U. S. N. M. Trackway from the Supai formation, Bright Angel Trail, Grand Canyon National Park, Arizona. About one-half natural size ..... 8.

PLATE 3

FIG. 1. *Hyloidichnus whitei,* new species. Type. No. 11,692, U. S. N. M. About natural size..... 5

FIG. 2. Unidentified tracks (invertebrate) from the Supai formation, O'Neill Butte, Grand Canyon National Park, Arizona. About natural size 12

PLATE 4

FIG. 1. Unidentified trail (invertebrate). No. 11,740, U. S. N. M. From the Supai formation on west side of O'Neill Butte, Grand Canyon National Park, Arizona. About one-half natural size..... 10

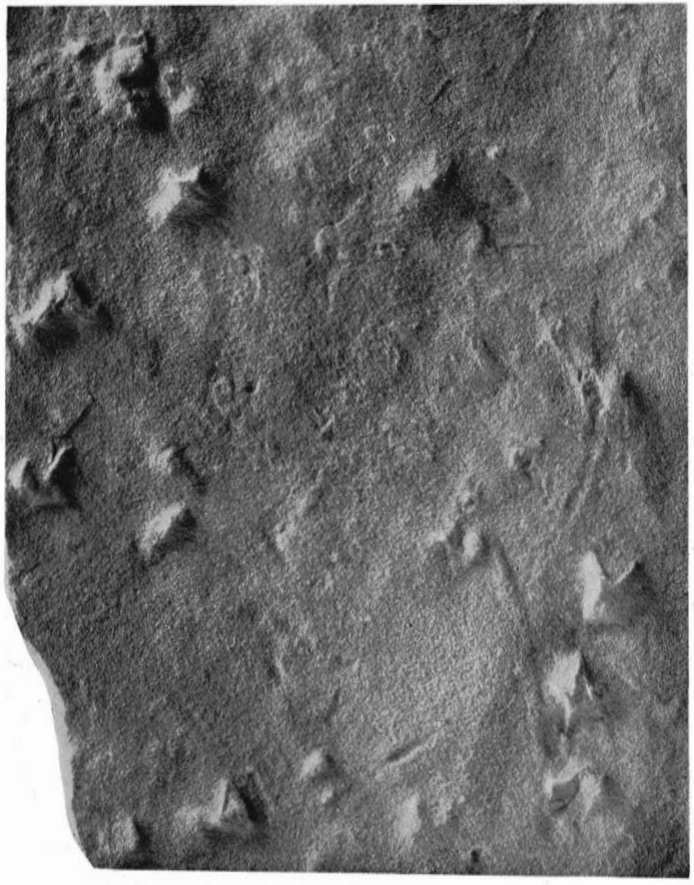
FIG. 2. Unidentified trail (invertebrate). No. 11,693, U. S. N. M. From the Supai formation (upper track-bearing horizon), on west side of O'Neill Butte, Grand Canyon National Park, Arizona. More than one-half natural size..... 12

PLATE 5

Trilobite tracks and trails. All from the Tapeats sandstone, Middle Cambrian, as exposed in the Bright Angel section, Grand Canyon National Park, Arizona. Figs. 1, 2, and 4, about three-fourths natural size. Fig. 3, natural size..... 14

Fossil footprints from Hermit formation.
(For explanation, see page 16)

Fossil footprints from Supai formation.
(For explanation, see page 16)

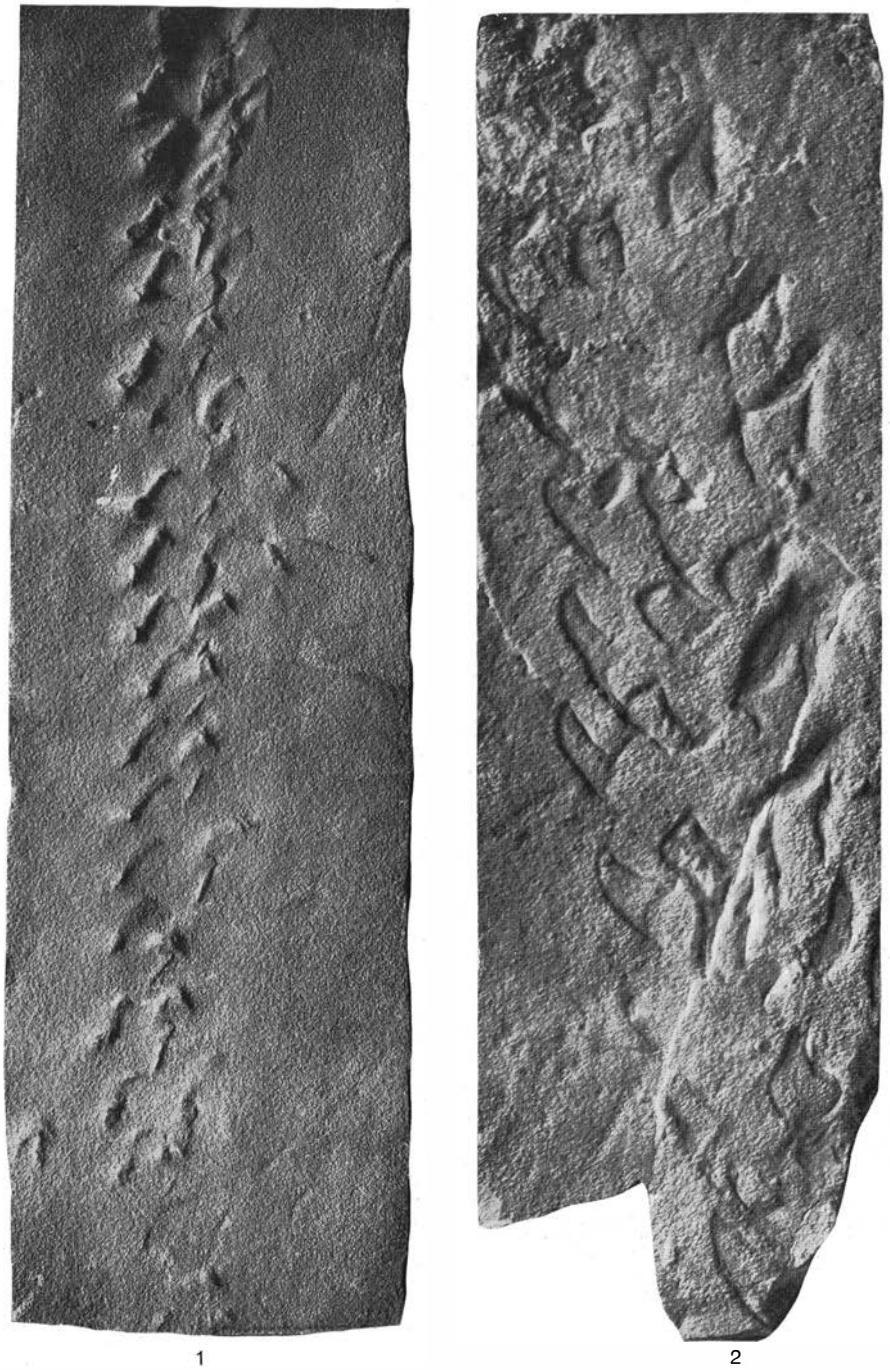


1

2

Fossil tracks from the Grand Canyon.

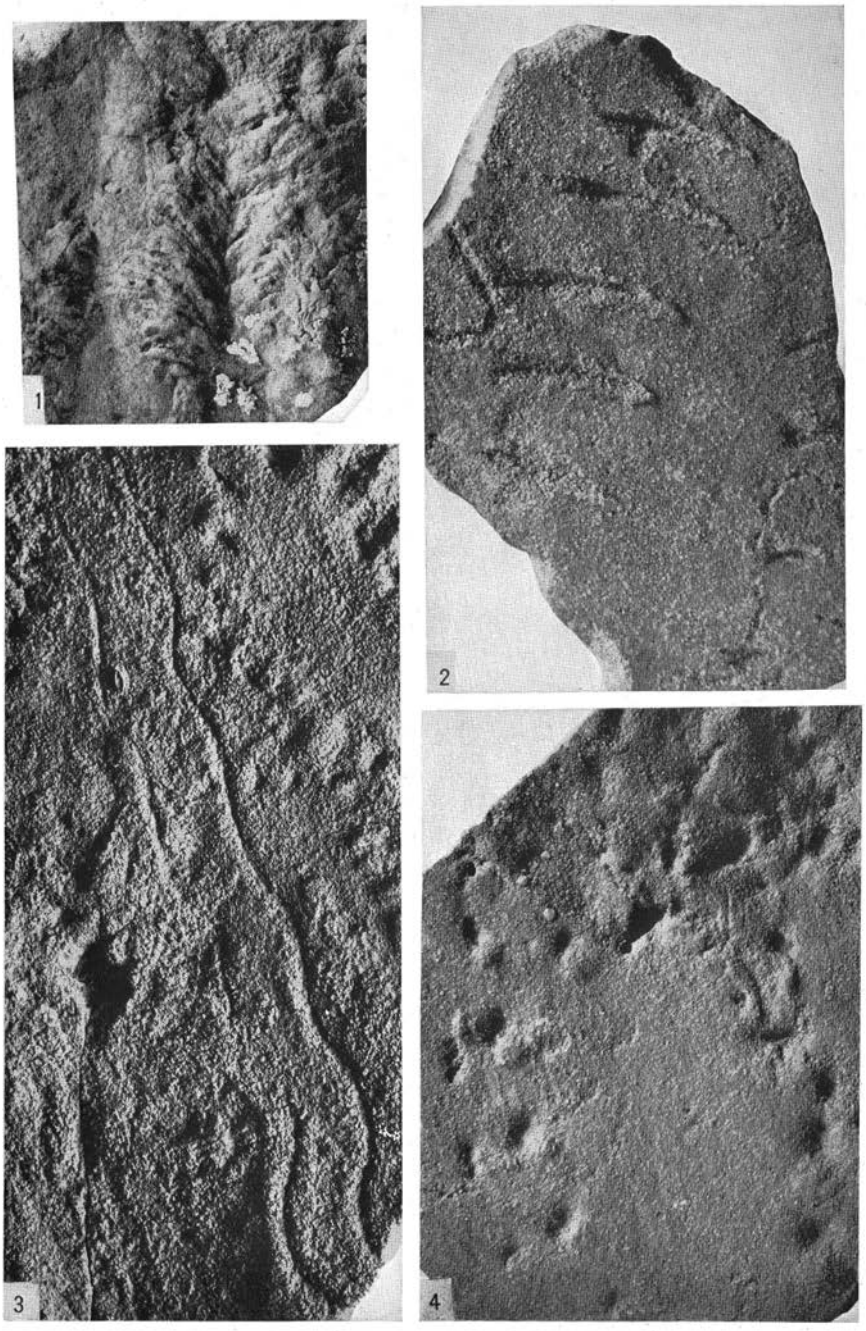
(For explanation, see page 16)



1 2

Fossil invertebrate trails from Supai formation.

(For explanation, see page 16)



Trilobite tracks and trails, Tapeats formation.

(For explanation, see page 16)