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THE EXTERNAL MORPHOLOGY AND LIFE HISTORY OF THE PSEUDOSCORPION *MICROBISIUM CONFUSUM* HOFF

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ABSTRACT

The external morphology and life history of *Microbisium confusum* Hoff completes the description of this species which was described by Hoff (1946) on the basis of 127 "adult" individuals. All instars are illustrated and described with special reference to chaetotaxy. Males, not collected in the quantitative life history study, were obtained from several localities.

The life history was based on quantitative sampling in a northern New York beech-maple woodlot over 2 years. Protonymphs and females were collected throughout the winter months under snow cover. Deutonymphs probably overwintered but were collected less frequently. There was no evidence that more than one generation was produced each year; however, females might reproduce in successive years.

INTRODUCTION

Little is known about the development of the species in the genus *Microbisium* Chamberlin (1930). Hagen (1869) described the type species *(Obisium brunneum)* and since that time only two other American species have been reported. Hoff's brief description (1946) of *M. confusum* was based on 127 females. The first male in this genus was reported by Lawson (1969). Because of the high female to male ratio in this group, it is thought that females reproduce parthenogenetically.

The status of the tritonymph in this genus is unclear. Weygolt (1969) stated that adults of *Microbisium* may represent neotenic tritonymphs. Four postembryonic instars occur in most pseudoscorpions, separated from each other by three postembryonic molts. These instars are the protonymph, deutonymph, tritonymph, and adult. The adults do not molt and are recognized by genital openings and sexual dimorphism. Females of *Microbisium*, and males when present, possess the number of chelal trichobothria found in tritonymphs of most other pseudoscorpion species. They have a total of 10 trichobothria, seven on the fixed and three on the movable finger, whereas the usual adult pseudoscorpion complement is 12 trichobothria, eight on the fixed and four on the movable finger. The other stages in *Microbisium* have the number of trichobothria characteristic of protonymphs and deutonymphs of most other species.

Nelson (1973) quantitatively examined a population of *M. confusum* in a beech-maple woodlot, known as Toumey Woodland, located on the campus of Michigan State University (Ingham County, Michigan, U.S.A.). During this study a total of 182 protonymphs,

deutonymphs and females were taken. Males, and what are usually considered tritonymphs, were not observed. Attempts were made without success to rear this species in the laboratory.

The intent of the present study is to provide additional information on the external morphology and life history of this species. The material is presented using the format, with modifications, used by Gabbutt and Vachon (1968).

METHODS AND MATERIALS

Gray Woods, a beech-maple climax woodland, was selected as the site to study the life history of *Microbisium confusum*. The site is directly south and within one mile of Oswego, New York (U.S.A.). Within the woodland a study area of 40 x 60 meters was plotted at 10-meter intervals. The area selected was covered by a dense overstory of beech and maple.

Approximately twice monthly, over the period March 1976 to November 1977, litter and soil were sampled randomly from 10 different sample sites. Litter and soil cores 5.55 cm in diameter were taken to a depth of 7 cm. Five samples were taken at each site and the number of pseudoscocrpions observed in each sample was corrected to an assumed number per square meter. The combined samples (5 x 10 sample sites) represented 0.119 m^2. Therefore, a factor of 8.4 was used to determine the assumed number of each instar. The results were rounded out to whole numbers. Litter and soil samples were removed to the laboratory in plastic bags. Animals were extracted by means of Tullgren funnels using 40-watt incandescent lamps. Extracted pseudoscorpions were prepared for microscopic examination using the methods described by Hoff (1949), though clove oil was used in place of beechwood creosote for clearing and dehydrating the specimens.

Fifteen protonymphs, deutonymphs, and females were randomly selected from the specimens collected and examined morphologically. As no males were collected during this study, information on males was based on review of literature and examination of males from other localities. The morphological information concerning males is based on measurements from five specimens. These specimens were collected in Maine, Michigan, and New York.

EXTERNAL MORPHOLOGY OF EACH INSTAR

Chaetotaxies given in the text refer, in part, to probable basic patterns. Table 1 gives the observed variations in these counts on particular structures. Measurements and ratios are given in Table 2.

Carapace

Figs. 1-4

Protonymph: Cephalothorax (Fig. 1) 0.98-1.3 times longer than wide: epistome present; two pair of eyes, eye of each pair separated by one ocular diameter. Carapacial surface smooth; 16 to 20 setae usually present, anterior and posterior rows with four setae each, ocular and median rows each with four to six setae.

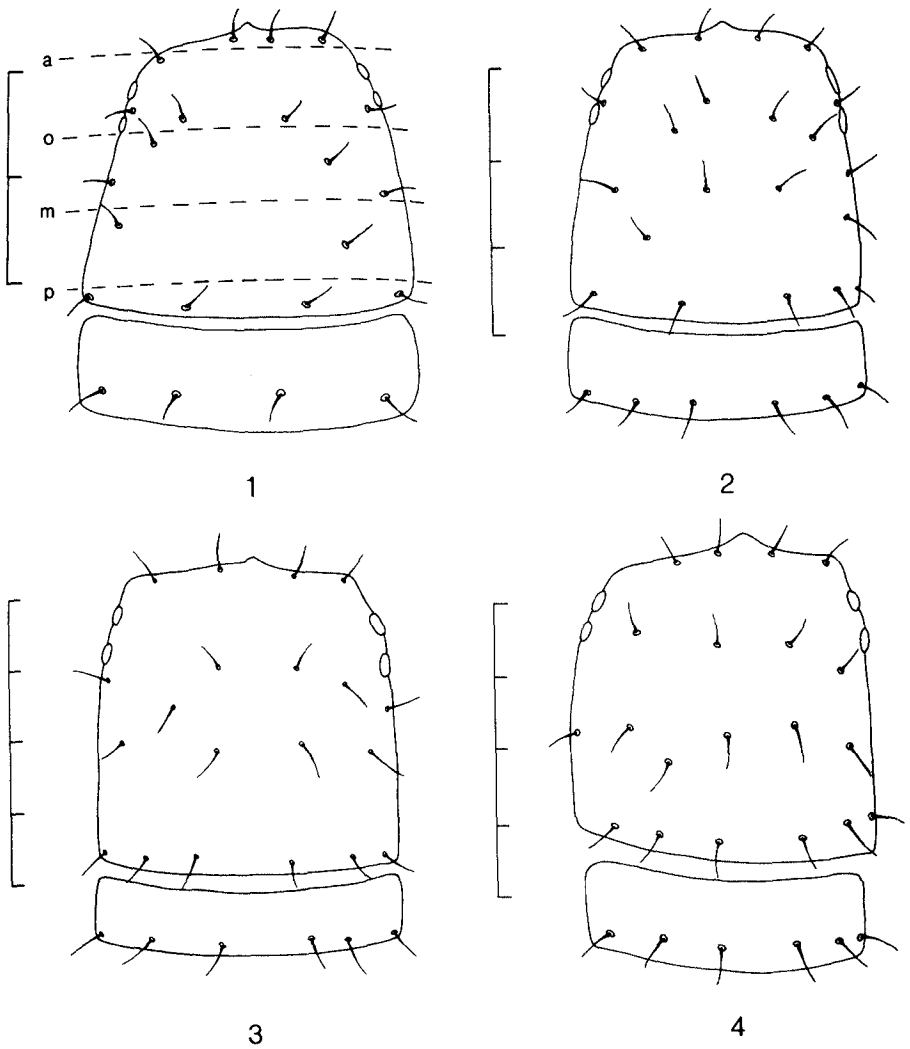
Table 1.–*M. confusum.* The number of setae present on various structures. (Figures in parentheses represent only one specimen.)

	Protonymph	Deutonymph	Female	Male
Chelae				
Trichobothria of movable finger	1	2	3	3
Trichobothria of fixed finger	3	6	7	7
Chelicerae				
Movable finger	0	1	1	1
Fixed finger	4	5	5	5
Flagellum	2+1, 3+1	3+1	3+1, 4+1	(4+1), 5+1
Cephalothorax				
Anterior row	4	4	4	4
Ocular row	4-6	6(4)	4-6	4-5
Median row	4-6	6(4)	6(4)	6
Posterior row	4	4-6	6	6
Tergites				
1	4	6-7	6(7)	6
2	4	6-7	6(7)	6
3	4	6-7	6-8	6
4	4	7-9	7-10	6
5	4	8-9	8-10	6-8
6	4	8-10	8-10	8
7	4	9-10	8-10	8
8	4	9-10	8-10	8
9	4	9-10	8-10	7-8
10	4	8-10	7-10	5-7
11	4	6	6-8	8
Coxal Area				
Manducatory process	2(3)	3	3	3
Maxilla anterior	2(1)	3	3-4	4-5
Maxilla posterior	1	2	2-3	2
Coxa I anterior	1	2-3	2-3	2-3
Coxa I posterior	0	2-3	2-3	2-3
Coxa II anterior	1	2-3	2-3	2-3
Coxa II posterior	0	2	2-4	2-3
Coxa III anterior	1	2-3	2-3	3
Coxa III posterior	0	2	2-3	2-3
Coxa IV anterior	1	3	2-4	3
Coxa IV posterior	0	2-3	2-4	2-3
Sternites				
2	0	0	2	10
3	2	6	8-12	(2)7-9(2-3) 7-8
4	4	8	8-12	8
5	6	8-10	9-12	8-10
6	6	2 8	2 8-12	2 8-11
7	6	2 6-8	2 8-12	2 8
8	6	2 6-8	2 9-13	2 8
9	6	2(10) 8	9-12	10
10	6	8-10	9-12	8-10
11	4	4	6	6

Deutonymph: Cephalothorax (Fig. 2) 1.09-1.32 times longer than wide; epistome, eyes and carapacial surface as in protonymph. Carapace with 20 to 22 setae usually present, anterior row with four setae, posterior row with four to six setae, ocular and median rows usually with six setae each.

Female: Cephalothorax (Fig. 3) 0.97-1.21 times longer than wide; epistome, eyes, and carapacial surface as in deutonymph. Carapacial setae as in deutonymph except posterior row always with six setae.

Male: Cephalothorax (Fig. 4) 1.04-1.06 times longer than wide; epistome, eyes and setae as in female. Carapacial surface smooth to weakly sculptured.



Figs. 1-4.–*M. Confusum.* Cephalothorax and tergite 1: 1, Protonymph; 2, deutonymph; 3, female; 4, male (illustration slightly skewed due to mounting technique). Abbreviations for setal series: *a*, anterior; *o*, ocular; *m*, median; *p*, posterior. (Scale: 1 division = 0.1 mm)

Table 2.–*M. confusum*. The measurements (mm) of various structures. The mean is followed by the range in parentheses.

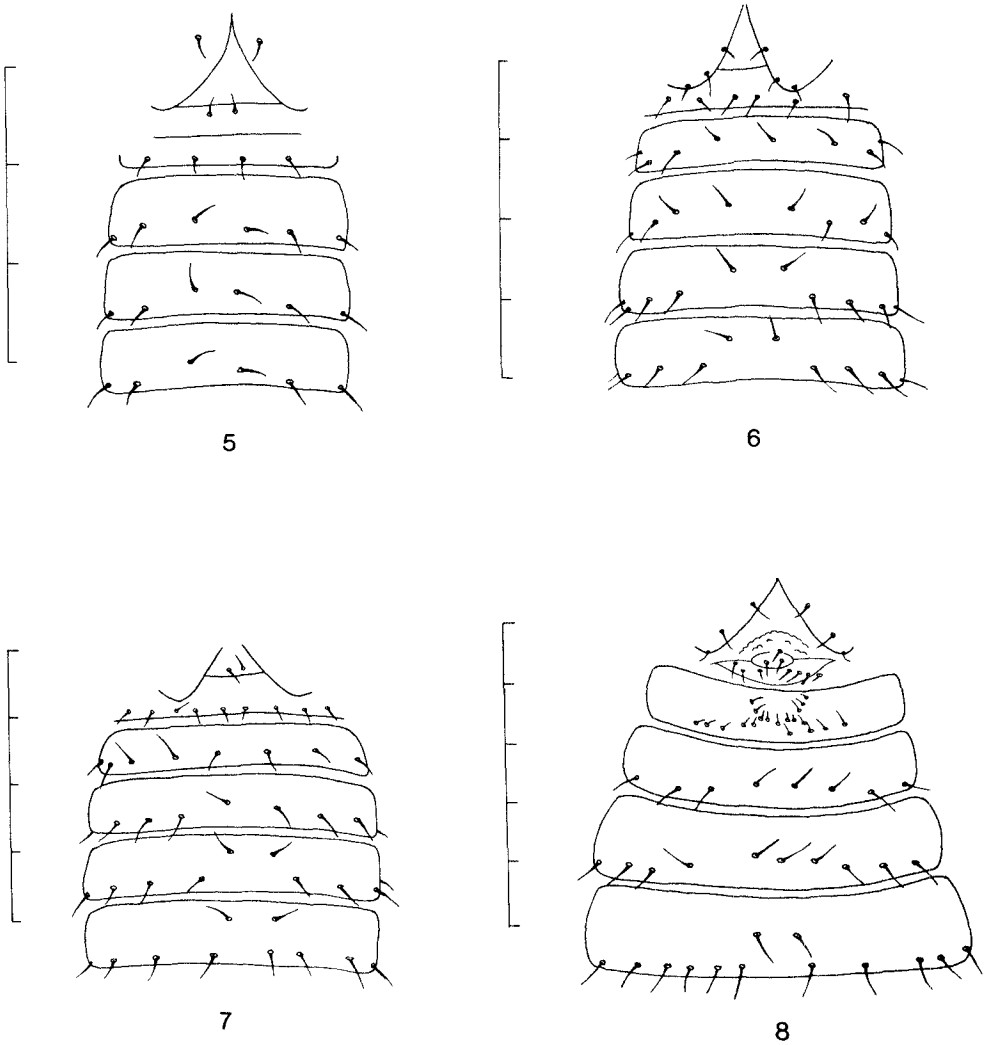
	Protonymph	Deutonymph	Female	Male
Pedipalps				
Total length of chela	0.348 (0.32-0.38	0.457 (0.43-0.49)	0.643 (0.62-0.67)	0.573 (0.51-0.64)
Length of hand of chela (1)	0.169 (0.15-0.18)	0.223 (0.20-0.23)	0.317 (0.31-0.34)	0.285 (0.28-0.29)
Length of movable finger (2)	0.178 (0.17-0.20)	0.243 (0.21-0.28)	0.348 (0.31-0.36)	0.320 (0.29-0.36)
Ratio 2/1	0.97-1.14	0.91-1.25	1.0-1.16	1.01-1.08
Width of chelal hand	0.114 (0.10-0.13)	0.165 (0.15-0.18)	0.227 (0.21-0.24)	0.198 (0.19-0.20)
Tibia length (3)	0.146 (0.13-0.15)	0.209 (0.18-0.23)	0.305 (0.28-0.31)	0.294 (0.26-0.34)
Tibia width (4)	0.090 (0.08-0.10)	0.124 (0.11-0.13)	0.167 (0.15-0.18)	0.162 (0.14-0.19)
Ratio 3/4	1.38-2.0	1.5-1.81	1.61-2.0	1.68-1.93
Femur length (5)	0.181 (0.17-0.20)	0.266 (0.24-0.28)	0.365 (0.36-0.39)	0.340 (0.31-0.37)
Femur width (6)	0.087 (0.08-0.09)	0.10 (0.09-0.10)	0.132 (0.13-0.14)	0.124 (0.11-0.15)
Ratio 5/6	2.0-2.66	2.49-2.8	2.57-2.88	2.4-2.78
Cephalothroax				
Length (7)	0.262 (0.23-0.30)	0.322 (0.31-0.35)	0.432 (0.41-0.52)	0.418 (0.39-0.43)
Anterior width (8)	0.238 (0.20-0.28)	0.284 (0.26-0.31)	0.407 (0.36-0.49)	0.396 (0.37-0.41)
Ratio 7/8	0.98-1.3	1.09-1.32	0.97-1.21	1.04-1.06
Chelicerae				
Total length (9)	0.163 (0.15-0.18)	0.204 (0.19-0.23)	0.265 (0.26-0.30)	0.20 (0.18-0.22)
Width	0.088 (0.08-0.10)	0.105 (0.10-0.12)	0.146 (0.13-0.18)	0.136 (0.12-0.16)
Length of movable finger (10)	0.092 (0.08-0.11)	0.131 (0.12-0.15)	0.153 (0.13-0.18)	0.161 (0.15-0.17)
Ratio 9/10	1.45-2.12	1.4-1.98	1.48-2.23	1.16-1.37
Leg I				
Femur I length	0.053 (0.05-0.06)	0.139 (0.12-0.15)	0.176 (0.15-0.21)	0.170 (0.16-0.18)
Femur I width	0.050 (0.04-0.06)	0.069 (0.06-0.08)	0.174 (0.07-0.77)	0.070 (0.06-0.08)
Femur II length	0.094 (0.08-0.10)	0.099 (0.09-0.10)	0.141 (0.12-0.15)	0.118 (0.11-0.12)
Femur II width	0.053 (0.04-0.06)	0.125 (0.06-0.75)	0.077 (0.06-0.10)	0.060 (0.06-)
Tibia length	0.065 (0.04-0.08	0.120 (0.10-0.13)	0.163 (0.13-0.18)	0.145 (0.14-0.16)
Tibia width	0.054 (0.04-0.06)	0.058 (0.05-0.07)	0.073 (0.06-0.08)	0.070 (0.06-0.08)
Metatarsus length	0.068 (0.06-0.08)	0.086 (0.08-0.09)	0.105 (0.10-0.13)	0.100 (0.08-0.11)
Metatarsus width	0.042 (0.04-0.05)	0.051 (0.04-0.07)	0.056 (0.05-0.06)	0.050 (0.05-)
Tarsus length	0.100 (0.08-0.12)	0.131 (0.13-0.14)	0.175 (0.15-0.21)	0.168 (0.15-0.18)
Tarsus width	0.036 (0.03-0.05)	0.048 (0.04-0.05)	0.051 (0.04-0.06)	0.048 (0.04-0.05)

Abdomen

Figs. 5-8

Protonymph: Four setae on each tergite. First visible sternite (Fig. 5) represents sternite 2, setae absent; sternite 3 with two setae; sternites 4 and 11 each with four setae; all remaining sternites each with six setae; sternites 3 and 4 with one microseta on each stigmatic plate; anal plate with four setae. Pleural membrane granular.

Deutonymph: Anterior tergites with fewer setae than posterior ones; some variation in number of setae on each tergite. First visible sternite (Fig. 6) as in protonymph; sternites 3, 4, 5, and 10 with six to 10 setae in a row; sternites 6 to 9 each with six to eight setae on posterior border and two setae set anteriorly on each side of midventral line; one specimen with 10 setae on sternite 9, anterior setae lacking; sternite 11 with four setae;



Figs. 5-8.–*M. confusum.* Sternites 2-7; 5, Protonymph; 6, deutonymph; 7, female; 8, male. (Scale: 1 division = 0.1 mm)

sternites 3 and 4 each usually with one microseta on each stigmatic plate; anal plate as in protonymph. Pleural membrane as in protonymph.

Female: Setae of tergites as in deutonymph. First visible sternite (Fig. 7) represents sternite 2, two setae present; genital complex simple, opening at posterior margin of sternite 2; sternites 3, 4, 5, 9, and 10 with eight to 12 setae in a row; sternites 6, 7, and 8 with eight to 13 setae on posterior border and two setae set anteriorly on each side of midventral line; sternite 11 with six setae; sternites 3 and 4 each with two microsetae on each stigmatic plate; anal plate as in protonymph and deutonymph. Pleural membrane as in protonymph and deutonymph.

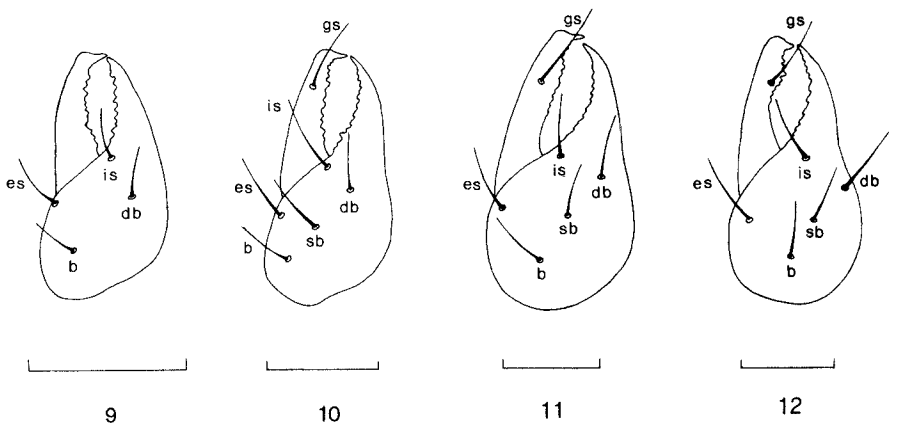
Male: Setae of tergites as in deutonymph and female. Genital complex (Fig. 8) with many microsetae; first visible sternite represents sternite 2, 10 microsetae present; anterior portion of sternite 3 with seven to nine microsetae in a horseshoe shape with two or three microsetae flanking base of horseshoe; posterior margin with seven or eight microsetae in a row. Sternites 4, 5, 9, and 10 with eight to 10 setae in a row along posterior border; sternite 6 with eight to 11 setae on posterior border and two setae set anteriorly on each side of midventral line; sternites 7 and 8 have eight setae each on posterior border with two setae set anteriorly as in sternite 6; sternite 11 with six setae; stigmatic setae as in female; anal plate as in other instars. Pleural membrane as in other instars.

Chelicerae

Fig. 9-16

Protonymph: Chelicerae (Fig. 9) 1.45-2.12 times longer than wide; cheliceral galea in form of sclerotic knob; cheliceral surface smooth. Movable finger without setae; hand with four setae, *es, is, db,* and *b.* Ten to 14 teeth present on each finger; flagellum (Fig. 13) with three or four blades, distal one usually separated from others by width of one blade.

Deutonymph: Chelicerae (Fig. 10) 1.4-1.98 times longer than wide; cheliceral galea and surface as in protonymph. Movable finger with one seta, *gs*; hand with five setae, *es,*



Figs. 9-12.–*M. confusum.* Chelicera (serrulae omitted): 9, Protonymph; 10, deutonymph; 11, female; 12, male. Abbreviations for setae of the chelicera; *gs*, galeal seta; *es*, exterior seta; *b*, basal seta; *s*,, sub-basal seta; *db*, dorsal basal seta; *is*, interor seta. (Scale: 1 division = 0.1 mm)

is, db, sb, and *b* (setae *gs* and *sb* not present in protonymph). Ten to 14 teeth present on fixed finger and 12 to 16 teeth on movable finger; flagellum (Fig. 14) with four blades, distal one separated from others as in protonymph.

Female: Chelicerae (Fig. 11) 1.48-2.3 times longer than wide; galea, surface and setae as in deutonymph. Thirteen to 18 teeth present on each finger; flagellum (Fig. 15) with four or five blades, distal one separated from others as in protonymph and deutonymph.

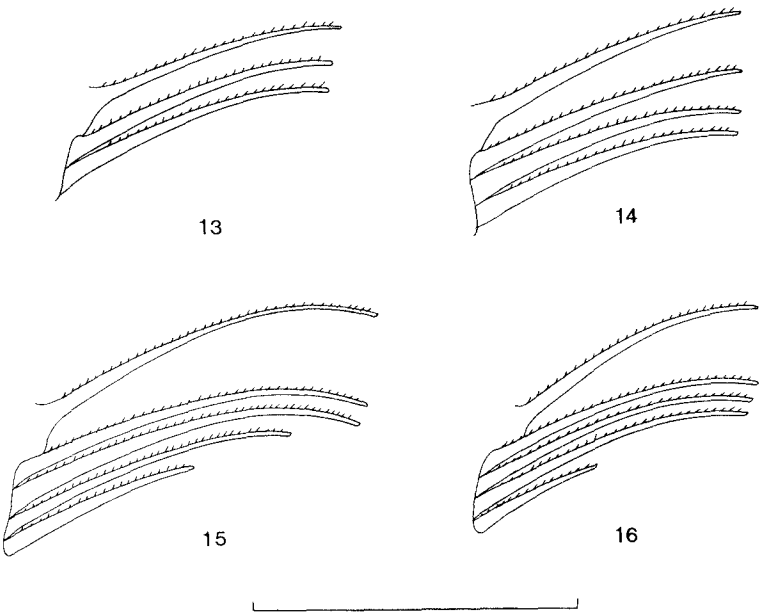
Male: Chelicerae (Fig. 12) 1.16-1.37 times longer than wide; galea, surface and setae as in deutonymph and female. Thirteen to 15 teeth on fixed finger and 10 to 15 teeth on movable finger; flagellum (Fig. 16) with five or six blades, distal one separated from others as in other instars.

Pedipalps

Figs. 17-28

Protonymph: Movable finger of chela (Fig. 17) 0.97-1.14 times longer than hand; hand longer than wide; chelal surface smooth; one trichobothrium, *t* present on movable chelal finger and three on fixed finger, *et* and *eb* externally and *ist* internally. Nineteen to 25 teeth on movable chelal finger and 17 to 22 teeth on fixed finger. Palpal tibia 1.38-2.0 times and palpal femur (Fig. 18) 2.0-2.66 times longer than wide; surfaces of tibia and femur smooth; coxae of pedipalps (Fig. 25) with five setae, two on manducatory process and three on maxilla.

Deutonymph: Movable finger of chela (Fig. 19) 0.91-1.25 times longer than hand; hand longer than wide; chelal surface as in protonymph; two trichobothria, *t* and *b* present on movable chelal finger and six on fixed finger, *et, est,* and *eb* externally and *it, ist,* and *ib* internally. Thirty or 31 teeth on movable chelal finger and 28 or 29 teeth on



Figs. 13-16.–*M. confusum.* Flagellum of the chelicera (stylized). Teeth not always seen in all specimens: 13, Protonymph; 14, deutonymph; 15, female; 16, male. (Scale: 1 division = 0.1 mm)

fixed finger. Palpal tibia 1.5-1.81 times and palpal femur (Fig. 20) 2.49-2.8 times longer than wide; surfaces of tibia and femur as in protonymph. Coxae of pedipalps (Fig. 26) with eight setae, three on manducatory process and five on maxilla.

Female: Movable finger of chela (Fig. 21) 1.0-1.16 times longer than hand; hand longer than wide; chelal surface as in protonymph and deutonymph; three trichobothria, *t, st,* and *b*, present on movable chelal finger and seven on fixed finger, *et, est, esb,* and *eb* externally and *it, ist,* and *ib* internally; trichobothrium *sb* on movable chelal finger and *isb* on fixed finger absent. Thirty-four to 37 teeth on movable chelal finger and 34 to 36 teeth on fixed finger. Palpal tibia 1.61-2.0 times and palpal femur (Fig. 22) 2.57-2.88 times longer than wide; surfaces of tibia and femur as in protonymph and deutonymph. Coxae of pedipalps (Fig. 27) with eight to 10 setae, three on manducatory process and five to seven on maxilla.

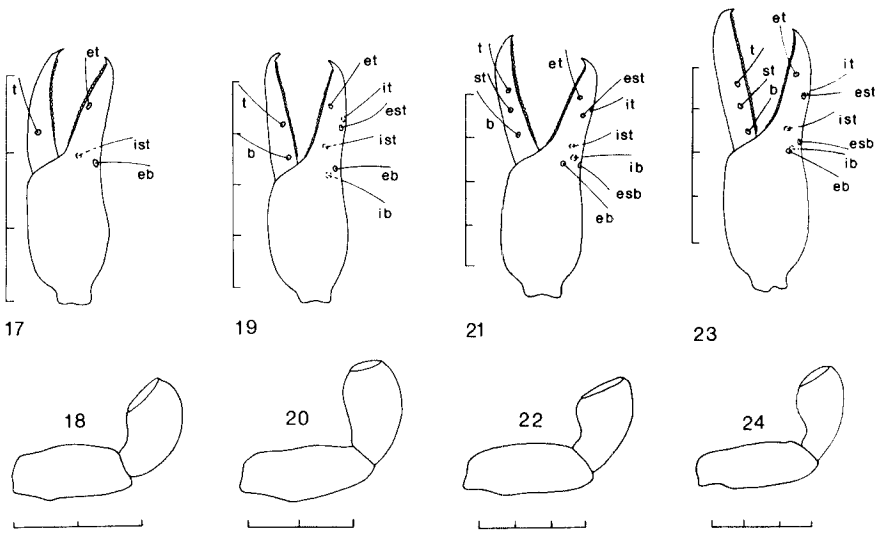
Male: Movable finger of chela (Fig. 23) 1.01-1.08 times longer than hand; hand longer than wide; chelal surface and number and position of trichobothria as in female. Thirty-two to 36 teeth on movable chelal finger and 30 to 34 teeth on fixed finger. Palpal tibia 1.68-1.93 times and palpal femur (Fig. 24) 2.4-2.78 times longer than wide; surfaces of tibia and femur as in other instars. Coxae of pedipalps (Fig. 28) with nine to 10 setae, three on manducatory process and six or seven on maxilla.

Legs

Figs. 25-28

Protonymph: Leg coxae I-IV (Fig. 25) each with one seta anteriorly; surface of legs smooth.

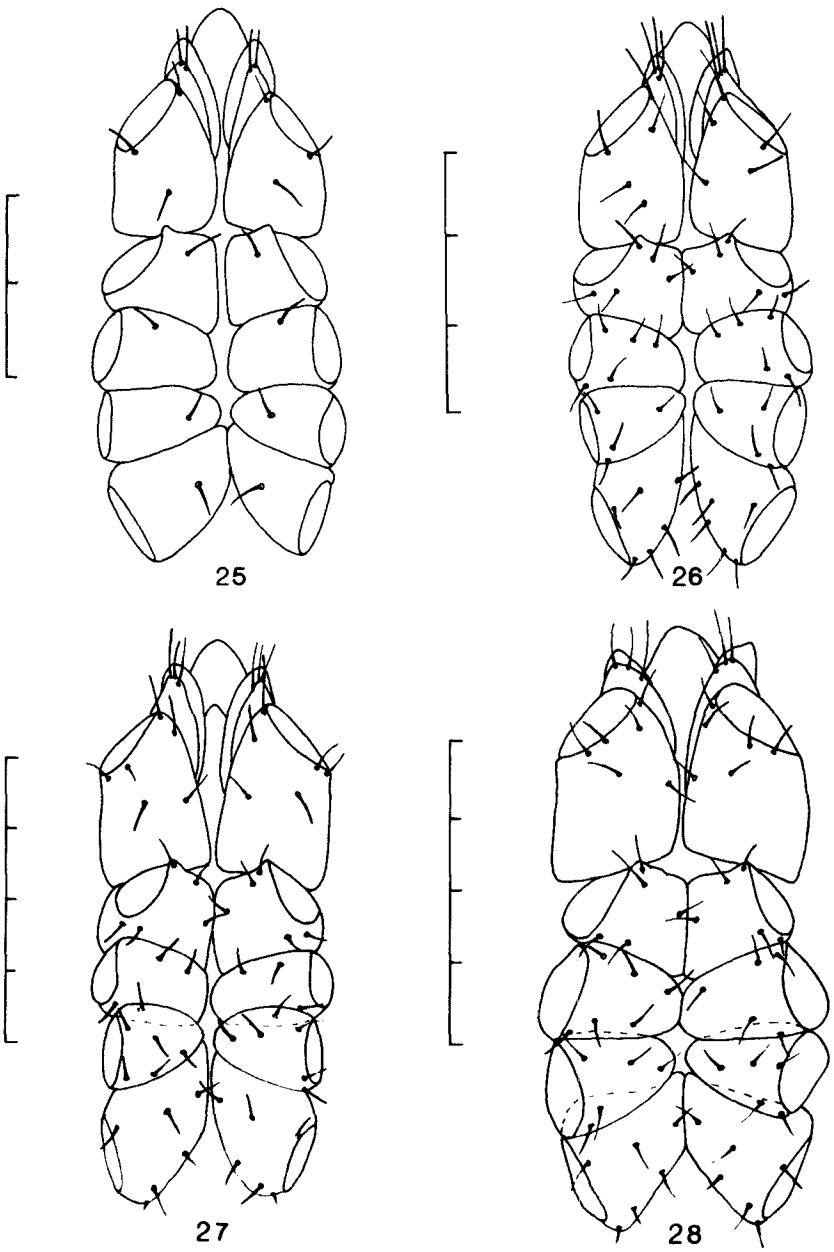
Deutonymph: Leg coxae I-IV (Fig. 26) each with two or three setae both anteriorly and posteriorly; coxal surface smooth; surface of legs smooth to weakly sculptured.



Figs. 17-24.–*M. confusum.* Chela: 17, Protonymph; 19, deutonymph; 21, female; 23, male. Femur and tibia of the pedipalps (setae omitted). 18, Protonymph, 20, deutonymph; 22, female; 24, male. Abbreviations for the trichobothria. Movable finger: *t*, terminal; *st*, subterminal; *b*, basal. Fixed finger: *et*, exterior terminal; *est*, exterior subterminal; *esb*, exterior sub-basal; *eb*, exterior basal; *it*, interior terminal; *ist*, interior subterminal; *ib*, interior basal. (Scale: 1 division = 0.1 mm)

Female: Leg coxae I-IV (Fig. 27) each with two to four setae both anteriorly and posteriorly; coxal and leg surfaces as in deutonymph.

Male: Leg coxae I-IV (Fig. 28) each with two or three setae both anteriorly and posteriorly; coxal and leg surfaces as in deutonymph and female.



Figs. 25-28.–*M. confusum.* Coxal area: 25, Protonymph; 26, deutonymph; 27, female; 28, male. (Scale: 1 division = 0.1 mm)

TAXONOMIC CONSIDERATIONS

Microbisium confusum belongs to the family Neobisiidae, subfamily Neobisiinae of the Suborder Diplosphyronida. It can be separated from other Neobisiinae by the presence of only three trichobothria present on the movable chelal finger and seven on the fixed finger. Other Neobisiinae have four trichobothria on the movable chelal finger and eight on the fixed finger. *Microbisium confusum* can be separated from *M. brunneum*, in general a much larger species, using the method described by Hoff (1949) and modified by Nelson (1975). With this method *M. confusum* was considered to have a palpal femur less than 0.42 mm long and a length x width ratio of 2.4-2.93. However, if the length is greater than 0.4 mm, then the length x width ratio is less than 2.8. *Microbisium confusum* and *M. brunneum* are sympatric for only part of their ranges. *Microbisium confusum* is often separated from *M. parvulum* (Banks), a southwestern U.S. species, by shorter palpal podomeres. However, according to Hoff and Bolsterli (1956) separation is difficult due to overlapping ranges in absolute sizes unless a series of specimens is available. They further indicate that differences in the shape of palpal podomeres may often work in separation of the species as *M. parvulum* usually has a less convex extensor margin of the palpal tibia.

DISPOSITION OF THE TRICHOBOTHRIA IN RELATION TO GROWTH

Gabbutt and Vachon (1968) state that "the time at which each of the trichobothria first appear during development can be summarized by using the method first employed by Vachon (1936). The interval between the oblique strokes represents a stage; proto-, deuto-, tritonymph and adult for the trichobothria of the movable finger (dm) and the internal (dfi) and external (dfe) series on the fixed finger of the chela." Thus the trichobothrial formula for *Microbisium confusum* and other species of *Microbisium* is:

dm	/	*t*	/	*b*	/	*st*	/
dfi	/	*ist*	/	*it, ib*	/	---	/
dfe	/	*et, eb*	/	*est*	/	*esb*	/

The sexually mature individuals bear the arrangement of trichobothria usually present on tritonymphs of other pseudoscorpions species *sb* and *isb*, trichobothria usually present in adults of other species, including other Neobisiinae are absent. Gabbut (1965) found the trichobothrial formula in three species of *Neobisium* to be:

dm	/	*t*	/	*b*	/	*st*	/	*sb*	/
dfi	/	*ist*	/	*it, ib*	/	---	/	*isb*	/
dfe	/	*et, eb*	/	*est*	/	*esb*	/	---	/

Therefore the trichobothria of *Microbisium* and the reported *Neobisium* appear at the same stage during post-embryonic development through the tritonymph stage; however, the adults of *Neobisium* possess setae *sb* and *isb*.

The status of a tritonymph in the genus *Microbisium* remains unclear. Individuals designated as females and males may be neotenic tritonymphs as indicated by Weygoldt (1969), adults, or a tritonymph-adult complex. A tritonymph-adult complex would consist of both tritonymphs and adults grouped in such a way that it would be difficult to distinguish one from the other except by rearing the species in the laboratory. This speculation assumes the adult instar lacks setae *sb* and *isb*. The solution to this problem is a course for future study.

Table 3.–The life stages and number per square meter of *Microbisium confusum* in Gray Woods during the period 26 March 1976 to 23 November 1977.

Date	Protonymphs	Duetonymphs	Females	Total
1976				
26 March	25	0	51	76
7 April	42	8	25	75
23 April	42	0	25	67
10 May	59	8	34	101
21 May	118	8	59	185
4 June	84	0	42	126
18 June	152	8	34	194
2 July	8	8	42	58
16 July	0	51	8	59
2 August	34	34	8	76
13 August	126	34	34	194
30 August	135	0	84	219
10 September	84	0	42	126
24 September	135	8	93	236
8 October	211	8	101	320
21 October	194	0	8	202
5 November	109	0	34	143
30 November	34	0	25	59
10 December	59	0	59	118
23 December	76	8	143	227
1977				
6 January	59	0	59	118
26 January	34	0	8	42
9 February	51	0	34	85
23 February	8	0	8	16
9 March	76	0	34	110
30 March	51	8	8	67
13 April	93	0	93	186
27 April	160	17	76	253
12 May	67	0	59	126
25 May	76	0	76	152
9 June	84	0	101	185
22 June	8	8	109	125
6 July	0	8	17	25
20 July	0	76	8	84
3 August	0	17	8	25
17 August	67	8	17	92
31 August	135	0	177	312
14 September	152	17	59	228
29 September	168	8	17	193
14 October	84	8	42	134
26 October	236	8	76	320
9 November	67	8	8	83
23 November	8	0	42	50

LIFE HISTORY

A total of 699 individuals (406 protonymphs, 45 deutonymphs, and 248 females) was collected during this study in Gray Woods. No males were found. The population structure of *Microbisium confusum* in Gray Woods is shown in Table 3. The data are projected into numbers per square meter.

Protonymphs were present in all but four collections and reached a peak of 211 per square meter on 8 October 1976 and 236 per square meter on 26 October 1977. Protonymphs were absent during at least part of July each year. The protonymphs also showed a spring pulse. Deutonymphs were less abundant and collected on only 23 of 43 dates during this study. The deutonymphs reached a peak of 51 per square meter on 16 July 1976 and 76 per square meter on 20 July 1977. The deutonymphs did not demonstrate the bimodal pulse as seen in the protonymphs. Females were present on all sampling dates. The females reached a peak of 143 per square meter on 23 December 1976 and 177 per square meter on 31 August 1977.

Nelson (1973) found that *Microbisium confusum* in Michigan reached a peak of 155 per square meter and dropped below 20, except for winter months, on a single occasion. The period December through March was interpreted as a "suspended" period with a marked absence of individuals. The absence of individuals was probably due to migration into the soil, to hiberation, or to both. The soil itself was generally frozen beyond the sampling depth. Such an absence of individuals did not occur as markedly in Gray Woods, and in fact the 227 individuals per square meter were found on 23 December 1976 under more than 0.6 meter of snow. Protonymphs and females were collected on all sampling dates throughout the winter months. Deutonymphs probably overwintered but were collected less frequently. Usually the ground was not frozen during the winter months, due to snow cover. However, individuals could still have migrated deeper into the soil and thus not be collected, and as a result the Gray Woods data would compare more favorably with the Michigan data during the winter period. The marked decrease in protonymphs and females during July and August does not appear to be related to a comparable summer "suspended" period due to aestivation, as the deutonymphs reached their peak during this period each year. However, some deutonymphs may have aestivated. This would possibly explain the reason why so few deutonymphs were collected.

Nelson (1973) reported a total of 182 individuals during the Michigan study. Of these there were 72 protonymphs, 43 deutonymphs, and 67 females. When compared to Gray Woods the data are summarized in percentages as follows:

It is noted that the deutonymphs in Gray Woods represent a marked difference in percentage. The difference in the percentage of deutonymphs is reflected in the protonymphs almost exclusively, as the percentage of females remains similar.

The pronounced spring and fall peaks for protonymphs and a somewhat similar situation for the females might indicate more than one generation per year. Nelson (1973) concluded that the data concerning *Microbisium confusum* from Michigan did not indicate more than one generation produced per year. Of six species examined by Gabbutt (1969) only one, *Neobisium muscorum*, produced more than one generation per year, and this did not hold for all populations of this species. Gabbutt (1970) explained the absence of females during certain periods of the year as being due to their construction of silken chambers for brood purposes. No females with eggs or embryonic stages attached were collected during this study. The cyclic activity of the protonymphs could also be

explained by the timing as to when they emerged from brood chambers compared to the actual sampling date.

A single peak per year for deutonymphs supports a single generation per year for this species. These data do not indicate that more than one generation is produced during a single year. However, females might reproduce in successive seasons.

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