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THE GENERIC AND SPECIFIC STATUS OF FOUR OHIO SPIDERS OF THE GENUS AGELENOPSIS

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INTRODUCTION

Every taxonomist sooner or later faces a situation in which he must determine whether he is dealing with a single highly variable species, or with several species which appears to intergrade. This problem confronting us has been recognized by Petrunkevitch, Emerton, Comstock, Chamberlin, Ivie, Gertsch and others.

Arachnologists have been perplexed by the variability of a species which has been considered *Agelena naevia* Walckenaer as the following quotations will indicate.

Petrunkevitch (1925) on page 561 states: "It does not require prolonged study to show that variation in size in *Agelena naevia* is very great. Specimens collected in the same locality, often under the same piece of loose bark, guarding their cocoons with eggs, and therefore in the same stage of maturity, are occasionally twice the size of others. The fact that two such distinguished arachnologists as Graf Keyserling and Becker have described two new species of *Agelena* from North America, which long since have been recognized as synonyms of *A. naevia*, shows that the variation in structure is also sufficient to be considered as specific in absence of intergradient forms."

Emerton (1890) recognized the great variation that exists in both the palpus of the male and epigynum of the female. He has illustrated four types of palps and seven variations in the atrial opening of the epigynum. He says that, "The shape of the external opening of the epigynum is even more variable than that of the palpal organ."

Comstock (1912), page 586, in his spider book: "This species is either a variable one in the form of the palpi of the males and

in the form of the epigynum of the female or more than one species have been confused under this name."

Chamberlin and Ivie recognize several species of this complex, four of which occur in the state of Ohio, namely: *Agelena naevia* Walckenaer, *Agelena americana* Keyserling, *Agelena utahana* Chamberlin and Ivie, and *Agelenopsis emertoni* Chamberlin and Ivie. These men (Chamberlin and Ivie) (1935) suggest that: "This species, with a number of others, has been consistently synonymised with *Agelena naevia* Walck. by later authors." They here were referring to another form (*Agelena potteri* Blackwell) which is referred to later in this paper.

PURPOSE OF PAPER AND ACKNOWLEDGMENT

This paper is an attempt to determine, from a detailed study of the epigyna and palps of a large number of specimens, the true status of the four forms of this genus found in Ohio.

This research was conducted in the Department of Zoology, The Ohio State University. The author wishes to acknowledge his indebtedness to Dr. W. M. Barrows, of the Department of Zoology and Entomology, for the advice and criticism given during the course of this study.

MATERIALS AND METHODS

Material for this problem was collected during the summers of 1937 and 1938. Most of the material was preserved in 95% alcohol. A few specimens were killed, in the field, in Petrunkevitch's fixing fluid. The fluid used was his second formula which keeps indefinitely and which can be used an unlimited length of time without harmful effects to the tissue. It does keep the tissue soft and in good condition. The formula, as Petrunkevitch (1933) gives it, is:

60% alcohol.....	100 cc.
Nitric Acid, c. p., sp. gr. 1.42.....	3 cc.
Ether.....	5 cc.
Cupric nitrate, c. p., crystals.....	2 grams.
Paranitrophenol, c. p., crystals.....	5 grams.

In the laboratory, the specimens were first separated as to sex. All of the specimens used were mature and therefore the males with their well developed palpal copulatory organs were easily distinguished from the females, which possess the epigynum.

All males were further separated into four groups on the basis of differences in appearance of several structures of the mature palp. For further study the right palp of ten specimens of each group was taken from the spider and preserved in cedar wood oil. It was found that cedar wood oil; firstly, cleared the specimen to a great degree thus

giving greater definition to its parts, secondly, its viscosity being greater than alcohol it aided in suspending the specimen at almost any angle desired for observation and thirdly, the specimens could be observed for long periods of time when using strong light without evaporation or movement due to evaporation currents.

The epigyna of the females, also, were observed to be of four types. From a large number of specimens, twenty-five of each type were selected without regard to size of the spider. The epigyna of these twenty-five females of each group were lifted from the venter of the abdomen, after breaking the chitin covering the copulatory sacs, with dissecting needles. They then were cleaned of excess fatty tissue and placed in individual vials, with the spider from which they were taken, for future study.

Some of the specimens of each type, which had been killed in Petrunkevitch's fixing fluid, were used for more detailed study. The epigyna of these were taken from the specimens in the same manner as the others, then washed in 70% alcohol and prepared for sectioning. The technique followed in the preparation of this material was worked out by Wynkoop (1939). He used diaphanol as a softener of the chitin rather than potassium hydroxide. This latter substance proved harmful to the minute tubules as well as to the softer parts of the epigynum. Diaphanol removes those substances in chitin which usually prohibits sectioning. In his technique, Wynkoop suggested subjecting the material to diaphanol from 70% alcohol. The time required for diaphanol to remove the undesired materials from the chitin depended on the density of the chitin. The smaller and softer epigyna required twenty-four hours while the larger and older specimens required as long as four days to turn milky white, which is the indication that the softening process is completed. When the material was ready for sectioning it was taken from the diaphanol and washed thoroughly in 70% alcohol, dehydrated and embedded, following the usual procedure of paraffin sectioning. The sections were cut eight microns in thickness. They were mounted serially and stained with aniline blue on the slides. It was found that an overstaining of the sections brought out the minute orifices and slight differences apparent in the chitin of the various structures. Camera lucida drawings were made of these serials, then in some instances the drawings were mounted on cardboard. These sectional drawings which were mounted on cardboard made exact models of the epigynum when cut out and put together, for detailed study.

RESULTS

Upon examination of the specimens in the collection it was found that both males and females could be separated into four distinct groups on characters presented by the mature palp of the males, and, by the epigynum of the females.

DESCRIPTION OF THE MALE PALPS

The palp contains the copulatory apparatus on the ventral surface of the terminal segment. Only the cymbium can be seen in a dorsal

view. It usually is covered with the same thin chitin, yellowish in color, as the other segments of the pedipalps. The basal portion of the cymbium is hemispherical but the distal end is comparatively long and narrowly tapered. The entire surface of the cymbium is sparsely covered with short hairs and contains from three to six spines, irregularly placed. This structure is similar in all the four groups. From the ventral view the main parts of the copulatory apparatus can be observed. Hidden from view, in a specimen which has not been especially dissected or treated, are various structures embedded in an excavation in the base of the cymbium. These structures are common to all types and therefore are not of importance in this study.

The two structures which differ in each group are the conductor (Pl. III, a) and the tip of the embolus (Pl. III, b). The embolus is a long, evenly coiled tube of one and a quarter to one and a half turns in length which usually does not extend much beyond the boundary of the cymbium. It has its origin near the center of the enlarged part of the cymbium. The swing of the coil is from the point of origin first ectal, then posterior, medial and anterior. The tip lies either in this anterior sector, or the posterior of the second loop, depending upon the length of the embolus and the tightness of its coil. The last quarter of its length shows that the embolus is a tube formed by a roll of the chitin with the outer edge overlapping as much as half the circumference of the tube thus formed. In some forms the roll is not complete at the tip, resulting in a trough instead of a tube.

The conductor is a hard and black chitinous projection, pointing forward and situated on the ectal side of the palp. It has its origin at the same level as, and ectal to, the origin of the embolus. Its length and shape varies in the different forms. The chitin is usually rough and, especially in the older specimens, is broken or splintered along the edges.

In comparing the differences in these two structures of the palp of these four groups; the length, thickness, and the end portion of the embolus, and the shape and size of the conductor are significant. The specific name of the spider possessing the type of palp being described will be used to distinguish it.

The longest, most uniform embolus is to be found in *naevia* (Pl. III, *naevia*, b). The hard portion of the chitin is shiny black with a series of fine ridges running the length of the coil. The portion of the roll which overlaps is of thin, almost transparent chitin. This overlap is toward the inside of the coil of the embolus. The coil of the embolus completes a full one and one half turns with the tip lying near the center of the circle formed by the complete revolution. Near the end the embolus tapers considerably and also bends back (dorsally) slightly toward the main body of the palp. The tip is plain, without a notch or protuberance and the roll remains wound to the tip. The conductor is very regular in this form (Pl. III, *naevia*, a). It is comparatively long and narrow with longitudinal ridges extending its entire length. The conductor is concave in cross-section with the cavity facing the palp. The anterior end is pointed, the point being formed by the ventral edge being longer than the dorsal.

The coil and appearance of the embolus of *emertoni* (Pl. III, *emertoni*, b) are essentially the same as in the preceding form. But the tip of the embolus is very distinctive for this type. The overlapping edge of the chitin breaks away from the roll in the last quarter turn and forms a gutter which widens toward the tip, with the tube portion forming its inside margin. At the tip the tight complete roll can be seen partially encompassed in the loose flap. The tip edge contains a heavy, black knob of chitin which gives it a forked appearance under low magnification. The conductor (Pl. III, *emertoni*, a) is very similar to the same structure of *naevia* except that it is not quite as long and pointed.

In *utahana* the embolus (Pl. III, *utahana*, b) is similar to *naevia* but is not quite as long. It is perfectly plain, except for a slight thickening of the chitin at the end, and continues the regular swing of the coil. The roll remains closed as a tube throughout the entire length of the embolus. The conductor (Pl. III, *utahana*, a) of this type is distinctive. It is very wide at the base, and has very little transverse curvature, when compared with the two forms already described. The anterior end is blunt with a thick chitinous knob at the outside, anterior edge.

These two diagnostic structures of the form *americana* show a great departure from the normal plan expressed in the other forms. Both structures are heavier in construction. The embolus is shorter and the conductor larger in size when compared with the others.

The embolus (Pl. III, *americana*, b) is short, thick and tightly wound. It completes only one revolution with just the tip extending over the origin. The roll of the embolus opens, before the complete revolution is made, into a deep trough, with the concave surface exposed anteriorly. The ventral edge of the trough has a distinct projection the apex of which protrudes forward beyond the regular curvature of the embolus. The distal side of this projection meets the dorsal edge of the trough at the tip.

The large and bulky conductor (Pl. III, *americana*, a) of this form is not hidden by the embolus. In cross-section it is almost a complete circle, with the open portion facing the main body of the palp. On the posterior end of the conductor is a hard black chitinous knob. The anterior edge is rough and the ventral corner possesses a protruding tip.

DESCRIPTION OF THE EPIGYNA

The epigynum, as found in the females of the four forms of this genus, may be divided into three units. It has a single cavity or atrium (Pls. I, II, h) which opens to the outside on the ventral surface. This atrium is common to the two large structures, the copulatory sacs (Pls. I, II, a), which extend anteriorly from each side of it. These two units are independent of each other and contain identical structures. The epigynum is therefore bilaterally symmetrical. Each of these two units is really a single, coiled and much-twisted tube in which appear definite structures differing in size, shape, color and position. The names given to the parts of the epigynum in this paper are the same as those suggested by Petrunkevitch (1925). They are the atrium, vulva, copulatory sac, diverticle, seminal receptacle, connecting tube, fertilization tube and the blind canals of the copulatory sacs and receptacles.

The only portion of the epigynum to be seen in an undissected spider is the atrium (Pls. I, II, h). It is the only external opening of the epigynum and is located on the anterior margin of the epigastric groove on the ventral side of the abdomen. The general shape of the cavity (atrium) is that of an ellipsoid with the long axis parallel to the epigastric groove. The chitin at the external edge of this invagination is heavier and darker than that of the surrounding exoskeleton, forming a ridge, hereafter called the vulva (Pls. I, II, g). The posterior edge of this chitinous ridge is the thickest and contains a depression in its vertical surface which faces the epigastric groove, in some species quite prominent and in others almost lacking. This depression (Pls. I, II, i) is usually wider inside than at the surface of its lateral extremities which gives it the semblance of a lateral pouch on each side.

The shape of this hard chitinous rim, or vulva, which surrounds the atrium differs for each of the four groups studied. The anterior edge may be without obstructions, that is, it is smooth and without a projection as in *americana* (Pl. I, Fig. 3), or may possess notches or a prominent lip. *Naevia* (Pl. I, Fig. 1, g) presents this other extreme. The anterior edge of this form possesses a pronounced lip in the center which extends over the atrium slightly more than half the short axis of the ellipse. The width of the lip is from one-half to one-third of the total width, or long axis of the atrium. This lip is slightly notched in the center of its margin. The anterior portions of the vulva of the two remaining types (*utahana* and *emertoni*) (Pl. II, Figs. 5, 7, g) are quite similar. Instead of either of the two extremes mentioned, their anterior margins possess two notches equally spaced, one on each side of the median line. The notches of *emertoni* are usually less pronounced. The atria differ in these two species in that *utahana* is wider in proportion to the width than is the other.

The shape of the pouch in the posterior margin of the rim of the vulva in *emertoni*, *naevia* and *americana* (Pls. I, II, Figs. 1, 3, 7, i) is very similar. It varies in specimens of the same group but in all three of these forms this depression takes in better than two-thirds of the posterior margin of the vulva. The epigynum of *utahana* (Pl. II, Fig. 5, i) stands in contrast with the others concerning this pouch in that it is almost as wide in its dorsal-ventral measurement as in its lateral extensions. The concavities at the lateral extremities are not prominent and are sometimes lacking.

The copulatory sacs proceed anteriorly from each side of the common atrium in all these forms. These sacs are of very thin, almost transparent chitin. They may be simple, undivided structures or may give the appearance of having a second lobe in which the anterior portion is bent back on the main stem leading from the atrium. These reverted portions occupy the space between the two lateral or main stems of each side with their extremities dorsal to the seminal receptacles.

The copulatory sacs of *americana* (Pl. I, Figs. 3, 4, a) are of the simple type, that is, they are single sacs arising from the lateral surface of the atrium and do not fold on themselves at the anterior edge. *Utahana* (Pl. II, Figs. 5, 6, a) shows a slight reversion of the sac while the two remaining forms, *naevia* and *emertoni* (Pls. I, II, Figs. 1, 2, 7, 8, a) are

long and fluted. In the latter two forms the sacs extend forward from the common atrium and then turn back on themselves with the folded portion toward the middle of the epigynum. Further, although the sacs in all these species are transparent, *naevia* and *emertoni* with *utahana* to a slight degree, appear to be wrinkled or plicated. These plications usually are darker than the sac proper in color.

The sacs end in a diverticle which can be distinguished from the sac proper in that it is heavier and more smooth although it is usually of the same light colored chitin. It is in the form of a wide band or roll in some and in others it is flat and covers most of the ventral surface of the copulatory sac to which it attaches. These diverticles end as blind tubes of small diameter on the dorsal surface between the copulatory sacs. The diverticle of *americana* (Pl. I, Fig. 3, c) is very large, covering most of the ventral surface of the sac and is made of comparatively thick, light colored chitin. In *naevia* (Pl. I, Fig. 1, c) it is tubular and connects with the lower part of the reverted portion of the sac. It then continues as a loop toward the ectal edge of the sac then bends anteriorly and finally ends in the blind tube on the median line of the epigynum with its end dorsal to the other structures and pointing backwards. *Emertoni* (Pl. II, Fig. 7, c) presents the longest diverticle. It is tubular and attaches to the end of the reverted portion of the sac, then extends anteriorly in an arc to the median line of the epigynum and ends as a short blind tube similar to *naevia*. The diverticle of *utahana* (Pl. II, Fig. 5, c) is short and simple. It is less distinguishable from the sac than in the other forms and tapers quickly as it extends dorsally along the medial edge, forming the blind tube.

On the ventral surface of each of the copulatory sacs lies a seminal receptacle. These two receptacles are located just anterior to the atrium. In some specimens the receptacles are so close together that their chitinous walls appear to be fused and in others they are quite separate. The cavities of the receptacles which have their walls fused are never connected.

There is so much variation in the shape and position of the receptacles in specimens of a single group that a description of them as found in a single specimen of any one group would not give a true picture (Pls. I, II, Figs. 1, 2, 3, 4, 5, 6, 7, 8, e). In general, it may be stated that in all forms studied the receptacles are easily recognized as the bodies composed of dark and very thick chitin which rest on the ventral surface of the copulatory sacs. Internally they possess a single cavity which may or may not be constricted in the center. Each of these areas, set apart by the constriction, is a continuation of the lumen of the tube which enters the receptacle at that point, one, of the tube connecting the receptacle with the diverticle and the other of the fertilization tube.

Each seminal receptacle is connected to the diverticle of the copulatory sac on which it rests by a single tube. In some this tube is long and narrow and composed of the same hard dark chitin as the receptacle while in others it is so short that the receptacle appears to be connected directly with the copulatory sac. The connecting tubes of *naevia* and *americana* (Pl. I, Figs. 1, 3, d) arise from the medial edge of

the copulatory sacs along with, and as a part of the diverticle and enter the receptacles along the dorsal surface, the lumen of the tube entering the cavity of the receptacle at a very sharp angle. In *emertoni* and *utahana* (Pl. II, Figs. 5, 7, d) these tubes arise from the lateral portion of the diverticles and progress across the ventral surface of the copulatory sacs. In *utahana* the tube enters the receptacle in the middle of the anterior surface whereas the tube in *emertoni* enters the receptacle in much the same manner and position as in the first two.

In all these forms there is a very prominent coiled tube (Pls. I, II, Figs. 1, 2, 3, 4, 5, 7, 8, f) leading from the lateral surface of each receptacle and extending almost to the posterior edge of the epigynum. This tube is small and dark in color. In tracing its path, it leaves the lateral edge of the receptacle and swings posteriorly over the ventral surface of the copulatory sac. Continuing posteriorly it then makes one and one-half turns around the neck of the sac and terminates on the dorsal surface of the atrium. The end of the tube (Pls. I, II, Figs. 2, 4, 6, 8, k), which is open, rests midway between the lateral edge and the mid-line of the epigynum. The lumen is small but well defined and extends the entire length of the tube without variation. This tube is called the fertilization tube since it apparently transports the sperm from the receptacle to the uterus which lies just inside the epigastric groove. Since the position of this tube is nearly constant for these four groups no detailed description for each species needs to be given.

The blind tube (Pls. I, II, Figs. 2, 4, 6, 8, j) of the receptacle is short and of the same hard and dark chitin as this body. It arises from the anterior dorsal surface and extends back along the receptacle. In most specimens of all four species the blind tubes of the diverticles end close to the end of these tubes from the receptacles.

DISCUSSION

The genus *Agelena* was erected, supposedly by Walckenaer, in 1805. But the type form is given in the literature as *A. labyrinthica* (Clerck). Apparently Walckenaer put the genus, to which the species was assigned by Clerck, in synonymy. The form was recognized by others since the following citation is given in Walckenaer's *Tableau des Araneides* (page 51):

"1. *Ag. labirinthe* (*Ag. labyrinthica*). Pl. 6, Fig. 55 et 56. Fabr., Linn., Walck., Faun. Paris, t. 2, p. 217, n.° 60. Schaeff., Icon., Pl. 19, Fig. 8. Albin, Pl. 17, Fig. 83. Clerck, p. 79, Pl. 2, tab. 8. Lister, tit. 18, Fig. 18, p. 60.

"2. *Ag. marquée* (*Ag. naevia*). Bosc, Manuscript sur les araignées la Caroline, Pl. 1, Fig. 2."

In his description in this work, Walckenaer says that the eyes are eight in number and nearly equal between themselves. The only figure given is of the eye pattern. This shows two strongly recurved rows, the anterior medians of which are much smaller than the rest, they being of equal size. The name of *Ag. marquée* (*Ag. naevia*) and the reference to Bosc's manuscript are the only mention of this form in this early work.

In the second volume of Walckenaer's *Histoire Naturelle des Insectes Aptères* he describes the genus *Agelena* again and gives a very meager

description of *naevia*. Although the date on the front page of the book is given as 1837 this work apparently did not appear until July of 1841, according to the footnote on page 473 by White (1841), "July 2. Since this paper was written the 2nd volume of Walckenaer's work has been published." The first published description of *naevia* appears in Walckenaer's second volume. The description is not original with him. He obtained manuscripts from two people who collected spiders in America and then he described the species from their descriptions and figures. In the preface to volume one of the *Histoire Naturelle des Insectes Aptères* he mentions that Bosc presented him with a manuscript, accompanied by drawings of twenty-five spiders from Carolina. The manuscript was given to him while writing his *Tableau des Araneides* and only the names of these forms were included. The other manuscript he obtained was written by Thomas Abbot, containing 535 Araneids and Phalangids from Georgia. These drawings were accompanied by a notebook written in English and entitled "Notes and Observations on the Drawings of the Spiders of Georgia." In his description of *naevia*, Walckenaer gives the notes, and not the drawings, of these two manuscripts. The following incomplete description is given by him:

"Abdomen ovale-allongé, fauve, avec deux linges brunes longitudinales, parallèles sur le milieu du bos, et deux bandes brunes sur les côtés, droites dans la femelle, ou qui sont légèrement festoonées dans le mâle. Corselet d'un jaune orange, avec deux bands brunes longitudinales, qui alleignent jusqu'aux yeux. Pattes d'un fauve jaunâtre, annelées de noir aux articulations."

Since the time of Walckenaer, arachnologists have added many species to this genus. It remained for Giebel (1869) to suggest a new genus for the American forms since they differed distinctly from the type form of the genus (*A. labyrinthica*). Many authors state that these new forms have been synonymized with *naevia*, or are variations of that form. The characters given by Walckenaer are of a very general nature and are of the sort which are subject to great variation and overlapping within the four species studied in this paper. Many modern workers with spiders now consider the figure of the palp of the mature male and the epigynum of the female as the most reliable characters necessary to delimit a species. The figures of the palps of *emertoni*, *utahana* and *americana* and the epigyna of *utahana* and *americana* are given with the original descriptions. No figures were given for *naevia* in the first descriptions and where they have occurred in later works they have been called a variety of *naevia*. It is probable, therefore, that the figures given in this study are the first given for this form as a distinct species.

Petrunkevitch (1925) recognized (p. 561) "the great dissimilarity between the external reproductive system of *A. naevia* and that of the closely allied European species, *A. labyrinthica*." The outstanding differences he noted are (p. 568): "The first and most important difference between this species and *A. naevia* is in the position of the organ. Instead of being directed forward, it is directed backward, so that the copulatory pouch and receptacle come to lie between the copulatory opening and the genital groove." Further he noted the "absence of a

common atrium and the consequent separation of the reproductive system into two independent units."

The genus *Agelenopsis* was erected by Giebel (1869) with the type form *A. albipilis*. He set apart this genus from *Agelena* on the position and size relationship in the eyes. In his new genus he suggests that the eyes are arranged in three rows; two in the first row, four in a straight line in the second and two again in the third row. The anterior laterals are the largest of the eyes. He found them to be different in *Agelena*. "Auffällig genug von *Agelena* verschieden, wo die Stirnagen erheblich kleiner, die zweite Reihe eine Bogenlinie bildet und die hintern Augen weiter aus einander gerückt sind."

Other authors have noted the differences between the American form and the European *agelenas*. Although he does not recognize the genus *Agelenopsis*, Simon (1898) describes the eyes of the genus *Agelena* as being nearly homogeneous, arranged in two sharply recurved rows. The four median eyes form a quadrangle with the sides almost parallel. Also he states, "dans la plupart des cas, les yeux médian antérieurs sont un peu plus gros que les latéraux et que les médians postérieurs." In a text figure, to which he here refers, of the eye pattern of *labyrinthica*, the anterior medians are much larger than the others. He also noted that the patella of the palp in the males of American species was without a point whereas the European forms have an apophysis of one shape or another on the anterior-external surface. In his figure of the patella and tibia of *labyrinthica* he shows a long pointed apophysis on the tibia which extends forward over the tarsus. We do find that the tibia of the palp in the American complex shows a slight rounded projection but it is not as exaggerated as the type shown in his figure.

Cambridge (1897-1905) recognized the genus *Agelenopsis* although the figures of his Central American forms do not agree in structures of the palp of the males and the epigynum of the females, with the North American forms of this genus. He does say that the spiders of the genus erected by Giebel "differ from *Agelena* (type *A. labyrinthica*) chiefly in the relative proportion of the anterior eyes, the laterals being much larger than the centrals, whereas in *Agelena* they are subequal."

Chamberlin and Gertsch (1929) noted that some forms of the genus *Agelena* had the apical joint of the hind spinnerets shorter than the penultimate and had a prominent, excavated region on the outer side of the tibia of the male palp with two or more conspicuous processes. For these forms Chamberlin erected the sub-genus (*Hololena*) of *Agelena*. On the other hand, the members of the genus *Agelena* (sens. str.) "form a group in which the hind spinnerets have the apical joint much longer than the penultimate, and in which the tibia of the palpus of the male has a single extension on the outer side."

Chamberlin and Ivie (1935) accept the genus *Agelenopsis*. They describe four new species of this genus in their work. *A. emertoni*, one of the four described by them, is one of the species used in the study of variations of the copulatory apparatus in this paper. The other three forms studied here were originally described as belonging to the genus *Agelena*. These authors state, however, that the type form (*A. albipilis*) used by Giebel, is a synonym of *A. potteri* Blackwell.

Blackwell (1846) described this species, taken in Canada in the vicinity of Toronto, as belonging to the genus *Agelena*. It is interesting to note that Blackwell says: "the eyes of the anterior row are larger than those of the posterior row, the intermediate ones being the largest of the eight." This condition is contrary to the findings of Giebel. In observations on the eye pattern of specimens of each group of this series, the author noted that the size relationship of the eyes varies enough so that in some the anterior medians are slightly larger than the laterals of the same row, and in others all four of the anterior row appear to be equal. Since the eyes are mounted on the front and top of the head, with those of the anterior row directed forward and those of the posterior—the medians directed upwards—the laterals to the sides, not all eyes can be seen in full view from any one angle, and their size relationship cannot be easily determined.

The form described by Blackwell (*potteri*) can be accepted as belonging to the genus *Agelenopsis*, since his description of the palp of the male is in accord with the description of this appendage of the American forms as given by Simon. Blackwell says:

"The cubital and radial joints of the palpi are short; the former is not provided with an apophysis, but the latter has a large, obtuse one at its anterior extremity, on the outer side; the digital joint is oval, but elongated, the extremity being slender and compact; it is convex and hairy externally, concave within, comprising the palpal organs, which are highly developed, complicated in structure with a large, spiral spine, brownish black on the outer and pale yellow on the inner side, which is very prominent and recurved at its extremity, and a strong, dark reddish brown process at the outer side projecting beyond the margin of the digital joint."

The rest of his description is of a general nature, but the description of the end of the embolus of the palp "which is very prominent and recurved at its extremity," and of the conductor "a strong, dark reddish brown process at the outer side projecting beyond the margin of the digital joint," are definitely diagnostic characters for the male of this species. He does not mention the epigynum of the female.

Keyserling (1877) described a new species (*A. americana*) of the genus *Agelena* from North America, from two specimens given him by Dr. L. Koch. He did not know in what part of the country they were taken since it was not mentioned by the collector. Besides giving a rather complete and detailed description of the color, markings, shape of the body and legs he mentions that the patella of the male palp is short and rounded on top and that the tibia bears a short protuberance which is thick and slightly curved at the tip. This is the typical condition of these segments of the palps of members of this complex.

His description is accompanied by two side views of the palp and one ventral view of the epigynum. He describes the cymbium of the palp as a cover which is somewhat broad and strongly curved and drawn out into a somewhat long, thin beak in front. Also, the embolus which is medium thick becomes thinner and hollow toward the end. He describes the conductor as a flat process, hollow below which is outside the embolus and extends forward. It ends in a small curved

tip. According to him the epigynum is a cross-oval pit at the rear part of a low rise. The figures of both the palps and the epigynum given by him are distinct for this form.

Americana has been recognized as a synonym of *A. pennsylvanica* C. Koch by several arachnologists. C. Koch (1843) gives a very meager description of his species and figures a colored dorsal view of the female. He does not mention the epigynum of the female and all characters used are of such a general nature that they could be used for several of the species recognized in this present study. The spelling *pensylvanica*, as it appears in the original description, apparently is a typographical error since it is spelled *pennsylvanica* on his plate. The male of this form was not known to C. Koch. Keyserling gives this comment at the end of his description of *americana*:

“Ob die von C. Koch beschriebene (*Ag. pensylvanica*₂) mit meiner identisch ist, von der sie in der Färbung abweicht, lässt sich unmöglich feststellen, da C. Koch nichts über die Gestalt der Epigyne in seiner Beschreibung sagt.”

The (2), after the name, refers to a footnote giving the reference to C. Koch's description.

SUMMARY OF THE STATUS OF THE GENUS

The females in this collection fell into four distinct groups on the basis of just one characteristic—the shape of the vulva of the epigynum. The internal structures of these epigyna were distinctly different for each of the four types. One has to note only the shape and position of the copulatory sacs and the diverticles of each type to see that these are characteristic for each species.

A degree of variation in the epigynum was to be noted in the twenty-five specimens of each species. In the first place the epigyna from a group of any one species are not the same size. Such measurements as the total length of the entire epigynum, the length and width of the vulva and the position and shape of the projections on the anterior lip, when present, were made for each group possessing them. The measurements showed that any one character may vary independently of the others. Although some of these measurements revealed considerable variation, none were great enough to cause any uncertainty as to the group in which they belong.

There also was no direct relationship between the size of the epigynum and the length of the spiders from which they were taken. Of the twenty-five specimens of *naevia* measured, the total length from the chelicerae to the spinnerets varied from 18 mm. to 13 mm. The other species showed similar variations in size. There was a tendency for the larger epigyna

to be found in the larger specimens but this was not always the case. It may be stated that the variation in the length of the specimen was greater than the variation found in the characters measured in the epigynum, and, that they did not coincide.

The table below gives the extremes for the measurements made in the twenty-five epigyna of each group. The numbers in parentheses represent the length of the spider, or spiders, in which these extremes were found. The measurement given for the length of the vulva equals the short axis of the ellipse while the width equals the long axis, except in *naevia* where the length equals the greatest distance from the anterior to posterior margins of the left side of the protruding lip or tongue, parallel to the length of the spider. The length of the lip in *naevia* is the distance it extends along the short axis. The epigynum of *americana* is without projections on the anterior margin of the vulva. The measurement given for the pouch in the posterior margin of the vulva indicates the width of the external edge of the depression and does not include the lateral pouches. All measurements are in millimeters.

Agelenopsis emertoni. Range of length of the spider, 12 mm. to 8 mm.

	Maximum	Minimum
Width of atrium.....	0.60 mm. (12)	0.39 mm. (8)
Length of atrium.....	0.27 mm. (9, 10, 11)	0.18 mm. (8)
Width of pouch.....	0.48 mm. (11, 12)	0.30 mm. (10)
Greatest length of epigynum	1.14 mm. (9, 12)	0.84 mm. (8)
Distance between points on anterior margin.....	0.33 mm. (12)	0.18 mm. (10, 8)

Agelenopsis naevia. Range of length of the spider, 15 mm. to 8 mm.

	Maximum	Minimum
Width of atrium.....	1.26 mm. (15, 17)	0.78 mm. (15)
Length of atrium.....	0.45 mm. (14, 17)	0.24 mm. (16)
Width of pouch.....	0.66 mm. (14, 15, 16, 17)	0.54 mm. (14, 15, 16, 17, 18)
Greatest length of epigynum	2.34 mm. (14)	1.74 mm. (14)
Length of lip.....	0.30 mm. (14, 15, 16)	0.18 mm. (13, 15, 17)

Agelenopsis americana. Range of length of the spider, 15 mm. to 8 mm.

	Maximum	Minimum
Width of atrium.....	0.72 mm. (13, 15)	0.42 mm. (9)
Length of atrium.....	0.42 mm. (10, 12, 14)	0.30 mm. (8, 10, 11)
Width of pouch.....	0.48 mm. (12, 14)	0.30 mm. (9, 10, 11)
Greatest length of epigynum	1.14 mm. (13, 15)	0.84 mm. (9)

Agelenopsis utahana. Range of length of the spider, 11 mm. to 6 mm.

	Maximum	Minimum
Width of atrium.....	0.54 mm. (10)	0.33 mm. (6)
Length of atrium.....	0.18 mm. (10, 11)	0.12 mm. (6, 7, 9, 10)
Width of pouch.....	0.18 mm. (9, 10, 11)	0.09 mm. (7, 10)
Greatest length of epigynum	1.11 mm. (6, 9)	0.84 mm. (7, 9, 10, 11)
Distance between points on anterior margin.....	0.27 mm. (10)	0.18 mm. (6, 7, 9)

Petrunkevitch (1925) suggested the epigynum of *Agelena naevia* to be quite variable and of two types, one larger and more complicated than the other. Of the four types described in this paper his two types probably present the greatest extremes in the series. His figures 1 and 2 of Plate I (page 573) are dorsal and ventral views of his small variety and are of *americana* while figures 3 and 4 of the same plate are of *naevia* of this series. They are not large and small types of the same species but two distinct species. He suggests that (page 571) "all parts of the male external reproductive organs are subject to considerable variation." Again, these structures may vary within limits in a species but the embolus and conductor of *naevia* are so different from those of *americana* that the two are easily separated. He does not figure the palp of *americana* but does give a lateral view of a palp with a long embolus which is *naevia* (text figure, page 569). The males of the two other forms used in this study (*emertoni* and *utahana*) also can be identified as separate species by the differences in these two structures.

Comstock (1912) does not figure the epigynum of an agelena in his spider book, but suggests that the epigynum of the female is quite variable as well as the palp of the male. He does figure two types of palps which he labels as variations of *naevia*. Neither of these figures (Figs. 665 and 666, page 587) is of the *naevia* suggested in this paper. In the revised edition of the Spider Book, Gertsch (1940) labels these same two figures *pennsylvanica* and *potteri*. The figure showing the long embolus, according to Comstock, is called *potteri* by Gertsch and the short form is labeled *pennsylvanica*. The *pennsylvanica* is the same as *americana* of this series while the other is the type form of the genus *Agelenopsis* (Giebel), called *albipilis* by him and found to be synonymous with *potteri* by later authors (Chamberlin and Ivie, 1935). *Potteri* was described by Blackwell in 1846 while *albipilis* did not appear until 1869. This species has not been taken by the author in the state of Ohio.

The eye patterns of the European form *Agelena labyrinthica* and of the American forms are different. The trochanters of the American forms are without a notch. The males of the American forms are without distinct apophyses on the tibia, but possess a long embolus and a distinctive conductor. The

epigyna of the American types differ markedly from *labyrinthica*, as figured by Petrunkevitch, as well as those figured by Cambridge. From these facts it is evident that these forms, each possessing definite characters, are different genera.

Since the study of a large number of specimens of the genus *Agelenopsis* showed that the individuals, both males and females, can be separated on the basis of a few structures—the condition of the embolus and conductor in the male, and the shape of the vulva in the females, into four groups, and that these characters are different and relatively constant for each group, it suggests that there are four distinct species in this complex.

It is obvious, therefore, from the material presented that we have been dealing with more than one species of spider.

CONCLUSIONS

1. The genus *Agelenopsis*, erected by Geibel, includes the American forms which differ from the genus *Agelena* representing the European species.

2. The specific name *A. americana* (Keyserling) is to be used in preference to *A. pennsylvanica* (C. Koch).

3. The epigynum of the female and the palp of the male are specific characters for these members of the genus *Agelenopsis*.

- a. The shape of the vulva of the epigynum is constant and distinctive for each species.
- b. The appearance of the conductor and embolus of the male palp is constant and distinctive for each species.
- c. While the length of the spider of a species is quite variable, the structures of the copulatory apparatus are fairly constant in size.

4. The descriptions of the epigyna of the two extreme variations of *naevia*, as given by Petrunkevitch, are correct.

5. These two variations, recognized by Petrunkevitch, are to be established as two distinct species, namely: *A. americana* and *A. naevia*.

6. There are four well founded species of the genus *Agelenopsis* occurring in the state of Ohio.

7. Descriptions and figures of the male palp and the epigynum of *Agelenopsis naevia* (Walckenaer) as a distinct species probably are given here for the first time.

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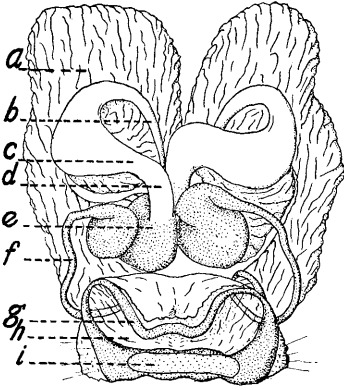


Fig.1

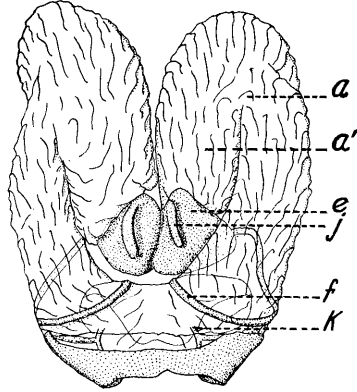


Fig.2

A. naevia

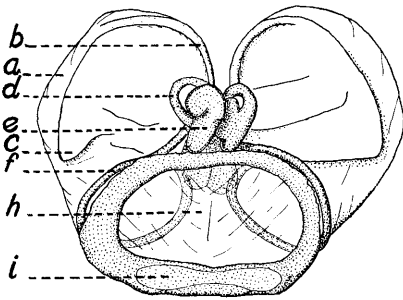


Fig.3

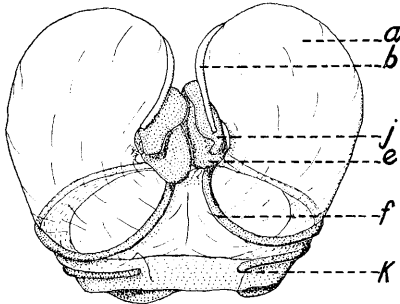


Fig.4

A. americana

- Fig. 1. Ventral view of dissected epigynum of *Agelenopsis naevia*.
- Fig. 2. Dorsal view of same.
- Fig. 3. Ventral view of dissected epigynum of *Agelenopsis americana*.
- Fig. 4. Dorsal view of same.

(All epigyna and palps drawn to the same scale.)

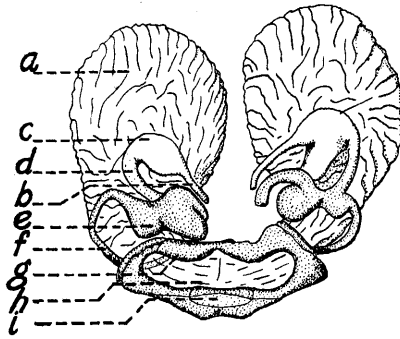


Fig. 5

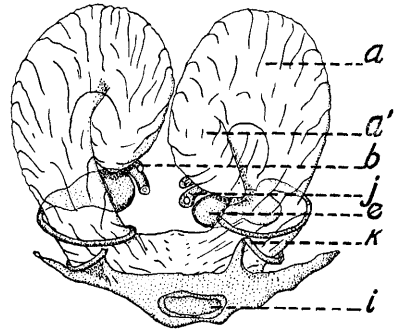


Fig. 6

A. utahana

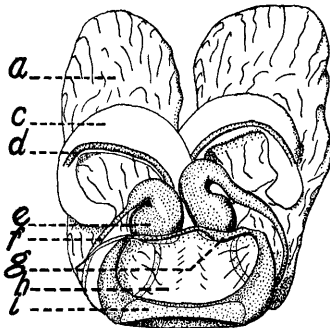


Fig. 7

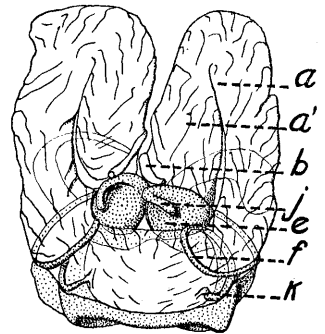


Fig. 8

A. emertoni

Fig. 5. Ventral view of dissected epigynum of *Agelenopsis utahana*.

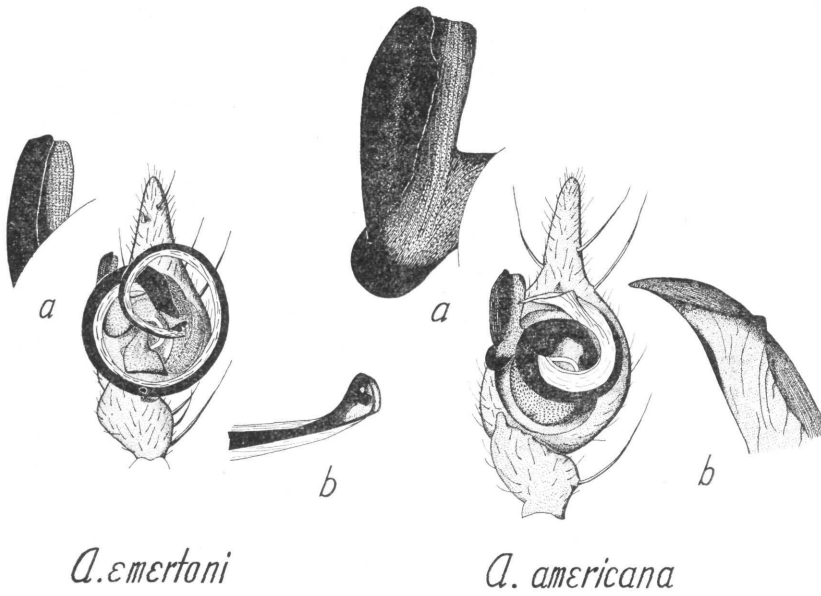
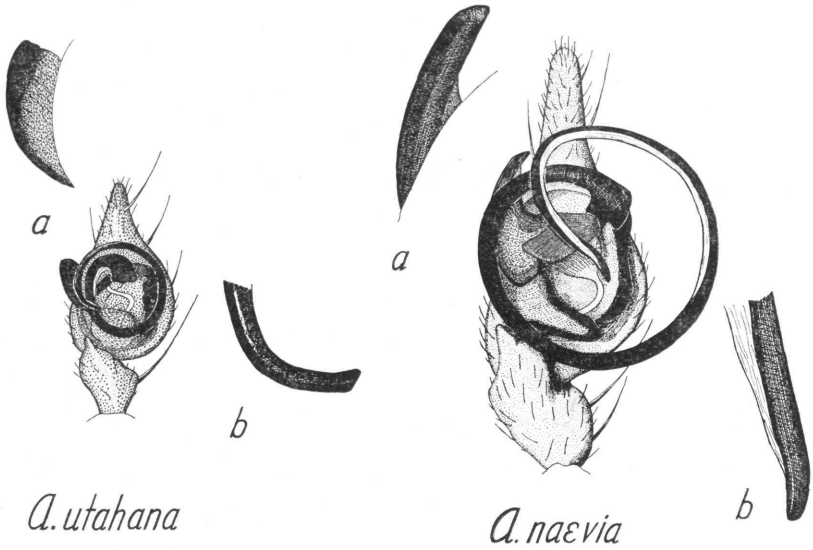
Fig. 6. Dorsal view of same.

Fig. 7. Ventral view of dissected epigynum of *Agelenopsis emertoni*.

Fig. 8. Dorsal view of same.

The structures in the above figures are indicated by letters.

- | | |
|----------------------------------------------------------------|---------------------------------------------------|
| a. Copulatory sac. | g. Projections on the anterior edge of the vulva. |
| a'. Reverted portion of copulatory sac. | h. Atrium. |
| b. Blind tube of the diverticle. | i. Pouch in the posterior margin of the vulva. |
| c. Diverticle. | j. Blind tube of seminal receptacle. |
| d. Tube connecting the diverticle with the seminal receptacle. | k. End of the fertilization tube. |
| e. Seminal receptacle. | |
| f. Fertilization tube. | |



Ventral views of the right palps of *A. utahana*, *A. naevia*,
A. emertoni and *A. americana*.

- a. Enlarged figures of the conductor.
- b. Enlarged figures of the tip of the embolus.