1951

Milliped Assembly Zinaria Butlerii Isogen (Xystodesmidae)

Nell B. Causey

Follow this and additional works at: http://scholarworks.uark.edu/jaas

Part of the Entomology Commons

Recommended Citation
Available at: http://scholarworks.uark.edu/jaas/vol4/iss1/13

This article is available for use under the Creative Commons license: Attribution-NoDerivatives 4.0 International (CC BY-ND 4.0). Users are able to read, download, copy, print, distribute, search, link to the full texts of these articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author.

This Article is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in Journal of the Arkansas Academy of Science by an authorized editor of ScholarWorks@UARK. For more information, please contact scholar@uark.edu, ccmiddle@uark.edu.
THE MILLIPED ASSEMBLY ZINARIA BUTLERII ISOGEN.
(XYSTODESMIDAE)

NELL B. CAUSEY
Fayetteville, Arkansas

The endemic character of most milliped species, as identified on the basis of the male genitalia, is well known to taxonomists working with the group. There are a few exceptional species, however, of which Spirobolus marginatus, Pseudopolydesmus serratus, and Scytotonotus granulatus are well known examples, with wide distribution in the Eastern United States and Mississippi Valley. Although each of these species shows a rather general uniformity of genitalia, there are slight geographic variations in color, size, and morphological features of unproven taxonomic significance. A thorough taxonomic analysis is needed to show whether these are polytypic species or whether they too are really composed of numerous endemic species.

In a few milliped genera of wide distribution in the same general area, all or part of the individuals of a genus may conform rather closely as to genitalia, but geographic groups are distinctive as to color, pattern, size, and, in some cases, convexity of the dorsum. Examples of such genera are Apheloria Chamb. 1921 and Zinaria Chamb. 1939, each with several species. Had the individuals of such a genus shown a uniform color and pattern throughout the range of the genus, they would be considered, at least at this stage of our knowledge of milliped taxonomy, as representing decidedly fewer species than have been proposed, but because they break up into geographic color and pattern groups, the genus is assumed to be one in which, contrary to the general condition in millipedes, all or part of the species in it are isogenitive, that is, the genitalia show a degree of uniformity which makes positive identification on them alone uncertain, or even impossible. Museum specimens of such species are almost always indistinguishable after the colors have faded.

Chamberlin established the genus Zinaria in 1939 for certain species until then included in Fontaria. In Zinaria the principal blade of each of the two gonopods of the male is relatively short, straight, and divided distally into two prongs; from its dorsal surface there arises a smooth, attenuated spine, usually straight, which is completely or nearly completely concealed in situ (figures 9-12). The unspined coxae, the stout spine on each prefemora, and the blunt sternal processes (figure 1) are features which serve to identify the females of the genus. These and the genitalia suggest a close relationship with Nannaria Chamb. 1928 and Castanaria Causey 1950, some species of which may occur in the same general area with Zinaria. Species of Zinaria have been collected from Oklahoma to Minnesota and east to Florida and Virginia. Some species appear normally to be confined to river bottoms and low, rich woodlands; others occur on somewhat

73
dry pine or hardwood covered hillsides. Various members of the genus have been incorrectly identified as *Fontaria virginiensisl* (Drury) for many years (Wood 1865, Bollman 1893, Willimans and Hefner 1928, Pratt 1935) and as such are probably labelled in many collections.

The known *Zinaria* species, as identified on the basis of the male genitalia, fall into two groups: viz., *cala* Chamb. and the 10 species with very similar gonopods, *butleri* isogen.¹ When sufficient material has been collected and analyzed, *butleri* isogen., or parts of it, may prove to be a polytypic species, but present knowledge does not warrant that designation.

Color and pattern have been the chief characters used to separate the species of *butleri* isogen. Whether they are reliable can be shown only by determining the degree of correlation between color and pattern and other differences. At present the only published record of a color variation is that of Hoffman (1949), who reported that Virginia specimens of *butleri* (McNeill) lack red on the dorsum, presumably meaning that the keels are red but that the pink bands on the caudal margins of the tergites are absent. In only one description, that of *rubrilata* Hoffman, is the color of the type specimens adequately given. An adequate description should include the color of the dorsum, with any differences between the colors of the prozonites and metazonites noted; the shape, intensity, and extent of the colored areas on the keels, collum, and the caudal margins of the metazonites; as well as the color of the antennae, head, pleurites, legs, and sternites. The difference between mature and immature coloration is often striking, so it should be included. The presence of a mid-dorsal line in this genus, I believe, will be seen only on animals with immature coloration.

Our present collections show the following distribution of color and pattern: red or pink keels and bands, *proxima* from Michigan and *butleri* from Indiana, Ohio, Virginia, West Virginia, and Pennsylvania. Species with varied size and shade combinations of yellow keels and bands are *iowa, urbana, mima, rubrilata,* and *busheyi* from Pennsylvania, Virginia, Indiana, Illinois and Iowa. A species with yellow keels and no bands or triangles, *brunnea,* is known from Minnesota, and Wood’s *virginiensisl,* with the same color pattern, is supposed to occur in the “Middle States,” presumably New York, New Jersey, Pennsylvania, Delaware, and Maryland. The two trimaculate species, *warreni* and *mirabilia,* the first from ¹Isogenitive (abbr. isogen.) is used here with the specific name *butleri* to simplify reference to an assembly of closely related species in which the male genitalia are so similar that the usual figures and descriptions of them are inadequate for separating the species. It is recommended that an assembly of isogenitive species be named for either the best known or the earliest described member.

The designation of an assembly of species as isogenitive does not mean that microscopic variations in the genitalia do not occur. There are constant differences, but they are difficult to see. The gonopods of three members of *butleri* isogen., shown in figures 10, 11 and 12 illustrate the range of specific differences encountered. In contrast, the gonopod shown in figure 9 is of a species not regarded as a member of *butleri* isogen.
FIGURE 1. Sternal processes between second pair of legs of thirteenth segment of: a, Zinaria urbana; b, Z. brunnea; c, Z. warreni; d, Z. miribilia; e, Z. butleri; f, Z. busheyi; g, Z. proxima; h, Z. cala. All are drawn from male specimens and to the same scale. Setae are omitted in a-g.

FIGURE 2. Labral profiles of: a, Z. proxima; and b, Z. butleri. Both are drawn from male specimens and to the same scale. Setae are omitted.

FIGURE 3. Keels of collum and second segment of: a, Z. cala; b, Z. warreni; c, Z. proxima; d, Z. brunnea. All are drawn from male specimens and to the same scale.

FIGURE 4. Keel of thirteenth segment of Z. busheyi.

FIGURE 5. Keel of thirteenth segment of Z. mima.

FIGURE 6. Keel of thirteenth segment of Z. warreni.

FIGURE 7. Projection of caudal end of segment fourteen of Z. busheyi. OB, bisector; CC', chord; BOH, height.
western Arkansas and eastern Oklahoma and the second from eastern Arkansas, are strikingly different in appearance. The background color of the dorsum ranges from nearly black in iowa, through black-brown in warreni, chestnut brown in several species, to orange-red or bright chestnut brown in rubrilata. The mature coloration for several species is not definitely known, having been inferred from either faded or immature specimens.

In my effort to find some character other than color to separate the species of butleri isogen., I have examined at least one male of all the species except iowa. For some species only one faded specimen or a fragment was available, but there were several specimens of urbana, butleri, proxima, warreni, and mirabilia. The following characters were studied: shape of labrum, keels, and sternites; number of labral setae, width, and convexity of dorsum.

There are four notches in the medial margin of the labrum, and the resulting labral profile, while varying greatly in some species, appears to be constant enough in others to be of diagnostic value. In proxima (2B) the labral teeth are much shorter than in butleri (Fig. 2A); in the specimens of proxima the labral profile shows a constant difference from that of the butleri specimens. In warreni, however, the labral profiles of specimens from the type locality vary widely, but whether from wear or from individual variation was not determined. In cala there is a single medial tooth and no definite lateral teeth, a very different appearance from that of any species of butleri isogen. In all species of butleri isogen., the number of labral setae, of which there are often three or four in one pore, is between 50 and 60 in the marginal row and between 20 and 30 in the upper row. In cala there are about 35 in the marginal row and 20 to 30 in the upper row. The labral pores were not counted.

The shape of the sternites between the third and fourth pairs of legs of the males in the warreni collection show so much variation they are not of value as diagnostic characters; in some specimens they are appressed and in others separated, with the incision between them either U- or V-shaped. The sternal processes between the second pair of legs of each segment behind the gonopods show a high degree of uniformity, however, so they were compared in the species available and found to have specific differences of diagnostic value. As shown in figure 1, the sharpest occur in brunnea, the fullest in mirabilia and in proxima, and the remainder are intermediate between these. In all species except cala there are from 20 to 25 setae scattered over the ventral surface of the processes. The small sternal processes between the first pair of legs of the corresponding segments were not studied.

The lateral margins of the keels are slightly thicker in cala than in any species of butleri isogen. They are slightly prolonged behind the keels in warreni (Fig. 6), mirabilia, brunnea, and cala; less prolonged in proxima, butleri, busbeyi (Fig. 4), mira (Fig. 5), and urbana; and prolonged almost none at all in rubrilata. The keels of the collum are less acute in butleri isogen. than in cala (Fig. 3); in both warreni and mirabilia the margin is
thicker on the collum keels than in any of the other species. Some difference is found in the shape of the keels in the middle body region: the lateral margins are slightly oblique to the body axis in *warreni* (Fig. 6), *miribilia*, *rubrilata*, *urbana*, and *brunnea*; they are less oblique in *busheyi* (Fig. 4), and almost parallel to the body axis in *mima* (Fig. 5), *butlerii*, and *proxima*; in *cala* they are slightly convex. The shape of the last five body segments is shown in figure 8; the keels of these segments are sharpest in *brunnea*. In most species the keels of the sixteenth segment are but slightly prolonged behind the medial margin of that segment, but in *brunnea*, *rubrilata*, *miribilia*, and *mima*, the keels make a definite oblique angle with the metazonite. In most species the openings of the repugnatorial glands are dorsal, but in *butlerii* and *proxima* they are almost lateral, resulting in a slight emargination of the lateral margin of the keels.

Records of individual and geographic variation in size in any one species of this group are still too meagre to have much meaning. In the various species, the width ranges from 8.8 mm down to 4 mm and the length from 41 mm down to 21 mm, with the females usually slightly larger than the males. The variation of width and length, as given in the literature and as found in my specimens, is recorded in Table I.

A morphological character often mentioned in describing species is the convexity of the dorsum. A method of quantitatively presenting this character is used here to replace the heretofore used method of roughly describing specimens as "dorsum compressed," "arched," etc. It is a bisector-chord-height proportion designated by the abbreviation B-C-H and derived from measurements obtained after dissecting out and projecting the caudal margin of the fourteenth segment of a male. The metazonite and its keel are considered the arc of a circle, and the chord (C) is the line drawn from the caudal angle of one keel across to the corresponding point on the other keel; the bisector (B) is the perpendicular line from the middle of the chord to the summit of the metazonite; and the height (H) is the line from the summit along the bisector to the midpoint of the external surface of the sternite (Fig. 8). B is taken as 1 and the proportions of the other two measurements are then derived. In order that the segment always be projected from the same angle, it is held so that the anterior sternite is just barely covered by the posterior sternite. C-B-H ratios of several species of *Zinaria* are given in Table I; *mima* is most convex, *warreni* and *miribilia* least, and *butlerii*, *proxima*, *cala*, *brunnea*, *rubrilata*, *urbana*, and *busheyi* in between, in descending order.

It seems wise to present the following notes on the synonymy of *Zinaria* species at this time because of the widespread confusion that has existed as to the status of Wood’s *viriniensis* and McNeill’s *butlerii*.

*Zinaria* Chamberlin

1942 *Zinaria* Chamberlin, Bull. Univ. Utah, vol. 34, no. 6, p. 16.
### TABLE I
DIFFERENCES IN GREATEST BODY WIDTH, APPROXIMATE LENGTH, AND B-C-H RATIO IN TWELVE SPECIES OF ZINARIA.

<table>
<thead>
<tr>
<th>Species</th>
<th>Locality</th>
<th>Number of Specimens</th>
<th>Greatest Body Width</th>
<th>Approximate Body Length</th>
<th>B-C-H Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
</tbody>
</table>
| warreni | Carroll Co., Ark.                | 7    | 4      | 7.7-7.9 mm | 32-38 mm | .21-1-.55
|         | Carroll Co., Ark.                | 1    | 1      | 7.7-8.3    | 32-41    |             |
|         | Cherokee Co., Okla.              |      |        | 7.2        | ?        |             |
|         | Latimer Co., Okla.               |      |        | 8.7        | 38       |             |
| miribilia| Clay Co., Ark.                   | 2    | 6      | 7.6-7.8    | 32-33    | .20-1-.55
|         | Clay Co., Ark.                   |      |        | 7.8-8.8    | 31-36    |             |
| busheyi | Grant Co., Ind.                  | 1    | 3      | 7.0        | 33       | .20-1-.59
|         | Grant Co., Ind.                  |      |        | 6.7-7.2    | 29-33    |             |
|         | Blackford Co., Ind.              | 1    | 1      | 8.3        | 36       |             |
| urbana  | Urbana, Ill. (Chamberlin)        | 1    | 2      | 6.9        | 29       | .20-1-.59
|         | Zion, Ill.                       | 2    | 1      | 5.9-6.4    | 28       |             |
|         | Tolono, Ill.                     |      |        | 6.0        | 29       |             |
| ?²      | Eldred, Ill.                     | 1    | 1      | 7.0        | 32       | .20-1-.61
| brunnea | Ft. Snelling, Minn. (Bollman)    | 1    | 1      | ?          | 25       |             |
|         | Rush City, Minn.                 |      |        | 5.9        | ?        |             |
| butleri | Bloomington, Ind. (McNeill)      | 1    | 1      | 7          | 30       | .23-1-.60
|         | Spencer, Ind.                    | 5    | 4      | 6.0-6.5    | 29-31.6  |             |
|         |                              |      |        | 6.3-6.7    | 28-31.7  |             |
| ?²      | Montgomery Co., Ind.             | 2    | 1      | 6.6-7.0    | ?        |             |
| ?       | Montgomery Co., Ind.             | 1    | 1      | 7.5        | ?        |             |
| ?       | Turkey Run St. Pk. Ind.          | 1    | 1      | 7.2        | 34       |             |
| proxima | Ann Arbor, Mich.                | 4    | 6      | 5.7-6.2    | ? 30     | .23-1-.60
<p>|         | Ann Arbor, Mich.                |      |        | 5.9-6.8    | 27-? 32  |             |</p>
<table>
<thead>
<tr>
<th>Species</th>
<th>Locality</th>
<th>Number of Specimens</th>
<th>Greatest Body Width</th>
<th>Approximate Body Length</th>
<th>B–C–H Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rubrilata</td>
<td>Lancaster Co., Va. (Hoffman)</td>
<td>1</td>
<td>1</td>
<td>5.6</td>
<td>32.5</td>
</tr>
<tr>
<td></td>
<td>Lancaster Co., Va. (Hoffman)</td>
<td></td>
<td></td>
<td>6.1</td>
<td>30</td>
</tr>
<tr>
<td>aberrans</td>
<td>Caddo Par., La. (Chamberlin)</td>
<td>1</td>
<td></td>
<td>6.0</td>
<td>30</td>
</tr>
<tr>
<td>mima</td>
<td>Greene Co., Pa. (Chamberlin)</td>
<td>1</td>
<td></td>
<td>6.0</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Greene Co., Pa.</td>
<td>1</td>
<td></td>
<td>5.4</td>
<td>?</td>
</tr>
<tr>
<td>iowa</td>
<td>Ames, Iowa (Chamberlin)</td>
<td>1</td>
<td></td>
<td>5.2</td>
<td>23</td>
</tr>
<tr>
<td>cala</td>
<td>Deer Park, Fla. (Chamberlin)</td>
<td>1</td>
<td>1</td>
<td>4.0</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Deer Park, Fla.</td>
<td></td>
<td></td>
<td>5.0</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Deer Park, Fla.</td>
<td></td>
<td></td>
<td>4.1</td>
<td>21</td>
</tr>
</tbody>
</table>

1 All measurements are original except those following names of authors in parentheses.
2 Specific determinations were not made on these specimens.


**Zinaria virginiensis** (Wood)


1893 *Fontaria virginiensis* Wood. Bollman, various papers reprinted in Myr. of N. Amer.


Wood described *virginiensis* as dark reddish chestnut, with the keels bright yellow, sometimes verging toward orange, and without bands or triangles on the caudal margins of the metazonites. Even though the coloration is strikingly different from that described for *butleri* (McNeill), later authors have attempted to combine the two species. It appears that *virginiensis* (Wood) - sometimes referred to as *virginiensis* (not of Drury), actually approximates the brief description which Bollman made of *brunnea*, but in the absence of Wood’s specimens and of more definite collection data than “Middle States,” the name *Zinaria virginiensis* (Wood) is a nomen nudum as of 1865.

**Zinaria brunnea** (Bollman)

Pl. I, Figs. 1B, 3D; Pl. II, Fig. 8D

1887 *Fontaria virginiensis brunnea* Bollman, Amer. Nat., vol. 21, p. 82.


The sharper sternal processes (Fig. 1B) and more acute keels on the posterior segments (Fig. 8D) set *brunnea* apart from other isogenitive species of *Zinaria*. It is known from Chisago and Hennipen Counties, Minnesota.

**Zinaria butleri** (McNeill)

Pl. I, Figs. 1E, 2B; Pl. II, Figs. 8G, 11


1893 *Fontaria virginiensis* (Wood). Bollman, various papers reprinted in Myr. of N. Amer.

FIGURE 8. Tergites of last five segments of: a, Z. cala; b, Z. urbana; c, Z. warreni; d, Z. brunnea; e, Z. proxima; f, Z. miribilis; g, Z. butleri; h, Z. rubrilata; i, Z. mima; j, Z. busheyi.

FIGURE 9. Right gonopod, subdorsal view, Z. cala.

FIGURE 10. Left gonopod, subdorsal view, Z. warreni.

FIGURE 11. Left gonopod, a, subdorsal view; b, medial view of spine, Z. butleri.

FIGURE 12. Right gonopod, subdorsal view, Z. proxima.


First described from Franklin Co., Indiana, *butleri* has been reported from Ohio (Williams and Hefner 1928), Pennsylvania (Chamberlin 1927), Virginia, and West Virginia (Hoffman 1949). Hoffman (1949, Proc. Biol. Soc. Wash., vol. 62, p. 86) reported that the Virginia specimens which he regards as *Z. butleri*, and which I have not seen, have no red on the dorsum, and the dorsal spine of the gonopod is larger and curved mesiad. My specimens from Spencer, Indiana, have a slight crook at the distal end of the dorsal spine and a slight lobe somewhere along the mesial margin of the principal blade (Fig. 11), making it possible to distinguish this species from *proxima*, another species with a high dorsum and red on the keels. Whether the pattern of the labial profile (Fig. 2B) is constant throughout the range is not known.

A recent (Aug. 31, 1950) extraordinary aggregation of *Z. butleri* was reported to me by Dr. Eliot C. Williams, Jr. An estimated six or seven thousand, apparently all adult specimens, were heaped up in two small areas at either end of a bridge over McCormick’s Creek, near Spencer, Indiana.

*Zinaria cala* Chamberlin

Pl. I, Figs. 1H, 3A; Pl. II, Figs. 8A, 9


Collections of *cala* have been made in Florida and Georgia. It should be easily distinguished from other species of *Zinaria* by its glabrous sterna, small size, and short dorsal spine on the gonopods.

*Zinaria urbana* Chamberlin

Pl. I, Fig. 1A; Pl. II, Fig. 8B


Loomis and Hoffman (1948) believe that the difference in size does not justify the maintenance of *urbana* as a separate species from *brunnea*, but I think that the sharper sternal process and the more acute posterior keels of *brunnea* as contrasted with those characters in *urbana* (Figs. 1A, 8B) warrant recognition of the two as separate species. The only specimens are from northern Illinois.

Zinaria iowa Chamberlin

1942 Zinaria iowa Chamberlin, Canad. Ent., Vol. 74, no. 1, p. 16, fig. 3.


Loomis and Hoffman (1948) rejected iowa because the gonopods, as figured by Chamberlin, are identical with those of brunnea. In view of the great similarity of the gonopods of members of butleri isogen., this does not constitute a valid reason for refusing to recognize iowa. The color pattern, distinctly unlike brunnea's, justifies its maintenance as a separate species; iowa has been reported only from Ames, Iowa.

Zinaria aberrans Chamberlin


Recently aberrans was made the type of a new genus, Thrinaxoria. Although the gonopods suggest those of Zinaria, the following characters are clearly those of another genus: the absence of sternal processes, spines on the posterior coxae, the three rows of tubercles across the metazonites, and the absences of sternal processes between the third and the fourth pairs of the legs of males.

Zinaria mima Chamberlin

Pl. I, Fig. 5; Pl. II, Fig. 81


The small size, very convex dorsum (Table I), and keels (Fig. 5) distinguish mima from other isogenitive species of Zinaria. It is known only from Greene Co., Pennsylvania.

Zinaria rubrilata Hoffman

Pl. I, Fig. 8H


The sternal processes on the posterior segments of rubrilata resemble those of urbana. After the colors have faded, it might be distinguished from other isogenitive species of Zinaria by the angle that the keels of the sixteenth segment make with the metazonite (Fig. 8H) and the fact that the margins of the keels are not prolonged behind the keels, as in most other species. This species is known from Lancaster Co., Virginia.

Zinaria warreni, n. sp.

Pl. I, Figs. 1C, 3B, 6; Pl. II, Figs. 8C, 10

A large member of the genus distinguished by the three yellow triangles

Published by Arkansas Academy of Science, 1951
on the caudal margin of most of the tergites. The sparsely setose sternites and shape of the gonopods establish it as a member of *butleri* isogen. It is distinguished from *miribilia* by its smaller sternal processes and larger maculae.

**Male holotype.** Dorsum black-brown; collum with yellow triangles on keels and both mid-dorsal margins; low, pale yellow triangles on mid-caudal margins of metazonites 2 through 17, none of them touching the larger, bright yellow triangles on the keels; tergite 20 yellow caudally. Epicranium brown, antennal sockets and antennae buff, antennae light brown, becoming darker distally. Stermites and legs bright yellow, a thin brown line around each article of the legs; tarsal claws brown and slightly twisted. Pleurites, except for the light brown triangles under the keels, pale yellow. Labral setae in marginal row about 50, about 20 in upper row.

Metazonites finely wrinkled; prozonites smooth. Raised margins on anterior margin of collum and lateral margins of keels slightly thicker than in any other species of *butleri* isogen, except *miribilia* (Fig. 3B). Beginning with segment 5 the margins are produced slightly caudad of the keels (Fig. 6). The lateral margins of the keels of the middle body region are slightly oblique to the body axis. The shape of the last 5 tergites is shown in Figure 8C.

Coxae of last pair of legs separated by .4 mm; this space widens cephalad, becoming 1.2 mm on the middle segments. Stermites between the second pair of legs of segments 8 through 17 bluntly produced caudal as shown in Figure 1C. The sternite between the third pair of legs is in the form of a pair of low triangles; between the fourth legs there are similar but larger triangles.

A gonopod is shown in Figure 10; the end of the dorsal spine is visible *in situ* between the prongs of the principal blade; the medial prong is narrower than that of *cala* (Fig. 9).

Length 38 mm, width 7.7 mm, B-C-H of segment 14 .21-1-.54.

**Female allotype.** Agreeing in general with the male, but differing in the following: all of the tergites have a small, medial, yellow triangle, length 40 mm, width 8.1 mm.

**Locality.** Arkansas, Carroll Co. The male holotype was collected by Mr. Lloyd C. Warren June 17, 1950, from a sandy, wooded, frequently flooded island in King's River on the farm of Mr. John Bains, Berryville. I collected 6 males, 4 gravid females, and several larvae of 19 segments from the same site July 2, 1950. A few of them were moving about in the shade, but most of them were under driftwood. No specimens were found on the wooded hills across the river from the island. Both adults and larvae emitted a strong odor of prussic acid when handled. The Oklahoma collections, made by Dr. R. D. Bird, consist of one male from Cherokee Co., July 12, 1929, and one gravid female from Latimer Co., Oct. 21, 1929.

*Zinaria busbeyi*, n. sp.

Pl. I, Figs. 1F, 4, 7; Pl. II, Fig. 8J

A moderately large member of *butleri* isogen. with yellow bands on the caudal margins of the tergites and narrow yellow bands on the lateral
Margins of the keels as in *mima*, from which it can be distinguished by its greater size and less convex dorsum.

*Male holotype*. Dorsum dark brown; entire margin of collum with yellow band, which is wider medially and on keels; a yellow band, wider than in *mima*, on caudal margin of metazonites, embracing caudal corners of keels, and continuing forward on lateral margins of keels as narrow lines. Epicranium brown, antennae light brown, becoming darker distally. Stermites and pleurites cream color, legs probably yellow, claws brown and slightly twisted. Labral setae in marginal row about .50, about 26 in upper row.

Metazonites finely wrinkled; prozonites smooth. Beginning with segment 5, the raised lateral margins of the keels are slightly produced caudad of the keels. The lateral margins of the keels of the middle body region are slightly oblique to the body axis (Fig. 4); this distinguishes *busbeyi* from *mima*, in which these keels are parallel with the body axis. The shape of the last 5 tergites is shown in figure 8J. The repugnatorial pores are sublateral, giving the segnents with them a slight emargination.

Coxae of last pair of legs separated by .36 mm; this space widens cephalad as usual. Stermites behind gonopods produced as in Figure 1F. Stermite between third legs in form of a pair of appressed lobes; between the fourth legs there is a pair of truncated lobes, the incision between then U-shaped. Posterior margin of gonopodal opening more concave medially than in *mima*.

Gonopods typical of *butleri* isogen. The prongs of the principal blade are relatively longer and closer together than in *mima*.

Length about 33 mm, width 7 mm, B-C = H of segment 14 .20-1-.59.

*Locality*. Indiana, Grant Co., Upland. Dr. C. J. Bushey collected the male type and two females May 5, 1950.

The females agree in general with the males, but differ in the following: the caudal bands are in the shape of wide, low triangles confluent with the yellow areas of the keels; length 32 mm, width 7.1 and 7.2 mm. A female collected at Hartford City, Blackford Co., Ind., by Dr. Bushey differs in the following characters: dorsum black-brown, legs pale yellow, wide yellow caudal bands have a mid-dorsal pale yellow dot confluent with them; margins of keels slightly more prolonged; length 36 mm, width 8.3 mm.

*Zinaria miribilia*, n. sp.

Pl. I, Fig. 1D; Pl. II, Fig. 8F

A large, trimaculate member of *butleri* isogen. similar to *warreni* but distinguished from it by the slightly longer and more bulbous sternal processes and by the smaller yellow areas on the keels and the indistinct mid-dorsal light brown areas.

*Male holotype*. Dorsum very dark brown; trimaculate, the mid-dorsal spots light brown, indistinct, and roughly triangular, the keels with narrow, bright yellow lateral margins much smaller than the yellow areas on the keels of *warreni*. Labral setae in marginal row about 60, about 35 in upper row.
Metazonites finely wrinkled; prozonites smooth. Raised margins of keels as in warreni; keels prolonged caudad as in warreni, except that the 19th keels are more rounded (Fig. 8F). Sternites between second pair of legs of segments 8 through 17 with processes slightly longer and more bulbous (Fig. 1D) than in any other species of the genus. Stemites sparsely setose between second legs of each segment, less setose at base of first legs of each segment. Between the third legs the sternite is in the form of low triangles; between the fourth legs the processes are similar but slightly larger. Coxae of last pair of legs separated by .4 mm; this space widens cephalad, becoming 1.3 mm on the middle segments.

The gonopods appear to be indistinguishable from those of warreni.

Length 31 mm, width 7.6 mm, B–C–H of segment 14 .20–1.55.

Female allotype agrees in general with the male; length 34 mm, width 8.2 mm.

Locality. Arkansas, Clay Co., 12 miles northeast of Piggott, highway 62, on Crowley's Ridge. I collected 2 males, 9 females, and several larvae of 19 segments from the rather dry litter on a north oak-hickory covered hillside. Both adults and larvae emitted a strong odor of prussic acid when handled.

Specimens in which the colors had not matured were drab brown, with broad mid-dorsal cream triangles almost confluent with the large cream triangles on the keels.

*Zinaria proxima*, n. sp.

Pl. I, Figs. 1G, 2A, 3C; Pl. II, Figs. 8E. 12

A species similar to butleri in color, size, and shape, but distinguished from it by differences in the labral profile, the sternal processes, and the male gonopods.

Male holotype. Colors faded, but apparently the dorsum is brown and the caudal margins of the metazonites are red-banded, the bands widened medially; the keels have a narrow red border on the lateral margins; entire margin of collum with red band, which is wider medially and on keels.

Metazonites finely wrinkled; prozonites smooth. The shape of the keels of the first two segments is shown in Figure 3C. The margins of the keels are very slightly prolonged behind the keels. In the middle body region the lateral margins of the keels are almost parallel to the body axis. The shape of the last five tergites is shown in Figure 8E.

The sternal processes between the second pair of legs of segments 8 through 17 are slightly fuller and the excavation between them is deeper than in butleri; the processes between the 13th legs are shown in Figure 1G.

A subdorsal view of a gonopod is shown in Figure 12; the dorsal spine is almost straight, without the more decided distal wave characteristic of specimens of butleri from Spencer, Ind.; the medial prong of the main blade is more narrow than in butleri, and the medial margin of the main blade is straight, without the small but characteristic lobe seen in butleri (Fig. 11); there are two brown spots on each medial prong.
Length about 30 mm, width 6.0 mm, B-C-H of segment 14.23-1.60. Female allotype agrees in general with the male; length about 30 mm, width 6.3 mm.

Locality. Michigan, Ann Arbor, 5 miles west, Liberty and Zeeb Roads. Dr. George C. Wheeler collected 5 males and 7 females, and several specimens of the last larval stadium June 6, 1948.

KEY TO THE SPECIES OF ZINARIA

1 (2) Sterna glabrous; dorsal spine of male gonopods reaching no more than half way up the undivided part of the principal blade to the base of the prongs (Fig. 9); gonopodal opening with margin raised all around; lateral margins of keels of middle body region slightly convex; dorsum dark brown; keels and metazonites with sharply defined yellow borders; venter and legs yellow. \( \delta \) 21 \( \times \) 4 mm. .......................................................... cala Chamberlin.

2 (1) Sterna sparsely setose; dorsal spine of male gonopods long enough to be visible or almost visible in situ between prongs of principal blade (Figs. 10-12); gonopodal opening with margin raised laterally; dorsum varying shades of brown to black with pink, red, or yellow bands or triangles. .................................................. butleriis isogen. 3

3 (6) Pink or red areas on keels and caudal margins of metazonites; dorsum moderately convex. .................................................. 4

4 (5) Dorsal spine of male gonopods straight or almost straight (Fig. 12), lateral margin of principal blade without lobe, (Fig. 12), labral profile as in figure 2A. \( \delta \) 30 \( \times \) 6 mm .......................................................... proxima, n. sp.

5 (4) Dorsal spine of male gonopods with crook in distal end, lateral margin of principal blade with small lobe (Fig. 11), labral profile as in figure 2B. \( \delta \) 6.5 \( \times \) 30 mm .......................................................... butleri (McNeill)

6 (3) Yellow areas on keels and, in some species, on caudal margins of metazonites; dorsum from strongly to weakly convex. .................................................. 7

7 (10) Caudal margins of metazonites without yellow bands or triangles. ........ 8

8 (9) Background color of dorsum largely orange-red or bright chestnut brown, exposed parts of prozonites black. \( \delta \) 32 \( \times \) 5.6 mm. rubrilata Hoffman

9 (8) Background color of dorsum chestnut brown; keels and sterna sharper than in other species of the genus (Figs. 1B and 8D). \( \delta \) about 25 \( \times \) 5.9 m. .......................................................... brunnea (Bollman)

10 (7) Caudal margins of metazonites with yellow bands or with yellow or light brown triangles. .................................................. 11

11 (16) Narrow yellow bands on lateral margins of keels .................................................. 12

12 (15) Bands on lateral margins of keels connected by wider bands on caudal margins of metazonites; dorsum either strongly or weakly convex. .................................................. 13

13 (14) A smaller species; dorsum strongly convex; lateral margins of keels parallel to body axis. \( \delta \) about 25 \( \times \) 5.7 mm. .......................................................... mina Chamberlin.

14 (13) A larger species; dorsum weakly convex; lateral margins of keels slightly oblique to body axis. \( \delta \) 33 \( \times \) 7 mm. .......................................................... busheyi, n. sp.

15 (12) Mid-dorsal region of metazonites with small, roughly triangular, light brown areas not confluent with yellow areas of keels; dorsum dark brown and weakly convex; lateral margins of keels more oblique to body axis than in busheyi. \( \delta \) 33 \( \times \) 7.7 mm. .......................................................... mirribilia, n. sp.

16 (11) Larger yellow triangular or rectangular areas on keels; dorsum weakly convex. .................................................. 17

17 (20) Yellow areas of keels connected by yellow bands on caudal margins of metazonites. .......... 18

18 (19) Dorsum nearly black; keels bright yellow, the bands connecting them dull yellow. \( \delta \) 23 \( \times \) 5.2 mm. .......................................................... iowa Chamberlin.

19 (18) Yellow bands connecting keels widened in mid-dorsal region. \( \delta \) about 28 \( \times \) 6.5 mm. .......................................................... urbana Chamberlin.

20 (17) Small light yellow triangles on mid-dorsal region of metazonites not confluent with bright yellow triangles on keels; dorsum black-brown. \( \delta \) 35 \( \times \) 7.8 mm. .......................................................... warreni, n. sp.
Type specimens of the *Zinaria* spp. described in this paper will be deposited in the collection of the Academy of Natural Sciences of Philadelphia.

I am indebted to the following people for the use of specimens of *Zinaria* spp.: Dr. R. V. Chamberlin, Dr. Milton W. Sanderson, Mr. Robert L. Hoffman, Mr. Lloyd O. Warren, Dr. C. J. Bushey, Dr. George C. Wheeler, Mr. James E. Sublette, and Dr. Eliot C. Williams, Jr.

**SUMMARY**

1. The term isogenitive is proposed to simplify reference to an assembly of closely related species of millipedes in which the genitalia are so similar that other morphological characters must be found to separate the species.

2. Useful diagnostic characters, not of equal value for all species, in *Zinaria butleri* isogen. are color and pattern, shape of labrum, sternites, and keels, length and width of body, and convexity of dorsum.

3. A simple procedure for quantitatively expressing the convexity of the dorsum is proposed.

4. *Zinaria virginiensis* (Wood) is declared a *nomen nudum* and the following new species of *Zinaria* are described: *warreni*, *busheyi*, *miribilia*, and *proxima*.

5. A key to 11 species of *Zinaria* is given.