McGhee, C. R. 1977. Observations on the use of measurements in the systematic study of *Leiobunum* (Arachnida: Phalangida). J. Arachnol. 5:169-178.

OBSERVATIONS ON THE USE OF MEASUREMENTS IN THE SYSTEMATIC STUDY OF *LEIOBUNUM* (ARACHNIDA: PHALANGIDA)

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ABSTRACT

The genus *Leiobunum* is widely distributed in the eastern United States and has been under investigation since Thomas Say described *L. vittatum* as the first North American species in 1821. Several species have been described by various workers since Say, but the characteristics used in describing them have often been highly variable and of little taxonomic value. Measurements such as total leg length and body length have been standard parts of species descriptions for many years. Such characters are often not definitive and may cause confusion and misidentification when derived from single specimens or small collections as has often been the case. The value of several measurements used in taxonomic descriptions of species of *Leiobunum* is evaluated in this paper, and the separation of two closely related species which have previously been collectively referred to as *L. politum* is demonstrated.

INTRODUCTION

Leiobunum politum (Figs. 1, 2 and 3) was described by Clarence M. Weed in 1889 from a specimen collected in Champaign County, Illinois. Weed's original diagnosis (1889:89) is as follows: "Male Body 5 mm long, 2.8 mm wide. Palpi 3.5 mm long. Legs: I, 25 mm, II, 51 mm, III, 26 mm, IV, 36 mm." The description of *L. politum* includes reddish brown coloration, no marking or faint indication of the central mark, a series of small, acute, black spines over each eye, slender palpi, some banding in coloration of the legs and a description of the shape of the penis.

Later descriptions of *L. politum* by Weed, and by a number of taxonomists who followed him, were based upon essentially the same taxonomic characters. The use of leg length became a regular part of species diagnoses, and characters such as coloration, marking, and spination became standard in descriptions and were included in the keys of some taxonomic papers. These characters are beneficial to a degree, but in descriptions of *Leiobunum* they are not always definitive.

The problem of variation in the species of *Leiobunum* was recognized early by Weed (1892a) in a paper dealing with variation in *L. vittatum* (Say). He states, "I conclude that we have to do with a very variable species, in which natural selection has increased the size of the body and length of the legs to the southward, and shortened them in the north." Further, "... the size of the body and length of legs varies greatly with the locality, as a rule the body becoming larger and the legs longer as we go southward." Measurements are presented to support his conclusion in the publication.

In an article published in the same year Weed (1892b) presented measurements of a male specimen which he believed to be *L. politum* collected in New Hampshire which are as follows: "Male 3.1 mm long, 2.4 mm wide; palpi 2.7 mm long. Legs: first 26 mm, second 48 mm, third 26 mm, fourth 37 mm." The rest of the description for the New Hampshire specimen is essentially the same as for the Illinois type specimen of *L. politum.* The New Hampshire specimen has shorter body length and pedipalp length than the specimen from Illinois, but leg length is essentially the same in both.

A year later Weed (1893c) published a description of a new subspecies, *L. politum magnum* Weed, from Mississippi which was based upon the following diagnosis: "Male body 5 mm long, 4 mm wide; palpi 3.8 mm long. Legs: first 40 mm, second 80 mm, third 40 mm, fourth 58mm." The primary difference between the Illinois type specimen and the subspecies from Mississippi is in leg length.

Other papers dealing with variation and subspeciation in *Leiobunum* have been published. For example, subspecies have been described for *L. vittatum* (Say), *L. ventricosum* (Wood), and *L. longipes* Weed, all of which have the same general distribution as *L. politum.* Some authors have recognized the subspecies designations, others have not. Bishop (1949) in a discussion of *L. politum* states, "In species common to both the north and south, the southern specimens have longer legs and, in the case of some forms, there is a well defined cline. We prefer to regard *L. politum* as a distinct species." Weed (1893a, 1893b) presents figures and graphs for *L. ventricosum* and *L. vittatum* which demonstrate a north-south cline for leg length. Included in the publication is a description of *L. vittatum dorsatum* as a northern "form" of *L. vittatum* and *L. ventricosum hyemale* as a geographic "race" of *L. ventricosum.* Most authors following Weed recognized the existence of geographic variation, but diagnoses, keys and descriptions continued to utilize single measurements rather than ranges and averages in species descriptions. The problems created by this method of numerical evaluation become apparent when dealing with highly variable characters such as leg length in keys and descriptions. This study attempts to point up the need for a change in methods of evaluation and description of *Leiobunum* species.

MATERIALS AND METHODS

Penis length, genital operculum length, total body length and femur I length are discussed in this paper. Other measurements may be of value in adding information about the species in descriptions, but will serve no useful purpose here. The map (Fig. 7) illustrates the sites in the eastern United States from which collections were taken. The bulk of the material studied was taken from an area which extends along the Appalachian Mountains from Maryland to northern Alabama. Additional museum collections extend the range southward to northern Florida and northward to Maine.

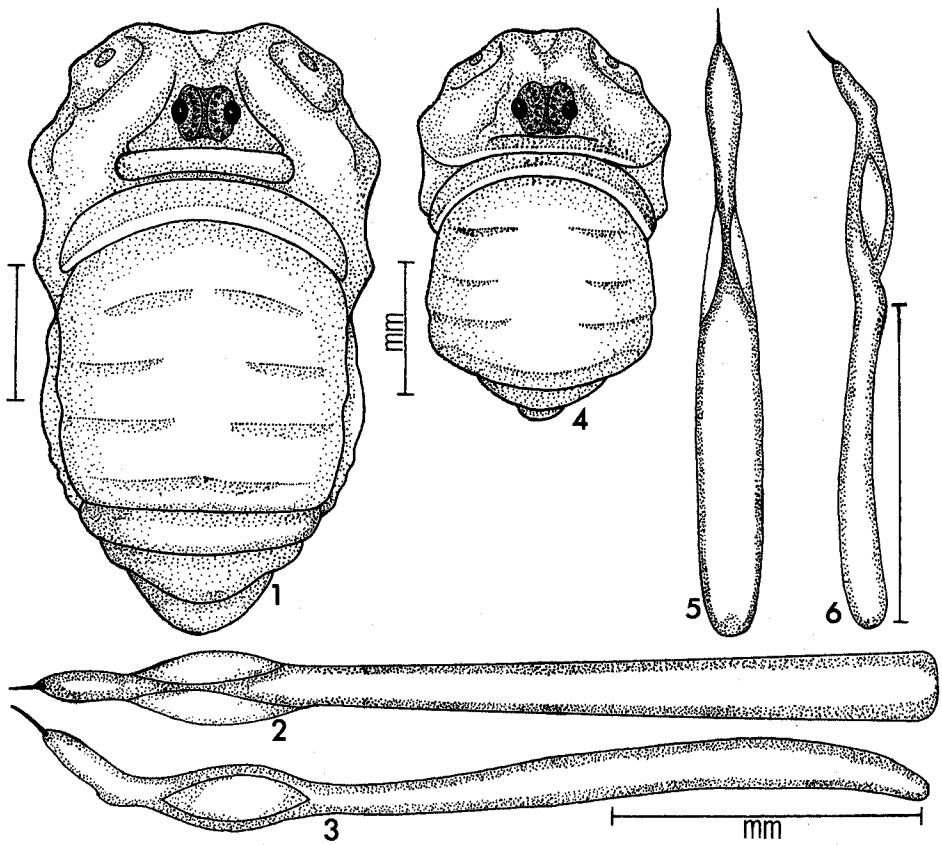
The graphs presented in the paper are analyses of collections of *L. politum* and *L. bracchiolum* McGhee (Figs. 4, 5 and 6). Part of the series consists of specimens on loan from The American Museum of Natural History and part from collections assembled between 1967 and 1971 from the southeastern United States. The measurements were obtained from mature male specimens, most of which were collected during the months of July and August. Measurements were made using a Bausch and Lomb zoom dissection microscope calibrated to 0.1 mm. Each graph has been arranged with measurements proceeding from south (A) to north (U) so that clines will be indicated. The graphs indicate total range (horizontal bar), mean (verticle bar), and 2X standard error of mean

(box) for each sample over size 5. The number of specimens in each sample is indicated to the right of each horizontal bar and the total range of all samples is indicated at the top of the graph. Location of the sample site is indicated on the right side of each graph by letters corresponding to those on the map (Fig. 7). Total range for each species and area of overlap between species is indicated by vertical dotted lines.

RESULTS AND CONCLUSIONS

The penis of *Leiobunum* is an important species character which has been used very little in past descriptions. Each species has a distinctive penial form which has not been found to be subject to extensive variation from one geographic region to another as are leg length, coloration, marking, etc. Some authors described the penis and a few illustrated it, which is of considerable value in helping determine species in the absence of type specimens. The first to adequately illustrate the penes of United States species was N. W. Davis (1934), and S. C. Bishop (1949) also illustrated the penes of several species which he described from New York.

Figures 2 and 3 illustrate the penis of *L. politum* Weed and figures 5 and 6 the penis of *L. bracchiolum* McGhee. The general similarity between these two species is obvious, and *L. bracchiolum* has undoubtedly been described as *L. politum* through the years because of similarities in morphology, coloration, leg length, etc. Anyone observing the



Figs. 1-6.–*Leiobunum politum*: 1, dorsal view of male; 2, dorsal view of penis; 3, lateral view of penis. *L. bracchiolum*: 4, dorsal view of male; 5, dorsal view of penis; 6, lateral view of penis.

similarity between these species in the southern and northern states, while assuming that the cline which has been described for leg length holds true for all measurements, and without knowledge of the variances in different body dimensions would probably consider them to be geographic variants of the same species. The same conclusion might be drawn from using the illustrations of *L. politum* from earlier publications. There is evidence that some past descriptions of *L. politum* may have been derived from specimens of *L. bracchiolum* as a result of the idea of a distinct north-south cline. Weed's New Hampshire description of *L. politum* may well have been a description of *L. bracchiolum.* Several museum vials of *L. bracchiolum* were labeled *L. politum.*

L. bracchiolum was first discovered in a collection from Frederick Co., Maryland which is at about the same latitude as Weed's type locality for *L. politum* (Fig. 7). While

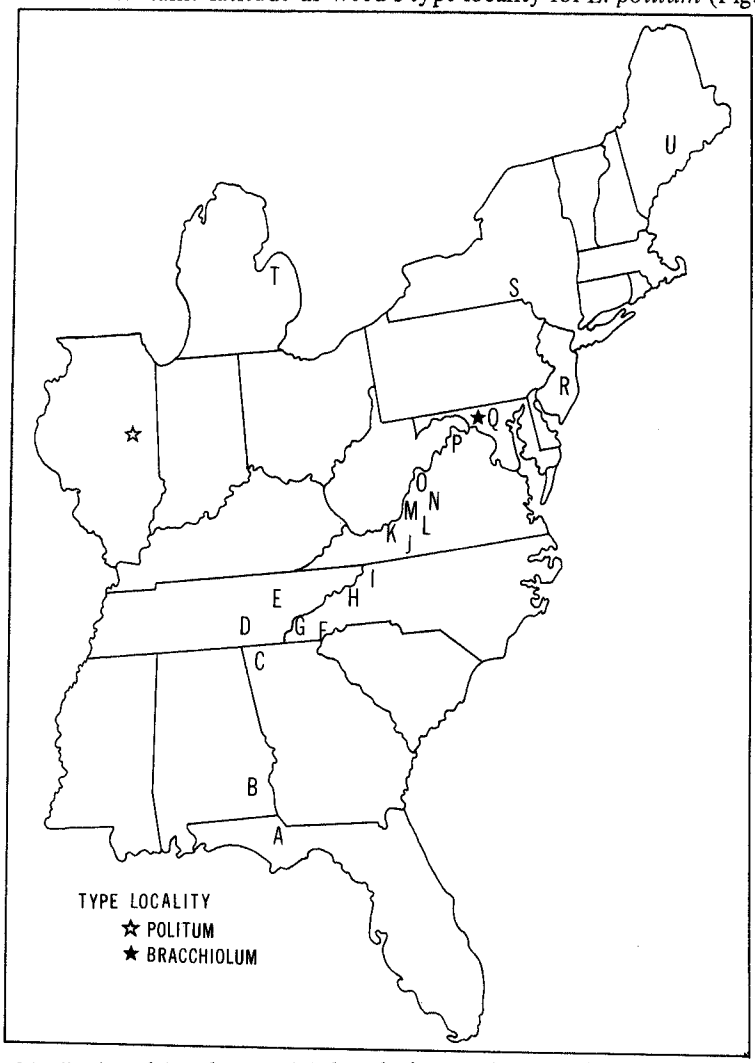


Fig. 7.–Distribution of *L. politum* and *L. bracchiolum* specimens used in the study. Collecting sites from south to north include: Liberty Co., Florida (A); Barbour Co., Alabama (B); Dade Co., Georgia (C); Van Buren and Anderson Co., Tennessee (D & E); Transylvania, Graham, Yancey and Wilkes Co., North Carolina (F, G, H, I); Montgomery, Giles, Bedford, Craig, Rock Bridge, Bath and Warren Co., Virginia (J, K, L, M, N, O, P); Frederick Co., Maryland (Q); Bargaintown, New Jersey (R); Ithaca, New York (S); Huron, Michigan (T); and Orono, Maine (U).

identifying the specimens of the Maryland collection it became apparent that two distinct groups of phalangids seemed to fit the general description of *L. politum*. Additional specimens of *L. bracchiolum* from farther south and the comparisons made during this study resulted in the recognition of *L. bracchiolum* as a distinct species.

Figure 8 is a graph of the measurements of the penes of both species taken from 135 specimens in 24 collections. The samples are arranged in an approximate order from south (A) to north (U) so that any indication of a cline will be demonstrated. The following observations concerning penis length are apparent: (1) No evidence of a north-south cline is indicated in penis length for either species. In fact, the Warren Co., Virginia (P) and the Frederick Co., Maryland (Q) specimens are, on the average, slightly larger than the Liberty Co., Florida (A) specimens in *L. politum*. Specimens from northern Michigan (T) fall within the same range as specimens from Virginia (J-P), North Carolina

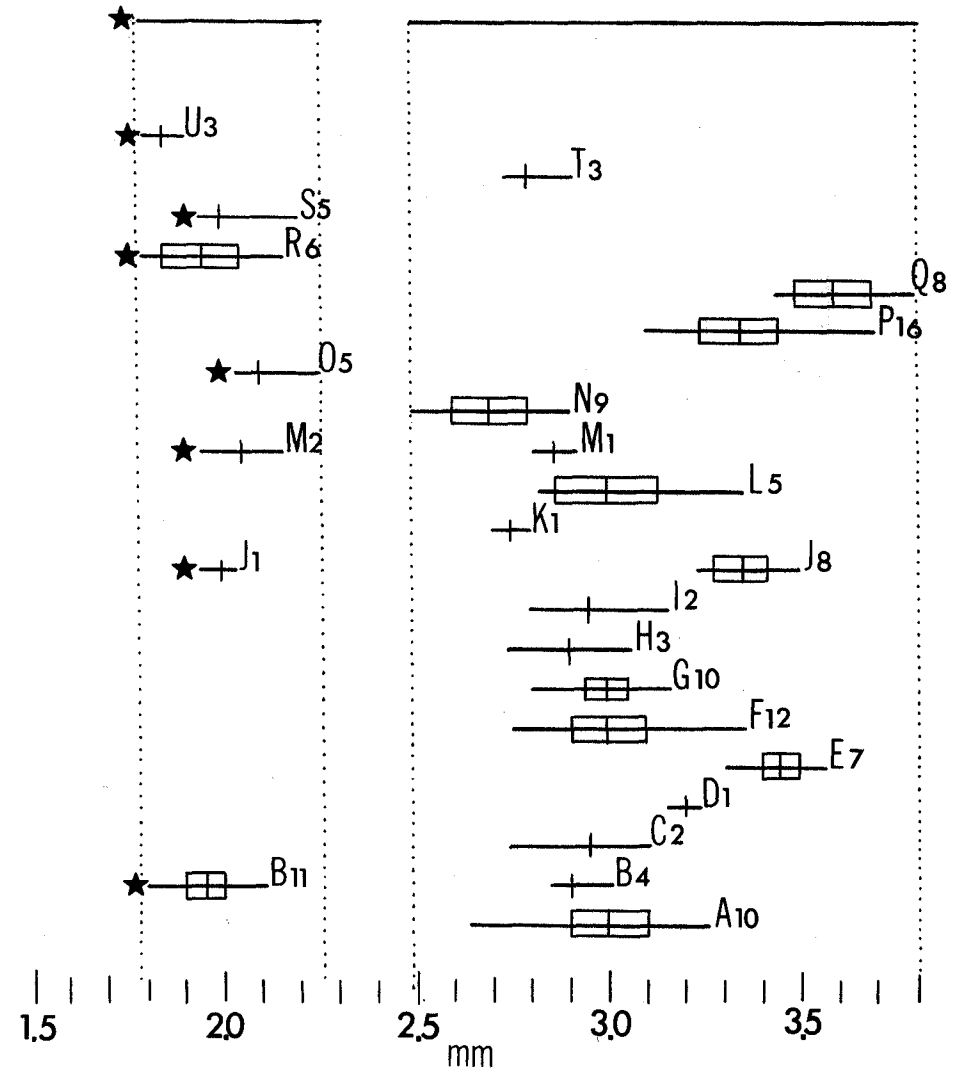


Fig. 8.–Graph illustrating the range, mean and 2X the standard error of the mean for penis length in *L. bracchiolum* and *L. politum*. *L. bracchiolum* populations indicated by stars. Total range for each species indicated by solid lines at the top of the graph.

(F-I), Tennessee (D-E), Georgia (C), Alabama (B), and Florida (A). (2) There are two distinct groups of ranges in penis length in which there is no overlap in size from Alabama to Maine. This cannot be attributed to seasonal variation, since all specimens were collected from July to August and it cannot be attributed to geographic variation, since both groups have almost identical ranges from the south to the north and often occur in the same area together. (3) The morphology (Figs. 3 and 5) of these two penial types remains relatively constant from south to north. The *L. politum* penis, with slight variations, has essentially the same appearance in Florida and Michigan specimens, and the *L. bracchiolum* penis is virtually identical in appearance along its entire range from Alabama to Maine.

The use of penial morphology alone could be misleading in species identification, especially where small samples from widely separated geographic areas are used and where too much reliance is placed in the north-south "cline theory" as applied to leg length. It is obvious that two quite distinct species are indicated by both morphology and size of the penis in this case.

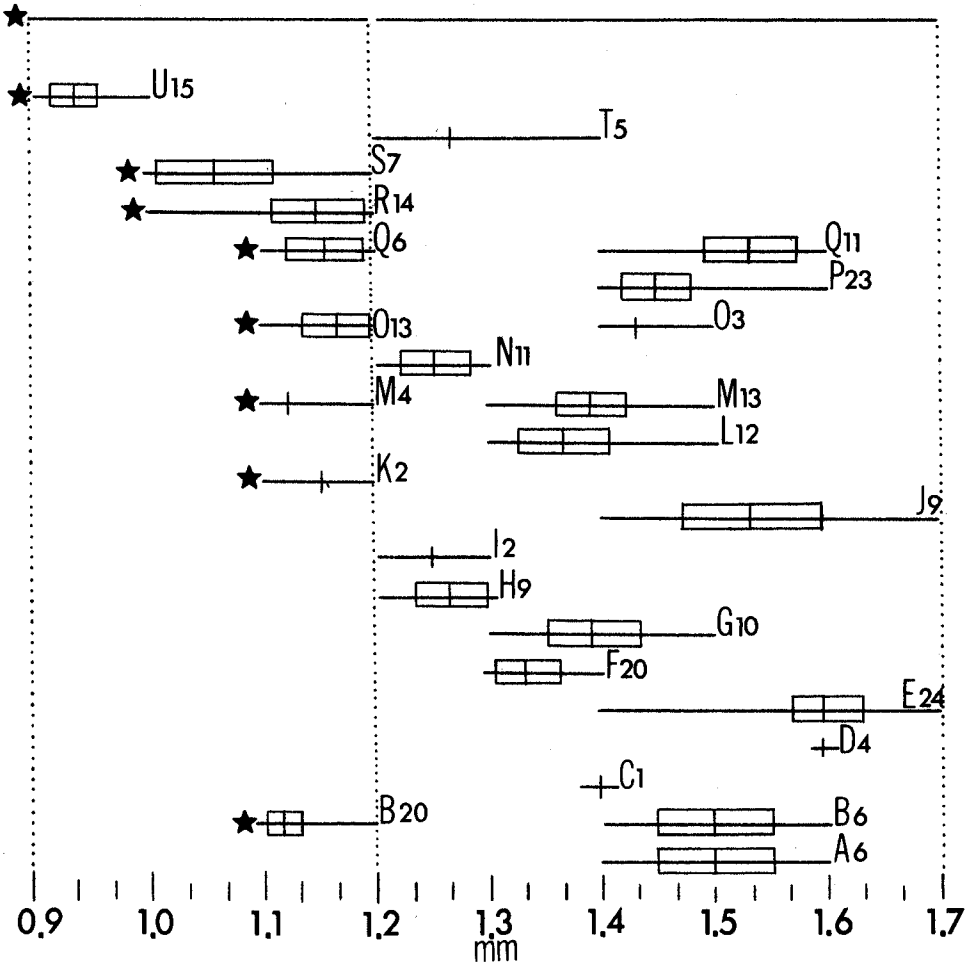


Fig. 9.—Graph illustrating the range, mean and 2× the standard error of the mean for genital operculum length in *L. bracchiolum* and *L. politum*. *L. bracchiolum* populations indicated by stars. Total range for each species indicated by solid lines at the top of the graph.

Figure 9 illustrates the length of the genital operculum of males of *L. politum* and *L. bracchiolum*. The following observations may be drawn from the graph: (1) The length of the genital operculum shows no clear indication of a north-south cline in either species, (2) the length of the operculum is of relatively constant size as compared to leg length (Fig. 11) and total body length (Fig. 10) throughout the entire range of the species, but is more variable than penis length (Fig. 8). (3) There is a rather clear line of demarcation between the ranges of operculum size in the two species and no overlap exists in the standard errors of the means from south to north. The length of the genital operculum in these species clearly demonstrates that variations of all body regions do not correspond to variations in leg length.

Figure 10 demonstrates the total body length of approximately 256 male specimens from 26 collections ranging from Florida to Maine. The following observations may be drawn from the graph: (1) There is little or no indication of a north-south cline in body length for either species. The specimens from Anderson Co., Tennessee (E) and Frederick Co., Maryland (Q) tend to be slightly larger than the Florida (A) and Alabama (B)

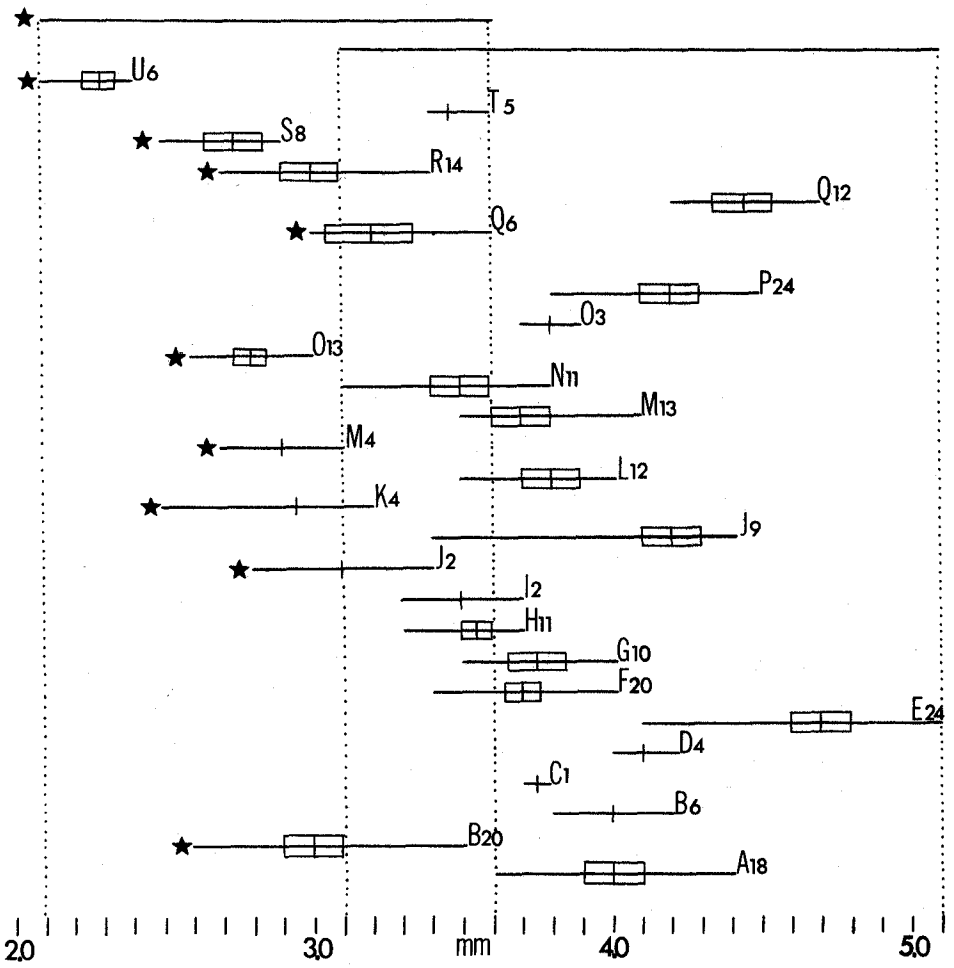


Fig. 10.–Graph illustrating the range, mean and 2× the standard error of the mean for total body length in *L. bracchiolum* and *L. politum*. *L. bracchiolum* populations indicated by stars. Total range for each species indicated by solid lines at the top of the graph.

specimens. The ranges and means for specimens from North Carolina (F-I), Virginia (J-P) and Michigan (T) tend to correspond for the most part. (2) Two distinct ranges of total length are indicated by the measurements, although, the distinction is not as clearly defined as in penial and genital operculum length. The larger specimens of *L. bracchiolum* overlap the smaller specimens of *L. politum* in a small percentage of cases, but there is no overlap in the standard errors of the means.

The graphs (Fig. 10 and 11) demonstrate little correlation between leg length and body length from south to north in these species. The legs become considerably shortened to the north but body length varies only slightly and on a more irregular basis. This seems to refute earlier ideas of a corresponding increase in leg length and body length toward the southern part of the range. It is also evident that, whereas, leg length gives no indication of two species, body length indicates this when sufficient numbers of samples and specimens are available from the species range. The use of single measurements taken from small samples is obviously of little value.

In surveying the taxonomic literature concerned with *Leiobunum* one becomes immediately aware of the extensive use of total leg length as a primary part of species descriptions. Of the numerous characters which were measured during the course of this study, leg length is by far the most variable. In addition to the extreme variability in leg

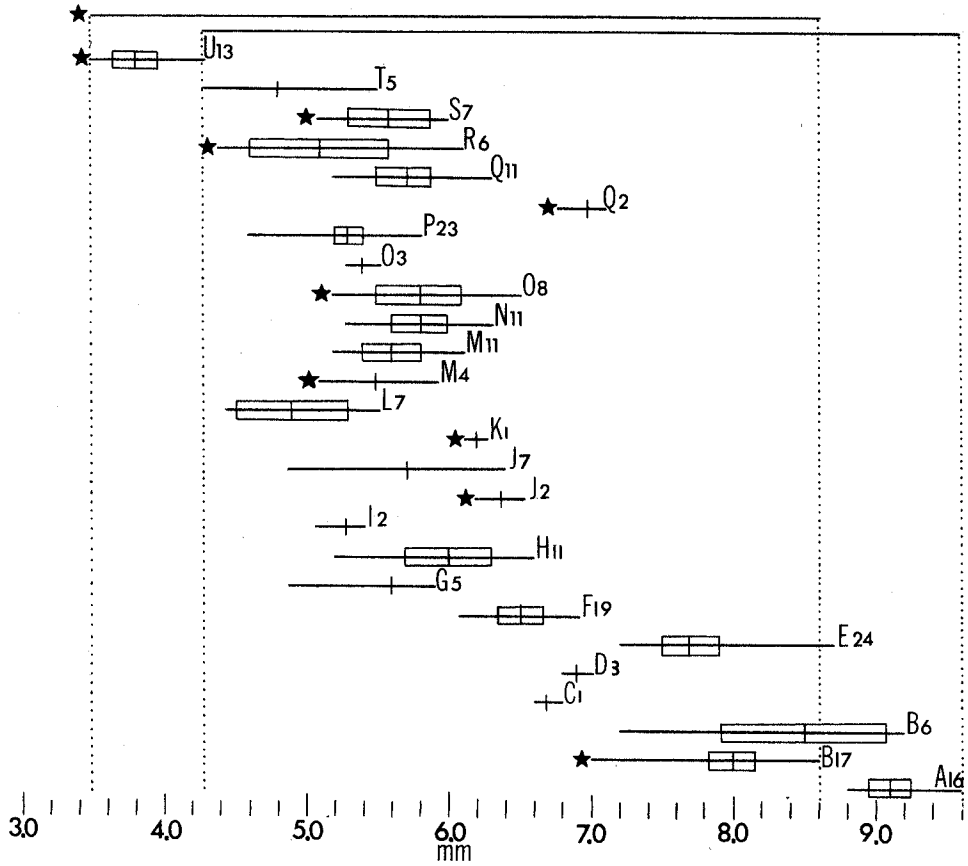


Fig. 11.—Graph illustrating the range, mean and 2× the standard error of the mean for femur I length in *L. bracchiolum* and *L. politum*. *L. bracchiolum* populations indicated by stars. Total range for each species indicated by solid lines at the top of the graph.

length, it is one of the most difficult measurements to obtain because of the tendency for legs to be broken and lost during capture or while in preservation.

In this study the length of the femur of the first pair of legs has been utilized to demonstrate the variation in leg length. The ratio of total length of the legs to individual segments has been found to be fairly consistent from specimen to specimen in species which have been studied. It is, therefore, easier to obtain information regarding variation in leg length from the measurement of a femur on one leg than to measure the total length of all legs.

Figure 11 is a graph representing the range, mean and 2X the standard error of the mean of 26 collections containing 225 male specimens from Florida to Maine. The following observations may be drawn from the graph: (1) Leg length is highly variable as compared with other measureable characters both within samples and between the southern and northern samples. (2) a cline exists in the length of the legs of both *L. politum* and *L. bracchiolum*, in which the legs become progressively longer from the north toward the south, (3) there is very little difference between the length of the legs in *L. politum* and *L. bracchiolum* over their range, and the species cannot be distinguished on the basis of this character, (4) there is a well defined break in the ranges of leg length between the Anderson Co., Tennessee (E) and the Transylvania Co., North Carolina (F) specimens of *L. politum.* This has (as previously indicated) been interpreted as evidence of subspeciation on the basis of leg length.

Leg length represents one of the weakest measurable taxonomic characters available in the study of *Leiobunum.* The inclusion of these measurements in descriptions may serve to add to the overall assessment of a species, but in order for them to be of value an understanding of the degree of variation from one geographic region to another must be gained. This character is of little use in diagnoses and keys as a single measurement taken from only a few specimens as it has been employed in the past in species descriptions.

An attempt has been made to demonstrate the value of using certain measurements as additional criteria in the descriptions of *Leiobunum* species. It has been shown that measurements can be beneficial if used correctly. Descriptions of characters such as the penis and pedipalp are essential in species determinations, but the use of these characters has been restricted and replaced with descriptions of leg length, color, markings and spination which are of limited or no value in keys and diagnoses of species. Such characters have been misleading and confusing in the taxonomy of this group of phalangids.

The study has shown that a cline exists from south to north in leg length as suggested by earlier workers, but that it is not as apparent or does not exist in other measureable characters. The cline theory has, therefore, caused misidentification of specimens in the past because it has been assumed that other body parts followed the variance and clinal characteristics of leg length, which is not the case. It has also been demonstrated that the concept of subspeciation in *Leiobunum* is vague and that leg length, which has been the primary consideration in describing subspecies, is probably the least reliable of all characters to use.

The conclusions arrived at in this paper are based upon observations derived from two closely related species. Similar measurements and comparisons have been made for several other species of *Leiobunum* which indicate that the same conclusions may hold true for other members of the genus with similar distributions.

ACKNOWLEDGEMENTS

My thanks to Dr. Perry C. Holt, Professor of Biology at Virginia Polytechnic Institute and State University for his suggestions during the preparation of this paper, and to Dr. Clay M. Chandler, Professor of Biology at Middle Tennessee State University for reviewing the manuscript. The American Museum of Natural History loaned part of the material used in the study and Middle Tennessee State University provided a grant which aided in the collection of specimens from Alabama and Florida.

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