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Parajulid Studies II. The Subgenus *Hakiulus* Chamberlin (Julida: Parajulidae: Parajulinae: Aniulini)

By Rowland M. Shelley

ABSTRACT

A comprehensive study of relevant parajulid samples shows that *Hakiulus* Chamberlin warrants only subgeneric status under *Aniulus* Chamberlin; it comprises eight species, one divided into five geographic races. *Parajulus neomexicanus* Chamberlin is returned to *Hakiulus* and *P. texanus* Chamberlin is transferred out of the genus and left unassigned. Modern diagnoses are presented for these taxa along with a key and distribution maps. The following new synonymies are proposed: *H. cyaneus* (Chamberlin) under *P. texanus*, and *Parajulus zakiwanus* Chamberlin and *H. occidentalis* Loomis under *A. (H.) diversifrons neomexicanus*.

INTRODUCTION

This contribution is the second in a series of planned studies on the Parajulidae, the dominant Nearctic milliped family. It concerns the taxon *Hakiulus* Chamberlin, which has enjoyed full generic status but which I think must be reduced to the subgeneric level because of newly discovered species that exhibit features of both *Aniulus* Chamberlin and *Hakiulus*; the former name holds taxonomic priority having been proposed eight pages ahead of the latter by Chamberlin (1940). *Hakiulus* can usually be recognized by a distal spur, lobe, or projection on the telopodite of the posterior gonopod, which arises from either the ventral margin or the medial surface.

This structure is absent from *victorianus* (Chamberlin), a localized race of the most widespread species, *A. (H.) diversifrons* (Wood), and from *A. (H.) brachygon*, n. sp., whose placement in *Hakiulus* is based on the distally broad posterior gonopod telopodite and the coxal lobes on the anterior gonopods, another feature displayed by most species. The coxal lobes are missing from *A. (H.) causeyae*, n. sp., but this species is assigned to *Hakiulus* because of the distal lobe/spur on the posterior gonopod telopodite and the breadth of the latter. Consequently, there is no single apomorphy that invariably distinguishes *Hakiulus* from other genus-group taxa in the Aniulini; the taxon is diagnosed by the presence of one or more of three separate characters.

The eight species of *Hakiulus* demonstrate two basic configurations to the posterior gonopod telopodite. The most common is a distally elongate and broad structure, whose overall shape has been described as a "swan-neck" (Wood 1865); it occurs in *A. (H.) diversifrons,* and to lesser degrees in *A. (H.) causeyae, brachygon,* and *houstonensis*, n. sp. The structure is narrower and shorter in *A. (H.) amophor* Chamberlin, the type species, and *minori* Causey, but I believe all the species are congeneric because the condition in *A. (H.) orthodox* Chamberlin is intermediate in length and bridges the anatomical gap. *Parajulus texanus* Chamberlin, assigned to *Hakiulus* by Chamberlin & Hoffman (1958), does not appear to be congeneric, as suggested by Hoffman (1999); it is transferred out of *Hakiulus* and left unassigned. I also place *Ethojulus cyaneus* Chamberlin in synonymy under *P. texanus* (**syn. nov.**!), following examination of the types of both names..

In the ensuing accounts, species are cited in chronological order, and in the interests of brevity I provide only diagnoses of the critical aspects of the gonopods in the terminology developed by Hoffman (1992). The cyphopods were examined but no differences were found at the species level and they are only illustrated for the nominate subspecies of *A. (H.) diversifrons*. Missing items in the locality citations (specific locality, date of collection, and name of the collector) were not provided on the vial labels and are unknown. Acronyms of sources of preserved study material are as follows:

AMNH – American Museum of Natural History, New York, New York.
FSCA – Florida State Collection of Arthropods, Gainesville.
MCZ – Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.
NCSM – North Carolina State Museum of Natural Sciences, Raleigh.
NMNH – National Museum of Natural History, Washington, DC.
VMNH – Virginia Museum of Natural History, Martinsville.
WTAMU – West Texas A & M University, Canyon, Texas.

TAXONOMY

Aniulus (*Hakiulus*) (Chamberlin), new status

Hakiulus Chamberlin, 1940:10-11. Causey, 1953:153. Chamberlin & Hoffman, 1958:136. Jeekel, 1971:159. Hoffman, 1980:108; 1999:155-156.

TYPE SPECIES. *Hakiulus amophor* Chamberlin, 1940, by original designation.

DIAGNOSIS. A genus of moderate-size Aniulini with ca. 50-55 segments in adults; color pattern showing vague, diffuse, light longitudinal stripe with narrow medial dark line. Sternum of segment 8 relatively short and narrow, slightly overlapping segment 7. Anterior gonopods usually with, occasionally without, glabrous syncoxal lobes; lateral syncoxal process variable, usually relatively narrow and reflexed laterad distad, occasionally curving broadly mediad and not reflexed. Posterior gonopod with variable prefemoral process, a blade-like structure of varying widths extending distad, tip usually overlapping telopodite stem; latter in form of broad general curve or subupright with distal bend around 2/3 length, with or without spiniform process arising from medial surface at level of bend or with lobe or spur distad, distal zone (part of stem distal to bend) usually relatively broad, either subperpendicular to stem or continuing curve of latter, occasionally with subapical tooth, teeth, or lobe. Cyphopods with coxal elements fused, projecting distad beyond synoperculum.

SPECIES. Eight are known, but more probably remain to be described, especially from Texas, the center of diversity.

DISTRIBUTION. The central United States from near the Canadian border in North Dakota and Michigan to the Rio Grande in Texas; east/west, the genus extends from central Ohio and eastern Michigan to southwestern Colorado (Figs. 51-52).

Key to Species of *Aniulus* (*Hakiulus*)
(based on adult males)

1. Anterior gonopods with syncoxal lobes; prefemoral process of posterior gonopod terminating short of ventral margin of telopodite 2
– Anterior gonopods without syncoxal lobes; prefemoral process of posterior gonopod extending beyond ventral margin of telopodite (Figs. 47, 49); Lousiana . . . . . *causeyae*, n. sp.

2. Anterior gonopod lateral syncoxal process reflexed or curved laterad distad (Figs. 2, 7, 11, 16) 3

– Anterior gonopod lateral syncoxal process curving broadly mediad, not reflexed distad (Fig. 43); Texas ..... *brachygon*, n. sp.

3. Distal zone of posterior gonopod telopodite strongly demarcated from stem by approximately a 90° bend (Figs. 3, 8, 12, 17, 22); North Dakota and Michigan to Texas and New Mexico ..... *.diversifrons* (Wood)
– Distal zone continuing general telopodal curvature (Figs. 27, 30, 35, 38) 4

4. Distal zone with basal projection (Figs. 30, 32, 41) 5
– Distal zone with subterminal spur or lobe (Figs. 27, 35, 38) 6

5. Distal zone projection short and blunt (Figs. 41-42); Texas *.houstonensis*, n. sp.
– Distal zone projection long and spiniform (Figs. 30-32); Texas. .....
..... *.orthodox* (Chamberlin)

6. Distal zone projection a distinct triangular spur (Fig. 27); Texas. .....
..... *amophor* (Chamberlin)
– Distal zone projection a poorly defined lobe (Figs. 35, 38) 7

7. Posterior gonopod prefemoral process long and broad, located primarily on dorsal side of telopodite stem (Fig. 35); Texas ..... *minori* (Causey)
– Posterior gonopod prefemoral process short, wholly overlying telopodite stem (Fig. 38); Texas ..... *brevis*, n. sp.

Aniulus (Hakiulus) diversifrons (Wood), new combination

DIAGNOSIS. Anterior gonopods with syncoxal lobes; lateral syncoxal process reflexed laterad distad, dorsodistal margin smooth or variably toothed. Posterior gonopod with variable prefemoral process, either sublinear or bent dorsad distal to midlength, variably expanded distad; telopodite generally sigmoid, with sharp distal bend (at 3/4 length), with or without variably long process arising from medial surface at level of distal bend, distal zone broad and sublinear, variably long, either prolonged beyond level of apical tooth/teeth/lobe or not.

REMARKS. The most widely ranging species in the genus, *H. diversifrons* has one of the largest distributions among all North American diplopods, extending from near the Canadian border to the Rio Grande and, east/west, from central Ohio to the "Four Corners" area of the southwest. There is considerable gonopodal variation in the species, and two localized variants have been assigned names by past authors. Chamberlin (1916) gave the name, *victorianus*, to the form in Victoria County, Texas, that has a reduced process on the posterior gonopod telopodite (Fig. 14); I regard this form as an intergrade and assign the name to the form in this county

without such a projection (Fig. 13). Causey (1952) named the variant in east Texas with a bent posterior gonopod prefemoral process as *texensis*, and I here name the form in southern Missouri with a distally expanded prefemoral process as *expansus*, n. subsp. The western part of the species' range is occupied by a race with teeth on the dorsodistal margin of the anterior gonopod lateral syncoxal process and with a slightly shorter posterior gonopod telopodite, which is not prolonged beyond the level of the apical tooth/teeth/lobe. I think this form has been named three times and that the oldest name is the enigmatic *neomexicanus*, a senior synonym to *zakiwanus* Chamberlin and *occidentalis* Loomis. The rest, and the majority, of the distribution is occupied by the nominate subspecies.

Aniulus (Hakiulus) diversifrons diversifrons (Wood), new status
Figs. 1-5

Iulus sp. Wood, 1864:11;1865:197, fig. 30.
Iulus diversifrons Wood, 1867:43-44.
Julus diversifrons: Preudhomme de Borre, 1884:54.
Parajulus castaneus Bollman, 1887*a*:33; 1887*b*:226.
Parajulus diversifrons: Bollman, 1893:181, 183. Williams & Hefner, 1928:128.
Ethoiulus diversifrons Chamberlin, 1931:98.
Hakiulus diversifrons: Chamberlin, 1940:11. Causey, 1952:201, figs. 4-5; 1953: 153-154. Chamberlin & Hoffman, 1958:136. Snider, 1991:182. Hoffman, 1999:156.
Hakiulus parallelus Chamberlin, 1940:12, pl. 5, figs. 41-43. Causey, 1952:201. Chamberlin & Hoffman, 1958:137.

TYPE SPECIMENS. The original type specimens of *I. diversifrons* are not known to exist; the type locality is south Illinois, and Wood (1867) also commented that the species is "rare in the Western States, but very plenty in Texas." Male neotype and one male and one female neoparatypes (FSCA) collected by J. G. Jacobs on 10 October 1941 at Saybrook, McLean County, Illinois.

Male holotype of *P. castaneus* (NMNH) collected by W. G. Howe on an unknown date at Fort Snelling, Hennepin County, Minnesota.

Male holotype, female allotype, and one male paratype (NMNH) of *H. parallelus* collected by R. D. Bird on 5 April 1929 at an unspecified location in Cleveland County, Oklahoma.

DIAGNOSIS. Anterior gonopod without teeth on dorsodistal margin of lateral syncoxal process. Posterior gonopod with relatively long, sublinear prefemoral process, overlapping telopodite stem, slightly expanded apically, telopodite with long process at level of distal bend, extending well beyond ventral margin of stem, distal zone prolonged beyond level of apical tooth (Figs. 1-5).

DISTRIBUTION. Occurring across much of the central United States, from North Dakota and Michigan to the Rio Grande in central Texas; east/west, it extends from central Ohio to west Texas (Figs. 51-52). The area is approximately 1,310 mi (2,096 km) north/south and 912 mi (1,459 km) east/west. In addition to the neotype, the following specimens were examined:

ARKANSAS: *Izard Co.*, ♂,♀♀, 22 December 1954 (FSCA). *Sebastian Co.*, Greenwood, ♂, 25 September 1950, R. Steuart (FSCA). *Washington Co.*, Fayetteville, ♂, June 1951 (FSCA).

ILLINOIS: *Champaign Co.*, Urbana, 4♂♂,♀, 25 September 1948, H. H. Ross (INHS, NCSM). *McLean Co.*, Normal, 2♀♀ (INHS).

MICHIGAN: *Berrien Co.*, ♂ (FSCA).

MINNESOTA: *Hennepin Co.*, Ft. Snelling, ♂, W. G. Howe (NMNH).

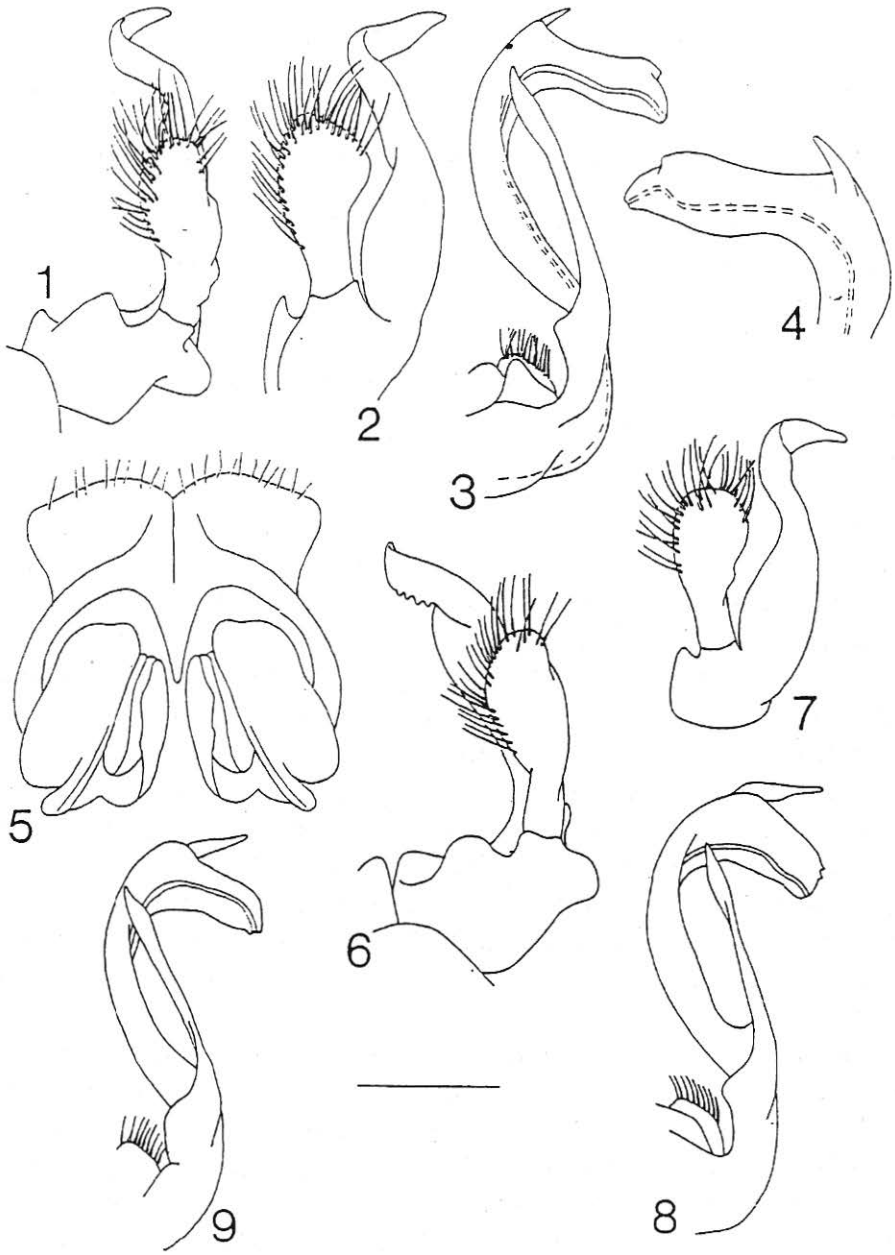
MISSOURI: *Cole Co.*, Jefferson City, ♂,♀, 1 September 1965, W. W. Dowdy (FSCA).

NORTH DAKOTA: *Grand Forks Co.*, Grand Forks, 3♂♂, ♀, 27 September 1949 (INHS); Arvilla, ♂♂, ♀, juv., 24 September 1949 (FSCA); and Turtle River St. Pk., ♀, 24 September 1949 (FSCA) .

OHIO: *Wayne Co.*, ?Wooster, ♂ , 1963, A. A. Weaver (NCSM).

OKLAHOMA: *Canadian Co.*, Yukon,4♂♂ , 12♀♀, 1930 (FSCA). *Cleveland Co.*, 3♂♂, ♀, 5 April 1929, R. D. Bird (NMNH). *Delaware Co.*, Flint, ♀, 26 March 1954, C. Hastings (FSCA). *Hughes Co.*, Calvin, ♂, ♀, 15 February 1953, O. Murray (FSCA). *Logan Co.*, Guthrie,♀♀, 24 October 1961, R. C. Harrel (FSCA). *Murray Co.*, ♂, 3 November 1958, R. C. Harrel (FSCA). *Pittsburg Co.*, 5 mi (8 km) N McAlester, Coal Cr., 4♂♂, 4♀♀, 8 November 1952, O. Murray (FSCA).

TEXAS: *Anderson Co.*, 2 mi (3.2 km) S Elkhart, ♂,♀, 7 April 1958, O. Sanders (FSCA). *Baylor Co.*, Seymour,♂♂, ♀♀, October 1961, A. Kemp (FSCA). *Brown Co.*, Bangs, ♂, 3 November 1973, J. R. Reddell (FSCA). *Cherokee Co.*, ♂♂,♀♀ (FSCA). *Colorado Co.*, Columbus, ♂, 8 December 1961, C. L. Redus (FSCA). *Dallas Co.*, between Duncanville and Cedar Hill, 4♂♂, 3 November 1927, O. F. Cook (FSCA). *Erath Co.*, 7 mi (11.2 km) E Dublin, ♂, ♀, 15 December 1956, O. Sanders (FSCA). *Grayson Co.*, Sherman, ♂♂, 1 December 1967, M. Cundliff (FSCA). *Hamilton Co.*, Hico, ♂♂, ♀ (FSCA). *Hopkins Co.*, 6 mi (9.6 km) W Sulphur Spgs., ♂♂, ♀♀, 2 January 1956, J. E. Sublette (FSCA). *Hunt Co.*, Caddo Mills, 7♂♂, ♀, 23 November 1961, J. C. Johnson (FSCA); and Greenville, 4♂♂, ♀, 3 November 1961, J. C. Johnson (FSCA). *Lavaca Co.*, Hallettsville, ♂, ♀♀, 19 January 1962, ♀♀, 8 March 1962, M. E. Key (FSCA). *Milam Co.*, Milano, 4♂♂, 2♀♀, 31 October 1962, O. D. Brown (FSCA). *Potter Co.*, W. Amarillo, ♂, 9 October 1993, M. Pyeatt (WTAMU). *Randall Co.*, Ceta Cyn., nr. Wayside, ♂, October 1998, W. D. Sissom (WTAMU). *Stonewall Co.*, Old Glory, ♂♂, ♀♀, 8 November 1927, O. F. Cook (FSCA); and 8 mi (12.8 km) SW Aspermont, ♂♂, ♀♀, 25 November 1961, C. Powell (FSCA). *Travis Co.*, Austin, ♂♂, ♀♀, 19 November 1945, R. V. Chamberlin (FSCA). *Val Verde Co.*, Devil's River Bridge W of Del Rio, 3♂♂, 24 December 1947, R. V. Chamberlin (FSCA). *Wilson Co.*, 8 mi (12.8 km) N Floresville, ♂, 21 May 1961 (FSCA).



Figs. 1-9. 1-5, *A. (H.) d. diversifrons*. 1, left anterior gonopod of a male from Cleveland County, Oklahoma, anterior view. 2, the same, lateral view. 3, left posterior gonopod of the same, lateral view. 4, distal extremity of telopodite of the same, medial view. 5, cyphopods *in situ*, caudal view of female from Izard County, Arkansas. 6-8, *A. (H.) diversifrons neomexicanus*. 6, left anterior gonopod of a male from Hudspeth County, Texas, anterior view. 7, the same, lateral view. 8, left posterior gonopod of the same, lateral view. 9, left posterior gonopod of an intergrade male from Garza County, Texas. Scale line = 0.375 mm for figs. 1-3 and 5-9, 0.50 mm for fig. 4.

The following additional literature records are available:

ARKANSAS: *Johnson Co.,* Clarksville; *Sebastian Co.,* Greenwood (Causey 1953). *Washington Co.* (Causey 1952).

MICHIGAN: *Alger, Antrim, Barry, Benzie, Charlevoix, Cheboygan, Clare, Crawford, Delta, Emmet, Grand Traverse, Hillsdale, Ingham, Kalkaska, Lake, Lapeer, Leelanau, Livingston, Manistee, Missaukee, Muskegon, Oakland, Oceana, Osceola, Otsego, Presque Isle, Roscommon, Saint Clair, Washtenaw,* and *Wexford counties* (Snider 1991).

MINNESOTA: *Winona Co.,* Winona (Bollman 1893).

OHIO: *Franklin Co.*, Columbus (Williams & Hefner 1928).

REMARKS. Bollman (1887*a*, *b*) described *Parajulus castaneus* as new twice in identically worded accounts. He later (1893) placed this species in synonymy under "*Parajulus diversifrons*."

Chamberlin & Hoffman (1958) placed *Iulus ellipticus* Bollman (type locality Fort Snelling, Hennepin County, Minnesota) in synonymy under *H. diversifrons,* but Hoffman (1999) questioned this action and placed *I. ellipticus* in the category of Parajulidae of uncertain generic position. The types of *I. ellipticus* are no longer present in the NMNH collection, but those of *P. castaneus* are there, and Bollman (1893) recorded both species from Fort Snelling, now in the suburbs of Minneapolis, and Winona, Winona County, Minnesota. I compared the descriptions[1] of *I. ellipticus* against the type specimens of *P. castaneus* and found agreement in all features except one, the "nearly elliptical" eye patch of *I. ellipticus*, which is subtriangular in *P. castaneus.* An elliptical eye patch is characteristic of the Julidae, of which *Ophyiulus pilosus* (Newport) probably occurs in these urban areas of Minnesota. Synonymy of *I. ellipticus* under *H. diversifrons* on a geographical basis is plausible, but the name could refer to *O. pilosus.* I therefore accept Hoffman's action and leave *I. ellipticus* in the uncertain category until fresh material is collected around Fort Snelling and Winona.

Causey (1953) placed *H. parallelus*, from Cleveland County, Oklahoma, in synonymy under *H. diversifrons.* Chamberlin & Hoffman (1958) revived *H. parallelus* and placed Chamberlin's usage (1931) of *Ethoiulus diversifrons* in synonymy, as it too referred to specimens from this county. Apparently, *E. diversifrons* was the original identification of this sample, and Chamberlin later decided it was a new species and proposed *H. parallelus.* Hoffman (1999) returned *H. parallelus* to the synonymy of *H. diversifrons*, which I confirm from an examination of the types.

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[1] Bollman described both *P. castaneus* and *I. ellipticus* as new species twice. He(1887*a*,*b*) placed the former in *Parajulus* both times and placed the latter in *Parajulus* and *Iulus* (1887*a*, *c*).

Aniulus (Hakiulus) diversifrons neomexicanus (Chamberlin), new combination, new status
Figs. 6-8

Parajulus neomexicanus Chamberlin, 1903:38-40. Hoffman, 1999:170.

Paraiulus zakiwanus Chamberlin, 1910:253-254, pl. 39, figs. 6-7, pl. 40, figs. 1-5. **New Synonymy.**

Hakiulus zakiwanus: Chamberlin, 1940:11. Chamberlin & Hoffman, 1958:137. Hoffman, 1999:157.

Hakiulus neomexicanus: Chamberlin, 1940:11. Chamberlin & Hoffman, 1958:136-137.

Hakiulus occidentalis Loomis, 1975:219-220, figs. 9-11. Hoffman, 1999:157. **New Synonymy.**

TYPE SPECIMENS. The types of *P. neomexicanus* are not known to exist; the original series included two males, one female, and several juveniles. The type locality is Beulah, San Miguel County, New Mexico, which is not on any map available to me, but its postal zip code is the same as that of Sapello (87745), a small town in this county on state highway 3 north of Las Vegas. Chamberlin (1903) stated that Beulah was at an elevation of about 8,000 ft., and there is an apparently isolated mountain, "Cerro de la Cruz" (elevation around 7,868 ft.), north of Sapello off New Mexico highway 94 near Manuelitas, which also has this zip code. Perhaps Beulah is in the vicinity of this mountain, but because of the zip code, it cannnot be far from Sapello. There is a near topotypical female taken at an elevation of 11,000 ft. from between Sapello and the Pecos River, which is about 23 mi (36.8 km) west of Sapello.

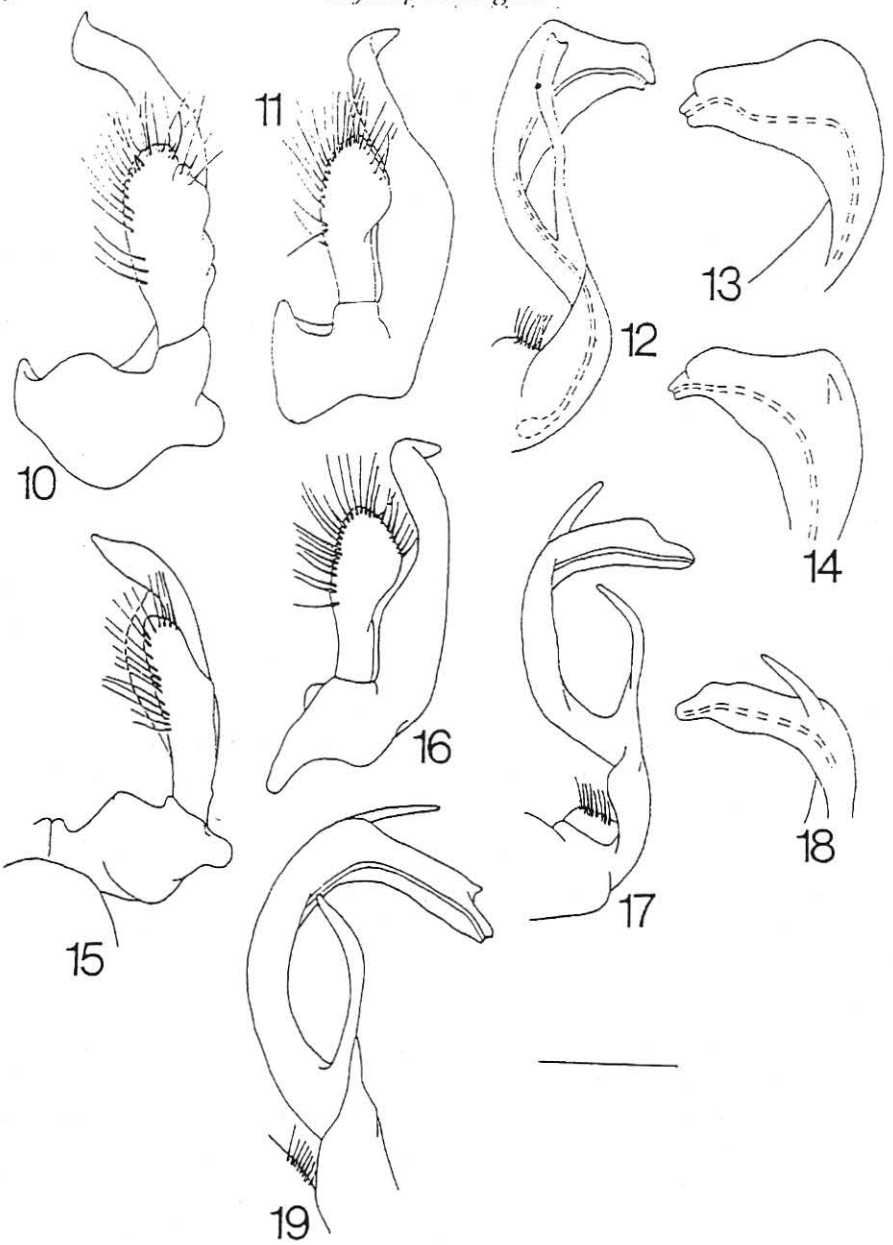
Male neotype of *P. zakiwanus* (FSCA) collected by D. Weems at Cloudcroft, Otero County, New Mexico, in the heart of the Sacramento Mountains.

Male holotype and four female paratypes of *H. occidentalis* (FSCA) collected by J. C. Loomis during April-May 1973 in the Guadalupe Mountains, Hudspeth County, Texas.

DIAGNOSIS. Anterior gonopod with teeth on dorsodistal margin of lateral syncoxal process. Posterior gonopod with relatively long, sublinear prefemoral process, overlapping telopodite stem, slightly expanded apically, telopodite with long process at level of distal bend, extending well beyond ventral margin of stem, distal zone not prolonged beyond apical tooth/teeth, terminating at level of latter (Figs. 6-8).

ECOLOGY. Habitat notations with labels of preserved specimens include "under logs" and in "aspen grove."

DISTRIBUTION. A triangular area covering west Texas, all of New Mexico, and central and southwestern Colorado (Figs. 51-52). In addition to the types, specimens



Figs. 10-19. 10-13, *A. (H.) diversifrons victorianus*. 10, left anterior gonopod of a male from Victoria County, Texas, anterior view. 11, the same, lateral view. 12, left posterior gonopod of the same, lateral view. 13, distal extremity of telopodite of the same, medial view. 14, distal extremity of telopodite of an intergrade male from Victoria County, medial view. 15-18, *A. (H.) diversifrons texensis*. 15, left anterior gonopod of the holotype, anterior view. 16, the same, lateral view. 17, left posterior gonopod of the same, lateral view. 18, distal extremity of telopodite of the same, medial view. 19, left posterior gonopod of an intergrade male from Wood County, Texas, medial view. Scale line = 0.375 mm for figs. 10-12, 15-17, and 19; 0.50 mm for figs. 13-14 and 18.

were examined from the following localities; the initials CSC signify specimens collected by C. S. Crawford:

COLORADO: *Alamosa Co.,* Mosca Pass. Sange de Cristo Mts., 9,400', ♀, 8 July 1952 (FSCA). *Hinsdale Co.,* 30 mi (48 km) E Creeds, along Squaw Cr., ♂, 18 July 1952, H. W. Levi (FSCA). *LaPlata Co.,* 27 mi (43.2 km) N Durango, Columbine Lk., San Juan Mts., ♂, ♀, 23 July 1952, H. W. Levi (FSCA). *San Juan Co.,* 1 mi (1.6 km) S Silverton, ♂, 5♀♀, 11 August 1946, S. & D. Mulaik (FSCA). *Summit Co.,* 1 mi (1.6 km) NE Frisco, ♂, 13 August 1953, O. Sanders (FSCA).

NEW MEXICO: *Bernalillo Co.,* Sandia Mts., locations not specified, ♂, 25 October 1948, C. C. Hoff (FSCA) and 2♂, 2♀, 10 August 1987, CSC (NCSM), and just N of South Peak, ♂, 16 August 1991, CSC (NCSM). *Colfax Co.,* ca. 15 mi (24 km) SW Cimarron, Philmont Scout Ranch, ♂, 3♀♀, 2 juvs., 12-28 August 1962, R. O. Albert (FSCA); Springer, ♂, 25 November 1961, D. I. Kenberry (FSCA); and Chicario Cyn., Raton, ♂♀, T. D. A. Cockerell (FSCA). *Eddy Co.,* surface nr. Hidden Cave, exact location unknown, ♂, 16 February 1992, J. C. Cokendolpher, V. J. Polyak, J. & G. Lee, C. Belski (VMNH). *Lincoln Co.,* Capitan Peak, 7 mi (11.2 km) S trailhead FS 1-58, ca. 4 mi (6.4 km) from jct. FS rd. 130 & NM hwy. 48, ♂,♀♀, 22 July 1992, CSC (NCSM). *Otero Co.,* Cloudcroft, ♂, 25-27 July 1948, G. E. Ball (FSCA) and 3♂♂, 2♀♀, 22 August 1962, H. V. Weems (FSCA). *Rio Arriba Co.,* ca. 13 mi (20.8 km) N Tres Piedras, San Antonio Mt., ♂, 13 August 1992, CSC (NCSM); and Canjilon Mt., ca. 9 mi (14.4 km) NE Canjilon on FS rd. 599, 2 mi (3.2 km) W Upper Canjilon Lake, ♂, ♀, 28 August 1992, CSC (NCSM). *Sandoval Co.,* 19 mi (30.4 km) W Los Alamos, Jemez Mts., off NM hwy. 94, 3♂♂, 2♀♀, 23 August 1991, CSC (NCSM); 17 mi (27.2 km) SE Bernalillo, ♂,♀, 17 August 1946, S. & D. Mulaik (FSCA); and Jemez Mts., 3 mi (4.8 km) W, 0.25 mi (0.4 km) N jct. NM hwy. 4 & FS rd. 280, ♂, 16 August 1990, ♂, Altenbach (NCSM), 0.25 mi (0.4 km) W Las Conchas Peak, ♀, 16 August 1990, ♂, Altenbach (NCSM), and Santa Clara Peak, 5♂♂, ♀, 18 August 1991, CSC (NCSM). *?San Miguel Co.,* between Sapello & Pecos R., 11,000', ♀, 2 August 1900, T. D. A. Cockerell (FSCA). *Santa Fe Co.,* Santa Fe Baldy Mtn., 2♂♂, 2♀♀, 4 August 1991, CSC (NCSM). *Torrance Co.,* 6 mi (9.6 km) W Manzano, ca. 2.5 mi (4.0 km) W Red Canyon Cpgd., ♂,♀, 16 July 1992, CSC (NCSM); and Manzano Mts., Gallow Peak, ♂,♀, 20 October 1990, CSC (NCSM) and Osha Peak, 2M, 29 August 1991, CSC (NCSM).

TEXAS: *Hudspeth Co.,* Guadalupe Mts., ♂,4♀♀, April-May 1973, J. C. Loomis (FSCA). *Potter Co.,* Amarillo, ♂, ♀, 2 April 1971, A. Hamblin (WTAMU); and NE Amarillo, M, 5 October 1995, J. Shriver (WTAMU). *Randall Co.,* Canyon, M, 7 December 1993, Cassagne, Bertrand (NCSM); and Ceta Cyn., ♂, 19 November 1995, A. Loerwald (WTAMU).

REMARKS. The identity of *H. neomexicanus* was deduced by the proximity of the general area of Beulah to sites in northcentral New Mexico from which the illustrated form is available. This form occurs at a high elevation on Santa Fe Baldy Mountain (maximum elevation 11,182 ft.), located just west of San Miguel County in Santa Fe County. It is therefore plausible that the form also occurs around Sapello in San

Miguel County. Chamberlin's description (1903) of the gonopods of *neomexicanus* is largely indecipherable, but he does mention "rather distantly placed teeth along the sides" of the "middle piece". I believe that these teeth are those on the distal portion of the anterior gonopod lateral syncoxal process and that *neomexicanus* is the oldest available name for the western race of *diversifrons*.

The type material of *P. zakiwanus* is also lost but Chamberlin's illustrations of the anterior gonopods (1910, pl. 40, figs. 1-2) clearly show teeth on the distal portion of the anterior gonopod lateral syncoxal process, and teeth are also present in the male from Lincoln County, New Mexico, adjacent to Otero County, which contains the type locality. As the type of *H. occidentalis*, from Hudspeth County, Texas, also exhibits teeth, I believe that *zakiwanus* and *occidentalis* are conspecific and that both names are junior synonyms of *A. (H.) diversifrons neomexicanus*.

Aniulus (Hakiulus) diversifrons victorianus (Chamberlin), new combination, new status
Figs. 10-13

Parajulus victorianus Chamberlin, 1916:35-36.
Hakiulus victorianus: Chamberlin & Hoffman, 1958:137. Hoffman, 1999:157.

TYPE SPECIMEN. Male holotype (MCZ) collected by J. D. Mitchell on an unknown date at Victoria, Victoria County, Texas.

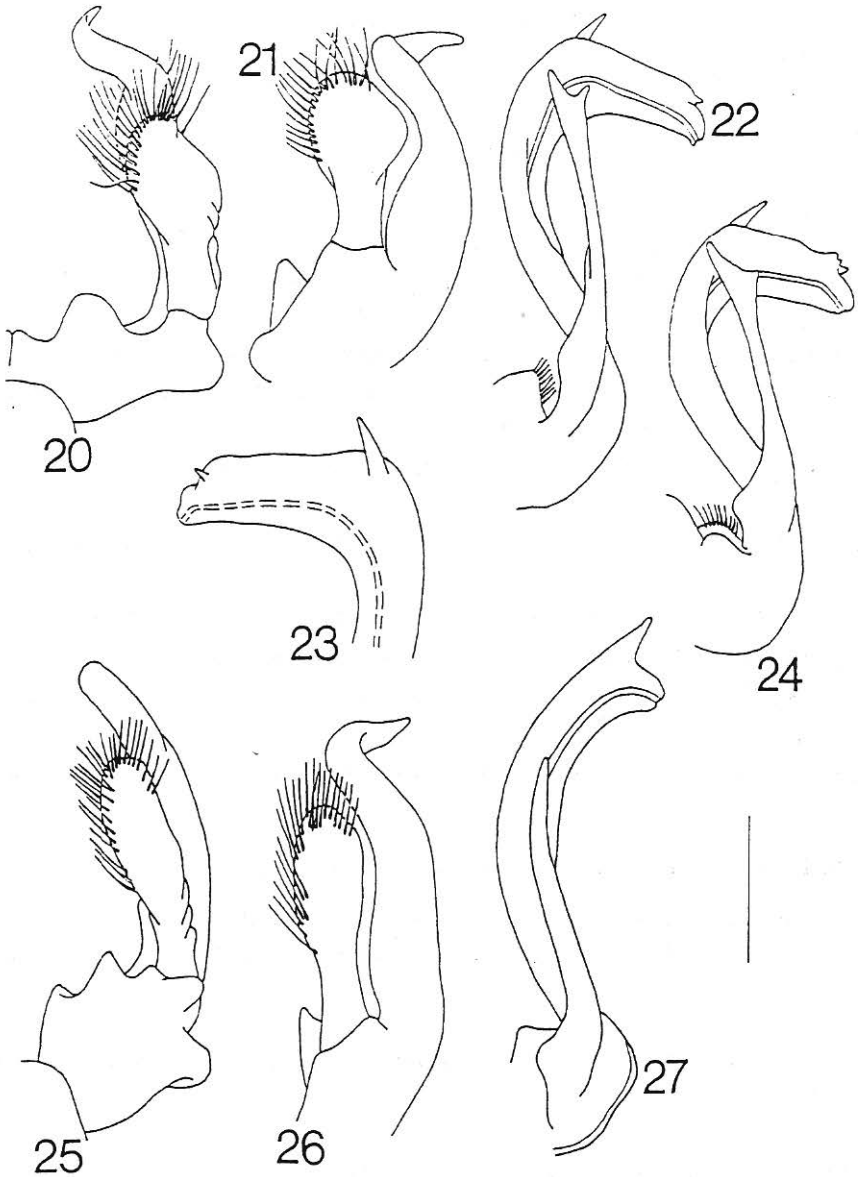
DIAGNOSIS. Anterior gonopod without teeth on distal margin of lateral syncoxal process. Posterior gonopod with relatively long, slightly bisinuate prefemoral process, overlapping telopodite stem, slightly expanded apically, with or without notch at tip; telopodite without process at level of distal bend, distal zone prolonged beyond level of apical tooth/lobe (Figs. 10-13).

ECOLOGY. Specimens from Victoria were encountered among sedge grass roots.

DISTRIBUTION. Known only from two adjacent counties in southeastern Texas (Fig. 52). Specimens were examined as follows:

TEXAS: *Lavaca Co.*, Hallettsville, 2♂♂, ♀, 30 January 1962, 2♂♂, 3♀♀, March 1962, R. E. Key (FSCA). *Victoria Co.*, Victoria, 2♂♂, 4 October 1904, O. F. Cook (FSCA) and ♂, 4♀♀, 5 December 1915, J. D. Mitchell (FSCA).

REMARKS. I assign this name to the localized variant in Victoria that lacks the spur on the distal zone of the posterior gonopod telopodite. The type specimen is actually an intergrade possessing a short spur that does not extend beyond the ventral margin of the telopodite and is invisible in lateral view (Fig. 14).



Figs. 20-27. 20-23, *A. (H.) diversifrons expansus*. 20, left anterior gonopod of the holotype, anterior view. 21, the same, lateral view. 22, left posterior gonopod of the same, lateral view. 23, distal extremity of telopodite of the same, medial view. 24, left posterior gonopod of intergrade male from Oregon County, Missouri, medial view. 25-27, *A. (H.) amophor*. 25, left anterior gonopod of the holotype, anterior view. 26, the same, lateral view. 27, left posterior gonopod of the same, lateral view. Scale line = 0.375 mm for figs. 20-22 and 24-27, 0.50 mm for fig. 23.

Aniulus (Hakiulus) diversifrons texensis (Causey), 1952,
new combination, new status
Fig. 15-18

Hakiulus texensis Causey, 1952:201, figs. 6-7. Chamberlin & Hoffman,1958:137. Stewart, 1969:384. Hoffman, 1999:157.

TYPE SPECIMEN. Male holotype (AMNH) collected by W. Benton on 22 December 1952 at Kilgore, Gregg County, Texas.

DIAGNOSIS. Anterior gonopod without teeth on dorsodistal margin of lateral syncoxal process. Posterior gonopod with relatively short prefemoral process, bent abruptly ventrad distal to midlength, not overlapping telopodite stem, not expanded apically; telopodite with long process at level of distal bend, extending well beyond ventral margin of stem, distal zone prolonged beyond level of apical tooth (Figs. 15-18).

ECOLOGY. Specimens from Nacogdoches were found on the ground under light in a garden, in copula.

DISTRIBUTION. Known from six counties in eastern Texas (Fig. 52). In addition to the type, specimens were examined from the following localities:

TEXAS: *Nacogdoches Co.,* Nacogdoches, 1♂, 1♀, 29 March 1963, W. W. Gibson (FSCA); and W of Nacogdoches on TX hwy. 731 just S of jct. with TX hwy. 21, 2♂♂, 3♀♀, 17 February 1991, K. J. McWest (NCSM). *Panola Co.*, Carthage, 2 ♂♂, 20 March 1962, L. P. Hull (FSCA)..

The following additional literature records are available:

TEXAS (all by Stewart 1969): *Rusk Co.,* 5 mi (8 km) S New Salem. *San Augustine Co.,* 5 mi (8 km) W San Augustine. *Shelby Co.,* 4 mi (6.4 km) SE Paxton. *Smith Co.,* Owentown.

Aniulus (Hakiulus) diversifrons expansus, new subspecies
Figs. 20-23

TYPE SPECIMENS. Male holotype and one male and two female paratypes (FSCA) collected by W. F. Ruston in October 1955 at Alton, Oregon County, Missouri.

DIAGNOSIS. Anterior gonopod without teeth on dorsodistal margin of lateral syncoxal process. Posterior gonopod with relatively long, sublinear prefemoral process, overlapping telopodite stem, expanded apically and often bifurcate; telopodite with long process at level of distal bend, extending well beyond ventral margin of stem, distal zone prolonged beyond level of apical tooth (Figs. 20-23).

DISTRIBUTION. Known only from the type locality (Fig. 51). Other samples from

this site are as follows (see also the following category of intermediate populations):

MISSOURI: *Oregon Co.*, Alton, ♂♂, ♀♀, 3 January 1954 and 26 July 1956, W. F. Rushton (FSCA)..

Aniulus (*Hakiulus*) *diversifrons* intergrades
Figs. 9, 14, 19, 24

Specimens from somewhat intervening counties displaying characters intermediate between those of two races are interpreted as intergrades. Between *A. (H.) d. diversifrons* and *A. (H.) d. neomexicanus* males exhibit fewer and shorter teeth on the anterior gonopod lateral syncoxal process and/or a slightly longer telopodite on the posterior gonopod (Fig. 9). Specimens were examined as follows:

COLORADO: *Larimer Co.*, Fort Collins, M, 15 October 1894 (VMNH).
TEXAS: *Garza Co.*, ♂♂, ♀♀, 8 February 1959 (FSCA).

The intergrade between the nominate subspecies and *A. (H.) d. victorianus* exhibits a reduced spur on the posterior gonopod telopodite (Fig. 14). Locality data are as follows:

TEXAS: *Victoria Co.*, Victoria, 1♂, J. D. Mitchell (MCZ).

The curve on the posterior gonopod prefemoral process of the following males are intermediate between the sublinear projection of the nominate subspecies and the more strongly bent process of *H. d. texensis* (Fig. 19).

TEXAS: *Jasper Co.*, Bouton Lake, 2♂♂, 3♀♀, 16 February 1991, K. J. McWest (NCSM). *Wood Co.*, Alba, ♂, 3 juvs., 7 February 1932, H. C. McNamara (FSCA).

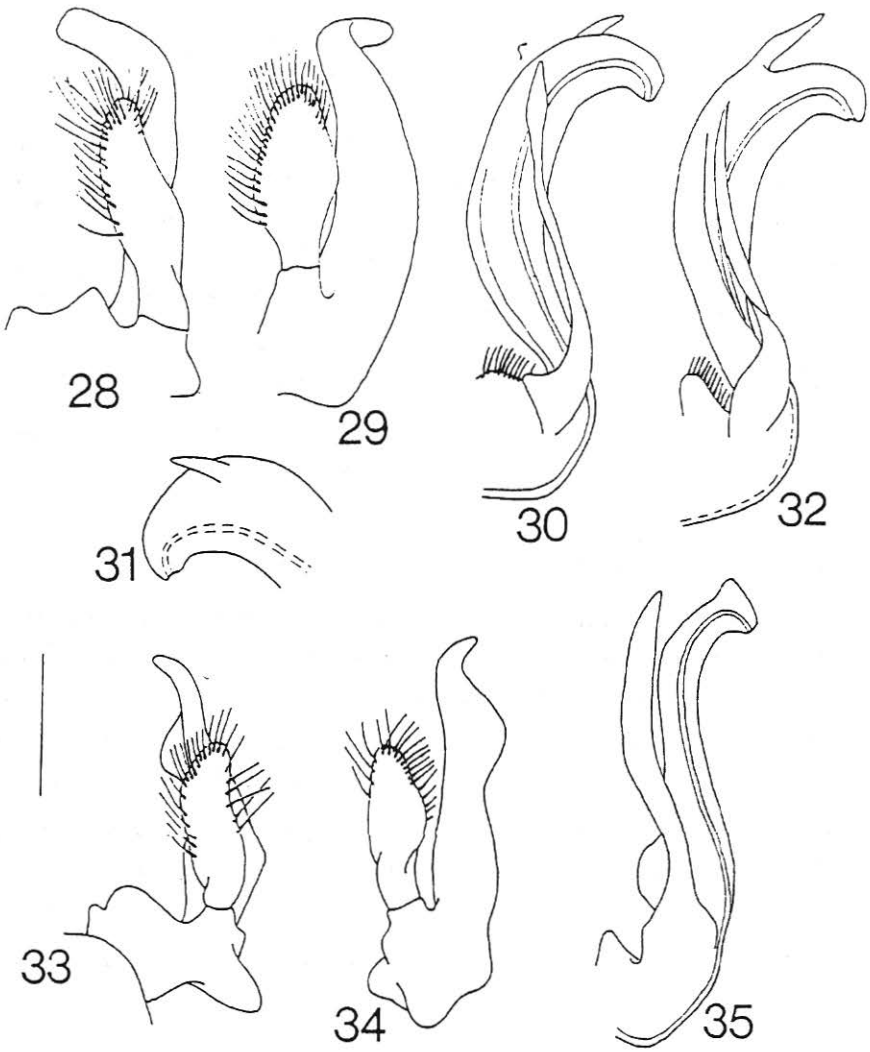
Some specimens from Oregon County, Missouri display an intermediate condition between the forked prefemoral process of *A. (H.) d. expansus* and the nominate subspecies (Fig. 24).

MISSOURI: *Oregon Co.*, Alton, ♂♂,♀♀, 1 March and September-October 1954, W. F. Rushton (FSCA).

Aniulus (Hakiulus) amophor (Chamberlin), new combination
Figs. 25-27

Hakiulus amophor Chamberlin, 1940:11, pl. 5, figs. 36-39. Chamberlin & Hoffman, 1958:136. Hoffman, 1999:156.

TYPE SPECIMENS. Male holotype and one male, 25 female, and two juvenile paratypes (NMNH) collected by S. & D. Mulaik in December 1939 along Turtle Creek, Kerr County, Texas. Two male paratypes (NMNH) taken by same collectors in same month and year south of Three Rivers, Live Oak County, Texas.



Figs. 28-35. 28-32, *A. (H.) orthodox*. 28, left anterior gonopod of the holotype, anterior view. 29, the same, lateral view. 30, left posterior gonopod of the same, lateral view. 31, distal extremity of telopodite of the same, medial view. 32, left posterior gonopod of male from Harris County, Texas, lateral view. 33-35, *A. (H.) minori*. 33, left anterior gonopod of the holotype, anterior view. 34, the same, lateral view. 35, left posterior gonopod of the same, lateral view. Scale line = 0.375 mm for figs. 28-30 and 32-35, 0.50 mm for fig. 31.

DIAGNOSIS. Anterior gonopods with syncoxal lobes; lateral syncoxal process reflexed laterad distad, dorsodistal margin smooth. Posterior gonopod with moderately long, broad, sublinear prefemoral process lying wholly over telopodite stem, tapering throughout length; telopodite in form of smooth, gentle curve, with triangular subterminal spur arising from ventral margin, distal zone short (Figs. 25-27).

ECOLOGY. Habitat information on labels with preserved specimens states "under leaves and logs along bank of San Antonio R." and "under and within oak logs."

DISTRIBUTION. Known from nine counties in southcentral Texas with one record, perhaps representing an allopatric population, in Jasper County, some 260 mi (352 km) northeast of the main area (Fig. 52). In addition to the types, specimens were examined from the following localities:

TEXAS: *Bexar Co.,* Helotes, Helotes Cr., ♂, 15 February 1969, D. C. Morizot (FSCA). *Gonzales Co.,* southern part, ♂, 8♀♀, 2 March 1961, J. F. Quinlan (FSCA); and 5 mi (8 km) S Sample, ♂♂, ♀♀, 25 February 1961, J. F. Quinlan (FSCA). *Guadalupe Co.,* 9 mi (14.4 km) S Seguin, ♂, 8♀♀, 6 April 1961, J. F. Quinlan (FSCA). *Jasper Co.,* Jasper, 3♂♂, ♀, 5 February 1962 (FSCA). *Karnes Co.,* 2 mi (3.2 km) W Falls City, 6♂♂, 3♀♀, 29 October 1961, J. F. Quinlan (FSCA); and 4 mi (6.4 km) SE Poth, 5♂♂, 6♀♀, 22 October 1961, J. F. Quinlan (FSCA). *San Patricio Co.,* Mathis, ♂♂,♀♀, 21 January 1962, R. O. Albert (FSCA); 4 mi (6.4 km) S Mathis on Nueces R., ♂♂, ♀♀, 14 January 1962, R. O. Albert (FSCA); and Sinton, ♂♂, ♀♀, 11 December 1960 (FSCA). *Wharton Co.,* Wharton, 4♂♂, 4♀♀, December 1905, O. F. Cook (FSCA). *Wilson Co.,* ♂, ♀, 1 April 1961 (FSCA).

Aniulus (Hakiulus) orthodox (Chamberlin), new combination
Figs. 28-32

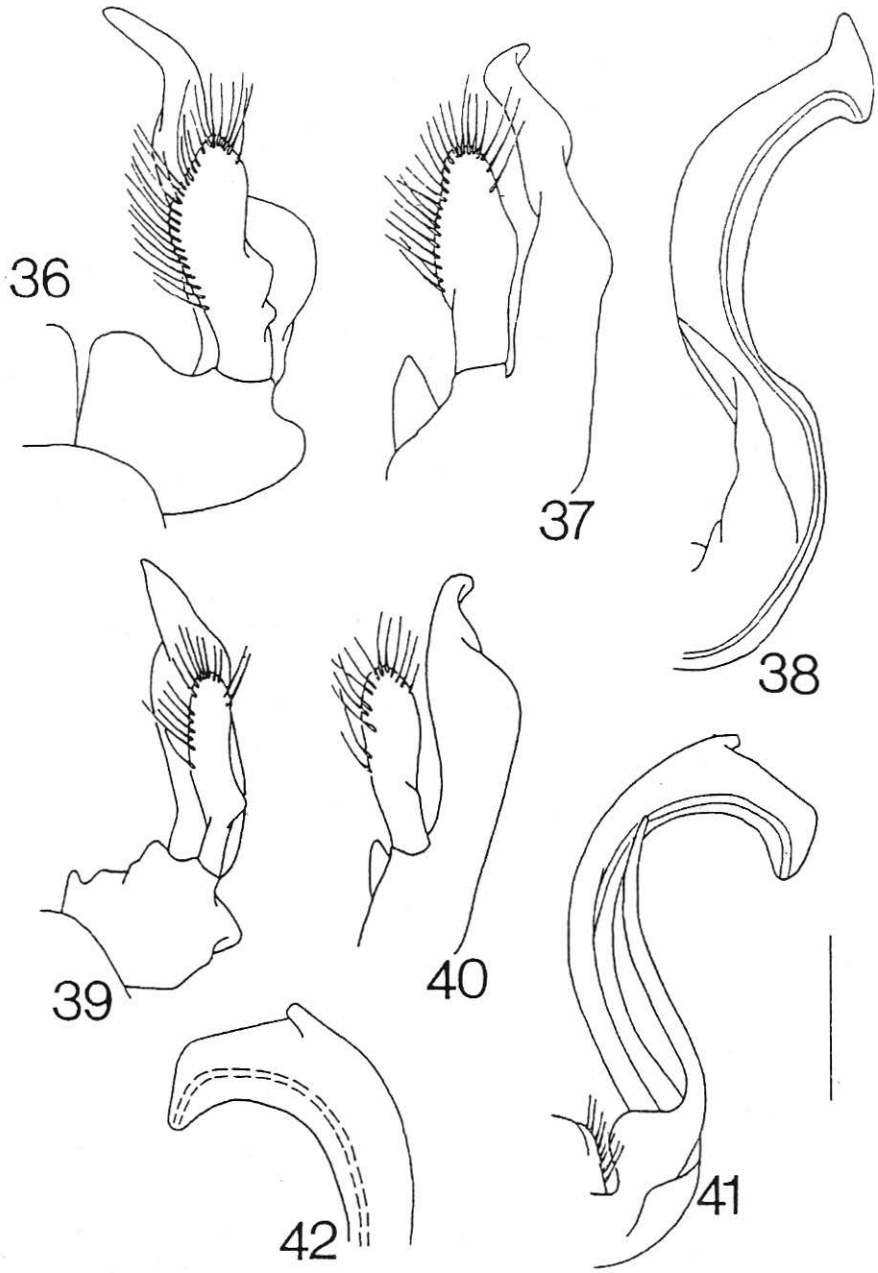
Hakiulus orthodox Chamberlin, 1940:11-12, pl. 5, fig. 40. Chamberlin & Hoffman, 1958:137. Hoffman, 1999:157.

TYPE SPECIMEN. Male holotype and one male paratype (NMNH) taken by an unknown collector on 22 December 1905 at College Station, Brazos County, Texas.

DIAGNOSIS. Anterior gonopods with syncoxal lobes; lateral syncoxal process reflexed laterad distad, dorsodistal margin smooth. Posterior gonopod with moderately long, sublinear prefemoral process, lying primarily over telopodite stem, expanded distad; telopodite in form of smooth, gentle curve, with long process arising from medial surface distad, distal zone moderately long (Figs. 28-32).

DISTRIBUTION. Known from two counties in eastern Texas (Fig. 52). In addition to the types, the following specimens were examined:

TEXAS: *Harris Co.,* La Marque, ♂♂, ♀♀, date unknown, W. A. Benton (FSCA).



Figs. 36-42. 36-38, *A. (H.) brevis*. 36, left anterior gonopod of the holotype, anterior view. 37, the same, lateral view. 38, left posterior gonopod of the same, lateral view. 39-42, *A. (H.) houstonensis*. 39, left anterior gonopod of the holotype, anterior view. 40, the same, lateral view. 41, left posterior gonopod of the same, lateral view. 42, distal extremity of telopodite of the same, medial view. Scale line = 0.375 mm for figs. 36-41, 0.50 mm for fig. 42.

Aniulus (Hakiulus) minori (Causey), new combination
Figs. 33-35

Hakiulus minori Causey, 1952:200-201, figs. 1-3. Chamberlin & Hoffman, 1958: 136. Hoffman, 1999:156.

TYPE SPECIMENS. Male holotype and female paratype (AMNH) and male paratype and female allotype (FSCA) collected by J. Minor on 29 December 1951 at Lufkin, Angelina County, Texas.

DIAGNOSIS. Anterior gonopods with syncoxal lobes; lateral syncoxal process reflexed laterad distad, dorsodistal margin smooth. Posterior gonopod with long, broad, gently curved prefemoral process, located primarily on dorsal side of telopodite stem; latter sublinear for most of length, curved distad, with broad subterminal lobe arising from ventral margin, distal zone short (Figs. 33-35).

DISTRIBUTION. Known from three adjacent counties in eastern Texas (Fig. 52). In addition to the types, specimens were examined from the following localities:

TEXAS: *Nacogdoches Co.*, Nacogdoches, 8♂♂, ♀, January 1931, (FSCA). *Polk Co.*, Corrigan, ♂, 12♀♀, 3 January 1952, N. B. Causey (FSCA).

Aniulus (Hakiulus) brevis, new species
Figs. 36-38

TYPE SPECIMENS. Male holotype and three female paratypes (FSCA) collected by R. Timbrook on 8 February 1962 at Woodville, Tyler County, Texas. Two male and seven female paratypes (FSCA) taken by same collector at same locality on 22 February 1962.

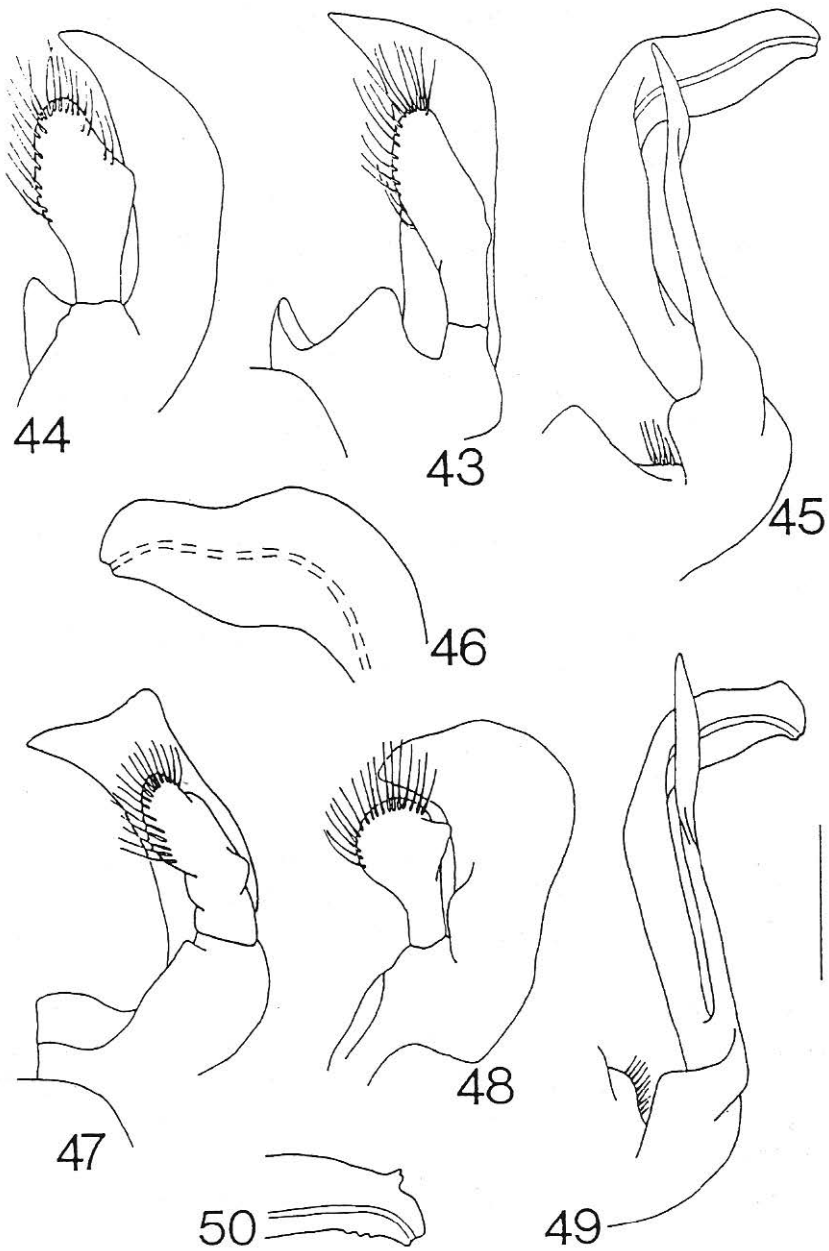
DIAGNOSIS. Anterior gonopods with syncoxal lobes; lateral syncoxal process reflexed laterad distad, dorsodistal margin smooth. Posterior gonopod with short, broad prefemoral process located wholly over telopodite stem; latter in form of slight, gentle curve, with broad subterminal lobe arising from ventral margin, distal zone short (Figs. 36-38).

DISTRIBUTION. Known only from the type locality (Fig. 52).

Aniulus (Hakiulus) houstonensis, new species
Figs. 39-42

TYPE SPECIMENS. Male holotype and one juvenile paratype (FSCA) taken by an unknown collector on 25 December 1929 at Houston, Harris County, Texas.

DIAGNOSIS. Anterior gonopods with syncoxal lobes; lateral syncoxal process reflexed laterad distad, dorsodistal margin smooth. Posterior gonopod with long,



Figs. 43-50. 43-46, *A. (H.) brachygon*. 43, left anterior gonopod of the holotype, anterior view. 44, the same, lateral view. 45, left posterior gonopod of the same, lateral view. 46, distal extremity of telopodite of the same, medial view. 47-50, *A. (H.) causeyae*. 47, left anterior gonopod of the holotype, anterior view. 48, the same, lateral view. 49, left posterior gonopod of the same, lateral view. 50, distal extremity of telopodite of a paratype, medial view. Scale line = 0.375 mm for figs. 43-45 and 47-50, 0.50 mm for fig. 46.

slender, gently curved prefemoral process, overlapping stem of telopodite; latter strongly curved, with short, blunt process arising from medial face near midlength of curve, distal zone relatively long, prolonged and curved dorsad apically (Figs. 39-42)

DISTRIBUTION. Known only from the type locality (Fig. 52).

Aniulus (Hakiulus) brachygon, new species
Figs. 43-46

TYPE SPECIMENS. Male holotype and five male and three female paratypes (FSCA) collected by O. F. Cook, 1 November 1927 at Tyler, Smith County, Texas.

DIAGNOSIS. Anterior gonopods with syncoxal lobes, lateral syncoxal process curving broadly mediad, not reflexed laterad. Posterior gonopod with upright, sublinear prefemoral process, overlapping telopodite stem, expanding slightly distad; telopodite stem generally upright, with abrupt 90° bend at 2/3 length, without distal lobe or process, distal zone very broad and relatively long, generally sublinear but with slight curves of both margins (Figs. 43-46).

DISTRIBUTION. Known only from the type locality (Fig. 52).

Aniulus (Hakiulus) causeyae, new species
Figs. 47-50

TYPE SPECIMENS. Male holotype and one male and seven female paratypes (FSCA) collected by J. D. Moberg, 13 November 1953 at Grand Ecore, Natchitoches Parish, Louisiana. Two male and five female paratypes collected by M. Sublette on 26 October 1954 at same locality. One male, three female, and two juvenile paratypes taken by an unknown collector on an unknown date at the same locality.

DIAGNOSIS. Anterior gonopods without syncoxal lobes; lateral syncoxal process curving broadly mediad, not reflexed laterad distad. Posterior gonopod with very long, upright prefemoral process, extending beyond ventral margin of telopodite stem, expanding slightly distad; telopodite stem generally upright, with abrupt, nearly 90° bend at 2/3 length, distal zone very broad and relatively long, with subterminal lobe or tooth arising from ventral margin (Figs. 47-50).

DISTRIBUTION. Known only from Natchitoches Parish, Louisiana (Fig. 51). In addition to the types, the following sample was examined:

LOUISIANA: *Natchitoches Par.*, Natchitoches, ♂, 3♀♀, 3 December 1953, J. E. & M. E. Sublette (FSCA).

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Fig. 51. Distributions of species of *Aniulus (Hakiulus)* outside of Texas; some symbols represent more than one locality. Dots, *d. diversifrons*; solid squares, *d. neomexicanus*; star, *d. expansus*; x's, *diversifrons* intergrades; open square, *causeyae*.

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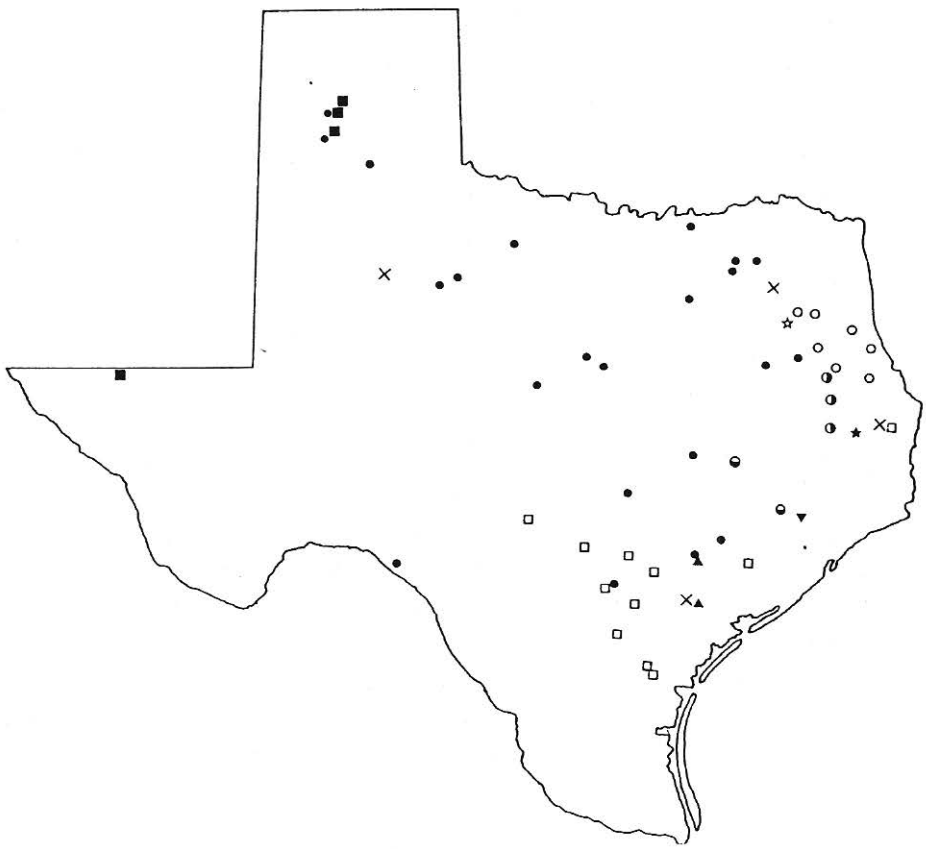

Fig. 52. Distributions of species of *Aniulus (Hakiulus)* in Texas. Dots, *d. diversifrons;* solid squares, *d. neomexicanus*; solid upright triangles, *d. victorianus*; circles, *d. texensis*; x's, *diversifrons* intergrades; open squares, *amophor;* horizontal half-shaded dots, *orthodox*; vertical half-shaded dots, *minori*; solid star, *brevis*; solid inverted triangle, *houstonensis*; open star, *brachygon*.

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Address of the author:

Dr. Rowland M. Shelley
Research Laboratory
North Carolina State Museum of Natural Sciences,
4301 Reedy Creek Rd., Raleigh, NC 27607