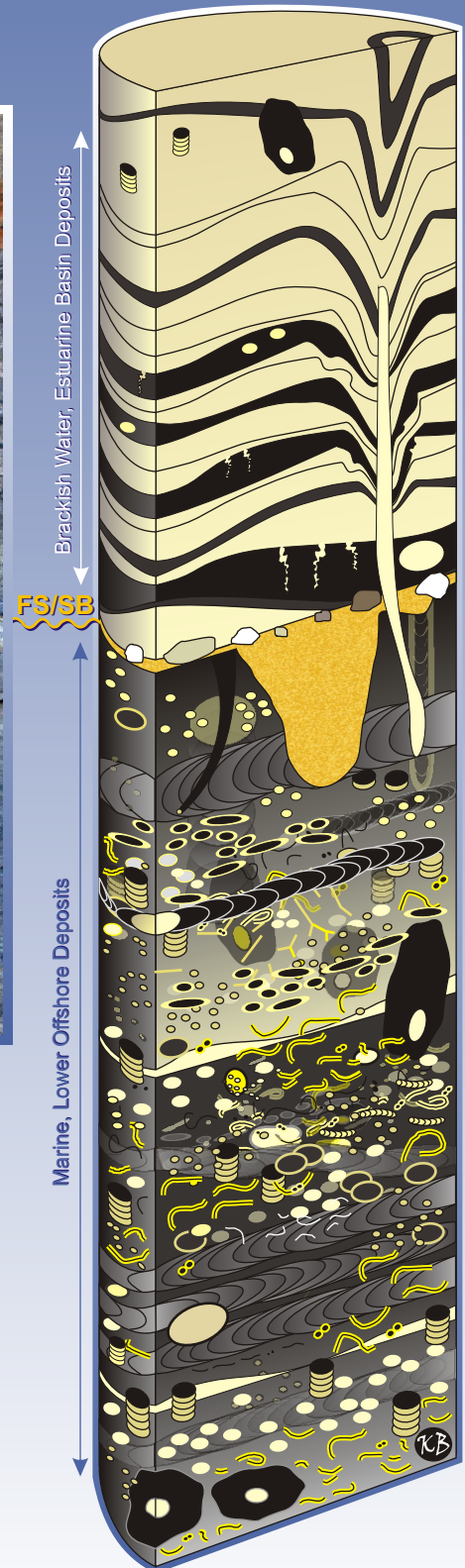


Ichnological Applications to Sedimentological and Sequence Stratigraphic Problems



Abstract Volume

SEPM Research Conference
Price, Utah, USA, May 20-26, 2007

Edited by James A. MacEachern, Murray K. Gingras,
Kerrie L. Bann & S. George Pemberton

Analysis of Variability in *Protichnites* Morphology and a Standardized Method of Identification

Matthew E. Burton-Kelly

Department of Geology and Geological Engineering, University of North Dakota, Grand Forks,
North Dakota, 58203, USA. matthew.burton.kelly@und.nodak.edu

Morphological characters of described specimens of the ichnogenus *Protichnites* Owen, 1852, (a probable arthropod trace fossil) in the literature were identified. For this study, *Protichnites* was defined as a trackway possessing the following characteristics: paired imprints across the midline, medial structure (groove(s) or ridge(s)), and a countable (i.e., generally unchanging) number of tracks in each repeating trackset. This definition removes certain described specimens and ichnospecies of *Protichnites* from that ichnogenus (and from this study), due mainly to a lack of ‘countable’ tracks per set, something that Owen (1852) considered an important aspect of these trackways when he named *P. septemnotatus* (“seven-marked”), *P. octonotatus* (“eight-marked”) and *P. multinotatus* (“many-marked”). Specimens that possess this morphology but have not been identified as *Protichnites* were not included in this study. Many specimens from the literature have been identified only to the level of ichnogenus.

Specimens were grouped according to shared characters in order to produce a hierarchical morphological tree. Number of medial grooves/ridges (1st level), number of tracks per set (2nd level), continuous vs. discontinuous medial structure (3rd level), and marginal vs. central location of medial structure (4th level) were taken into account to distinguish specimens identified as belonging to the ichnogenus *Protichnites*. These characters were arrived at as a basis for comparison through analysis of both what data has historically included in trackway descriptions and what can conceivably be easily noted in future work or in the field. Location of medial structure appears last, due to the lack of such information in most of the literature concerning *Protichnites* specimens that have not been identified to the ichnospecies level.

These methods were used to produce a dendrogram showing the relationship between defined *Protichnites* ichnospecies and unidentified (to the ichnospecies level) specimens attributed to that ichnogenus in the literature. *Protichnites* specimens identified to the ichnospecies level group quite well. The distinction between closely ‘related’ ichnospecies occurs at varying levels of the tree hierarchy (e.g., *P. septemnotatus* and *P. octonotatus* (Owen, 1852) are alike in all but track number, while *P. gallowayi* (Sharpe, 1932) and *P. carbonarius* (specimen, Keighley and Pickerill, 1998) differ in the position of the medial structure). This does not seem to be problematic; ordering of characters within the tree has no effect on the grouping of end members, because the relationships are morphological rather than phylogenetic. It is interesting to note that no formal definition of a *Protichnites* ichnospecies includes the presence of two (or more) medial grooves, suggesting that this characteristic be used to define a parallel ichnogenus. A key was produced to aid in field identification of trackways that may fall under this definition of *Protichnites*.

The ichnogenus *Protichnites* was found to be much more diverse at the ichnospecies level than previously realized. The definition of the ichnogenus used herein allows for a more specific and quantitative approach to identification of *Protichnites*, by removing problematic specimens and ichnospecies that are not in keeping with what is perceived as Owen’s (1852) original intent; however close re-study of this material is warranted to justify such a removal. The methods used in this study suggest that the systematic addition of quantitative characters to trackway analysis can simplify identification of additional problematic genera.

Although the potential uses of arthropod trackways for stratigraphy are obviously limited, e.g., to understanding sediment saturation, dune angle or sedimentation rates, this study is intended to

promote the use of a strictly defined key set of morphological traits in the identification of other ichnofossils.

References

- Keighley, D.G., and R.K. Pickerill. 1998. Systematic ichnology of the Mabou and Cumberland groups (Carboniferous) of western Cape Breton Island, eastern Canada, 2: surface markings. *Atlantic Geology*, 34:83-112.
- Owen, R. 1852. Description of the impressions and footprints of the *Protichnites* from the Potsdam Sandstone of Canada. *The Quarterly Journal of the Geological Society of London*, 8:214-225.
- Sharpe, S.C.F. 1932. Eurypterid trail from the Ordovician. *The American Journal of Science*, 24:355-361.

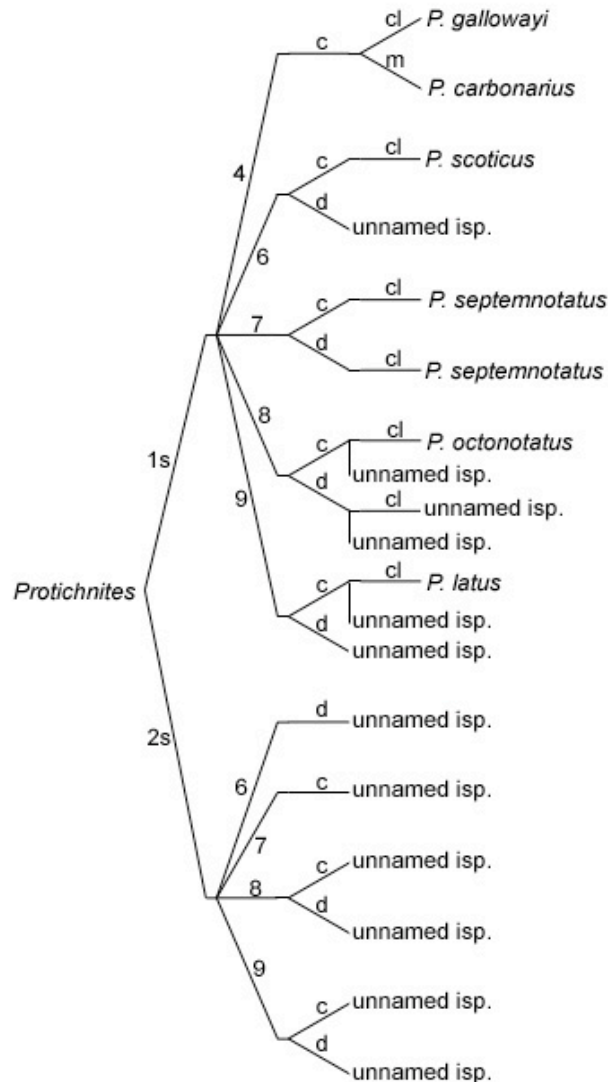
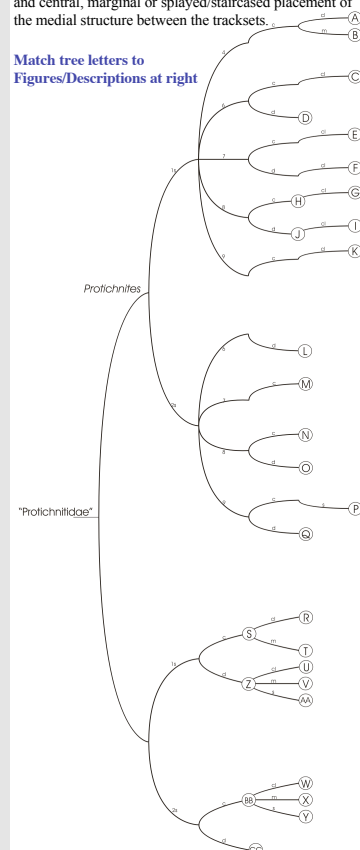


Figure 1. Dendrogram of morphological similarities between *Protichnites* ichnospecies, “Unnamed isp.” refers to examples from the literature of *Protichnites* occurrences that were not identified to the ichnospecies level. Four ichnotaxobases are illustrated in hierarchical form (from left to right): Number of medial grooves/ridges (1st level), number of tracks per set (2nd level), continuous vs. discontinuous medial structure (3rd level), and marginal vs. central location of medial structure (4th level). Key to character symbols: **1s**, single medial structure; **2s**, double medial structure; **4, 6, 7, 8, 9**, number of tracks per trackset; **c**, continuous medial structure over the course of the trackway; **d**, discontinuous medial structure; **cl**, medial structure located approximately halfway between tracksets; **m**, medial structure biased toward one side of the trackway.

Start Here

**Match tree letters to
Figures/Descriptions at right**

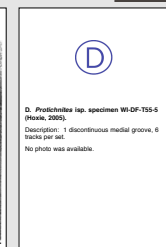
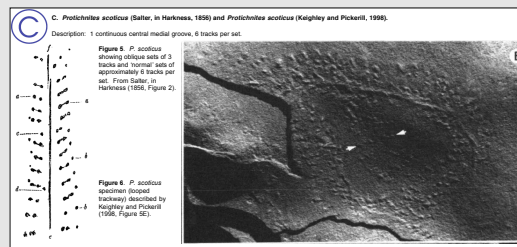
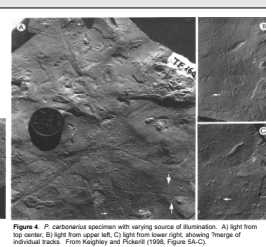
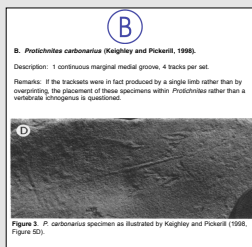
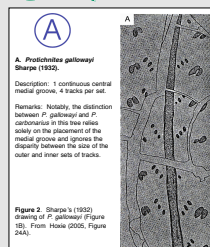


Three distinct groups are formed. The first (A-B) represents those trackways with countable tracks and a single medial structure. This is most similar to Owen's (1982) original description. The second (C-D) possesses countable tracks and two medial structures; no named ichnospecies appears in this group. The first two groups make up what can be termed *Protrichites* sensu stricto. The third group (E-CC) has similar morphologies to the other two, but the number of tracks per set is unidentifiable due to preservation or behavior (e.g., leg placement) of the producer.

1a: 1 medial structure; 2a: 2 medial structures; 4,6,7,8,9: number of tracks per set; c: continuous medial structure; d: discontinuous medial structure; cl: central medial structure; m: marginal medial structure; s: splayed/staircased medial structure

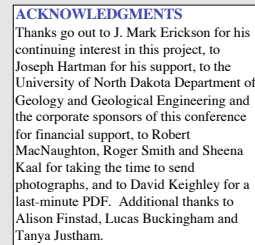
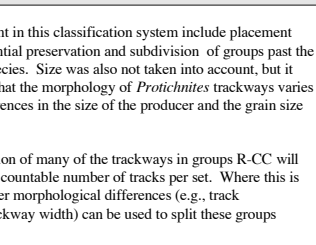
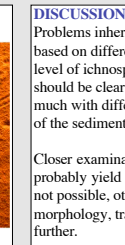
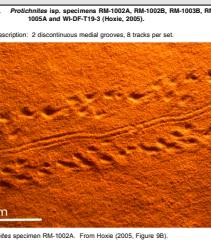
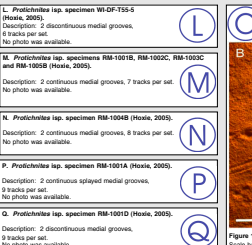
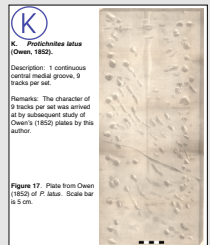
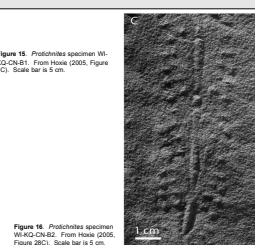
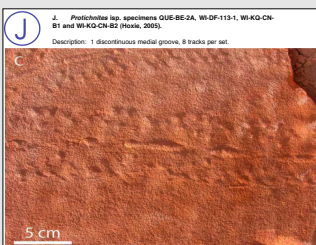
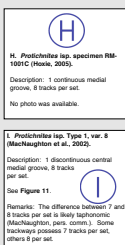
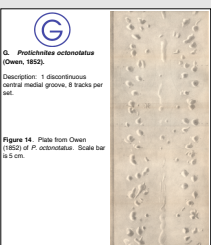
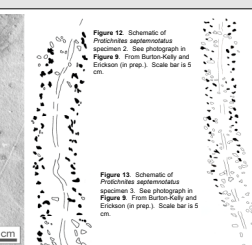
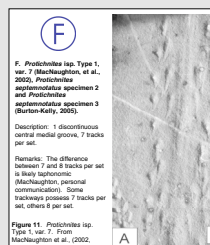
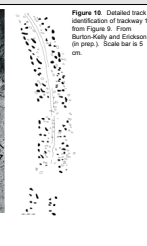
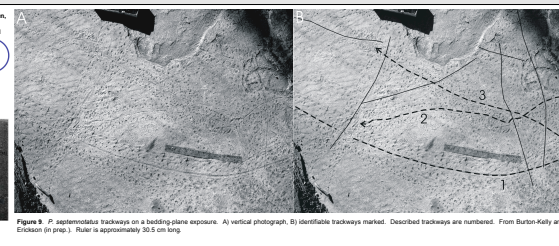
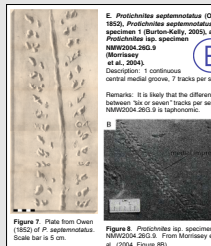


Matthew E. Burton-Kelly, Department of Geology and Geological Engineering, University of North Dakota, Grand Forks, ND 58202
matthew.burton.kelly@und.nodak.edu



INTRODUCTION

For the most consistent discussion of trace fossils, ichnofossil identification and classification should be based on morphology alone. In this vein, all described occurrences of the ichnogenus *Protichnites* Owen, 1852, (probably of arthropod origin) are here addressed in terms of shared quantitative characters. Only *Protichnites* specimens were studied—possible synonyms with other ichnogenera (e.g., *Siskemia*, *Koupichnium*, *Stiaria*, *Danstairia*, etc.) are not discussed. *Protichnites* is a multipart trace consisting of 1) a medial structure bordered by 2) repeating paired tracksets. Owen (1852) placed much value on the number of tracks per set, and the medial structure has traditionally been diagnostic of this ichnogenus. It is proposed, therefore, that *Protichnites* (*sensu stricto*) be limited to those trackways with a countable number of tracks per set.



DISCUSSION

Problems inherent in this classification system include placement based on differential preservation and subdivision of groups past the level of ichnospecies. Size was also not taken into account, but it should be clear that the morphology of *Protichnites* trackways varies much with differences in the size of the producer and the grain size of the sediment.

Closer examination of many of the trackways in groups R-CC will probably yield a countable number of tracks per set. Where this is not possible, other morphological differences (e.g., track morphology, trackway width) can be used to split these groups further.

ACKNOWLEDGMENTS

Thanks go out to J. Mark Erickson for his continuing interest in this project, to Joseph Hartman for his support, to the University of North Dakota Department of Geology and Geological Engineering and the corporate sponsors of this conference for financial support, to Robert MacNaughton, Roger Smith and Sheena Kaal for taking the time to send photographs, and to David Keighley for a last-minute PDF. Additional thanks to Alison Finstad, Lucas Buckingham and Tanya Justham.

