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NYMPHS OF THE STONEFLY (PLECOPTERA) GENUS TAENIOPTERYX
OF NORTH AMERICA

THESIS

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

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Fullington, Kate M., Nymphs of the Stonefly (Plecoptera) Genus Taeniopteryx of North America. Master of Science (Biology), May, 1978, 79 pp., 26 illustrations, literature cited, 33 titles.

Nymphs of the 9 Nearctic Taeniopteryx species were reared and studied, 1976-78. Two morphologically allied groupings, the Taeniopteryx burksi-maura, and T. lita-lonicera-starki complexes corresponded with adult complexes. A key separating 7 species, based primarily upon pigment patterns and abdominal setal arrangements, was constructed. Taeniopteryx lita and T. starki were indistinguishable; T. burksi was separated from T. maura when no developing femoral spur was present. This study was based upon 839 nymphs. Mouthparts were not species-diagnostic.

Detailed habitus illustrations were made for 6 species. Egg SEM study revealed that 3 species were 1.2-1.4 mm diameter, with a highly sculptured chorion, generally resembling a Maclura fruit; micropyle were scattered. Taeniopteryx lita, lonicera, starki and ugola nymphs were described for the first time.

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CHAPTER I

INTRODUCTION

Resh and Unzicker (1975) emphasized the importance of specific identification of aquatic organisms in ecological and water quality monitoring studies. This is a perplexing problem, since our current state of knowledge does not allow species-level identification of over half of the immature nymphs or larvae of important aquatic insect orders. For example, only recently have single volume generic-level keys been provided for Nearctic Ephemeroptera (Edmunds et al, 1976) and Trichoptera (Wiggins 1971). No comparable works are available for Plecoptera and Diptera. The situation exists mainly because (1) species descriptions have primarily been based on morphological studies of adults, (2) the small number of persons doing rearing-correlation work has resulted in relatively few new descriptions of immatures, and (3) the morphological homogeneity, and therefore revision difficulty, of some groups (e.g. Chironomidae, Diptera; Isoperlidae, Plecoptera) have required that an inordinate amount of attention be given to the adults.

The problem has brought about a resurgence of interest in rearing-correlation studies to enable descriptions, and development of keys, to eggs and nymphs or larvae. To be

of greatest value, such descriptions and keys should be based on inclusive studies of a given stream system, geographical area or major taxonomic category such as the genus or family. Ideally, such studies should be done for genera or families of at least a major zoogeographical region. It is difficult and often impossible to gain a species-level identification of field-sampled individuals when only isolated species descriptions of immatures for a portion of a taxon are available.

Correlations of immatures and adults are usually made in the following ways: (1) rearing from eggs to adults, or pre-emergent nymphs or larvae reared to adults; correlation in this case is certain or ab ovo, (2) immatures are collected from the same stream or habitat as adults; possibility of error arises here and correlation is only ex societate imago, unless intensive study establishes that adults of only one species in the genus exists there, (3) immatures display diagnostic, developing genitalia or other characters in late instars.

The catalogs of Illies (1966), Zwick (1973) and the review by Baumann (1976) indicate that only 40% (203) of the approximately 503 Nearctic Plecoptera species are known as nymphs. To date, no complete key to all nymphs of any genus or family, with moderate or large numbers of species, has been provided. Nymphal descriptions from the early classic

of Claassen (1931), encompassing only 68 species, are of little practical use for modern identification purposes. Nymphal study has not kept pace with new developments and revisions in Plecoptera systematics over the past 45 years. Ricker (1959) explained why so few nymphs at that time could be identified to species: "the principal difficulty in preparing a key to nymphs is that they often show no trace of important structural differences that distinguish adults." For this reason, alternative characters such as mouthpart morphology, setal patterns, characters of the cerci and other appendages, and developing genitalic characters such as the epiproct, clefts in the male abdominal terga etc., must be comparatively studied as was done by Hynes (1941) for British Plecoptera larvae. Pigment patterns and color may also be of great value if extensively analyzed for specificity and potential geographic variation. Good isolated nymphal descriptions were provided in the early works of Frison (1929, 1935), Harden and Mickel (1952) and more recently by Harper and Hynes (1971), using such characters.

The present study was designed to provide species descriptions and a key for all male nymphs of an entire workable-sized, relatively difficult (morphologically homogeneous) stonefly genus from the Nearctic region, based on morphological study of reared-correlated material. The genus

Taeniopteryx was selected for a number of reasons: (1) the genus has recently undergone revision of adults (Ricker and Ross 1968), (2) the genus is of workable size; Ricker and Ross (1968) included eight species and Stewart and Szczytko (1974) described the ninth, T. starki, from Texas, (3) seven of the nine species (burksi, lita, lonicera, maura, metequi, starki, and parvula) are available from Texas and adjacent states (Stewart et al. 1974); thus facilitating field collections and rearing, and (4) the species are relatively poorly known in the egg and nymph stages.

A secondary objective was to characterize eggs of the genus, since no detailed morphological descriptions of Taeniopteryx eggs have been reported. Frison (1935) described egg laying habits and number of eggs/mass of T. burksi.

Five Taeniopteryx nymphs, burksi, maura, metequi, nivalis, and parvula, have been partially described at one time or another (Claassen 1931, Frison 1925, 1939, Harper and Hynes, 1971). Harper and Hynes (1971) separated male nymphs of these five species in eastern Canada by differences in color pattern, cercal and antennal length, and arrangement of setae on the eighth abdominal tergum.

CHAPTER II

MATERIALS AND METHODS

Extensive collecting trips were made in the winter of 1976 to east and central Texas, and in the winter of 1977 to eastern Oklahoma, western Arkansas, and Tennessee. Nymphs were collected from submerged leaf packs and with a kick net in riffles, and around debris in pools of streams. Adults were taken by actively searching among rocks and debris along stream margins, and by knocking them onto the water surface from overhanging vegetation using the wooden handle of a kick net. Forty-eight localities were collected, including many of those listed by Ricker and Ross (1968).

Nymphs

Study material consisted of field collected nymphs, those in the North Texas State University Aquatic Insect Museum, specimens borrowed from other museums and universities, and personal collections. Specimens were loaned by J. Unzicker (Illinois Natural History Survey), and R. Baumann (Brigham Young University) and R. Surdick-Pifer (University of Utah) during personal visits by Dr. K. W. Stewart, and by O. Flint, Jr. (Smithsonian Institution), P. Harper (University of Montreal), D. Huggins (Kansas Biological Survey),

W. Inns (University of Missouri), R. Kirchner, Barboursville, West Virginia, B. Stark (Mississippi College), D. Tarter (Marshall University), V. Tolbert (University of Tennessee, Knoxville), H. Burke (Texas A & M University) and S. Szczytko (North Texas State University).

Nymphs were correlated with adults in one or both of the following ways:

(1) Abdomens of preserved, black wingpad nymphs were severed from the rest of the body at segment four or five. Terminalia were placed in 10% KOH and heated slowly to soften tissue; sufficient softening usually took place by the time the solution began swirling and before boiling. Developing genitalia were then removed with a forceps via the severed end of the abdomen. Comparisons of epiprocts, paraprocts or other diagnostic characters could then be made with those of adult paratypes. The vesicle, on Ab₉ sternum of males of some species could often be seen under the nymphal exuvium or after removal of the developing terminalia. This technique is quite valuable in making nymph-adult associations in some Plecoptera (B. Stark, personal correspondence), and is becoming referred to as "taking the pants off the nymph."

(2) Nymph-exuvia-adult correlations were made by rearing mature nymphs collected just prior to emergence. "Six-pack" styrofoam drink containers were used as rearing chambers. They have six cylindrical compartments about 8 cm in diameter and 11 cm in length. An inverted six ounce styrofoam

cup fits tightly into each compartment making an effective rearing chamber. Six different groups of nymphs per container could be reared while collecting in the field.

These methods enabled naming of male nymphs of all species. Detailed morphological studies of pigment patterns, mouthparts, setal arrangements, appendages, genitalia and other characters were then made. Mouthparts of nymphs and exuvia were mounted in Turtox CMC and drawn at 250X while viewed under a Zeiss compound light microscope. Drawings of whole nymphs were made from preserved specimens using a Wild Camera Lucida mounted on the Wild M-5 Stereomicroscope. An attempt was made to correlate late instar female nymphs by association with males and characters of the developing subgenital plate.

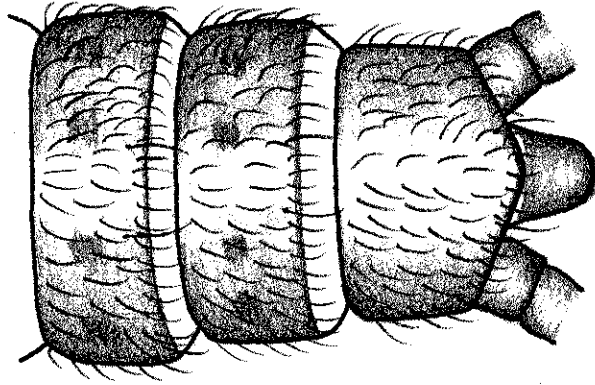
Eggs

Eggs of T. burksi, T. lita, and T. nivalis were dissected from preserved gravid females, then prepared according to methods of Watters and Buck (1971). Eggs were gold-coated with a Film-Vac EMS-41 Mini-Coater, then photographed using an International Scientific Instruments Mini-SEM 1S1 Scanning Electron Microscope.

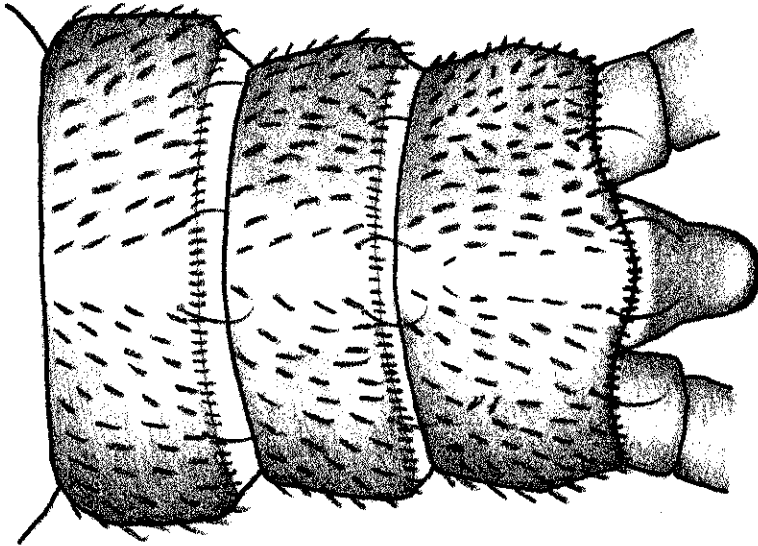
Fig. 1. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx ugola nymph.

Fig. 2. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx nivalis nymph.

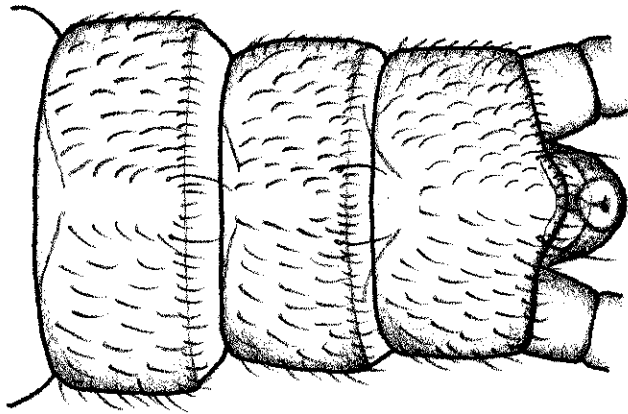
Fig. 3. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx parvula nymph.



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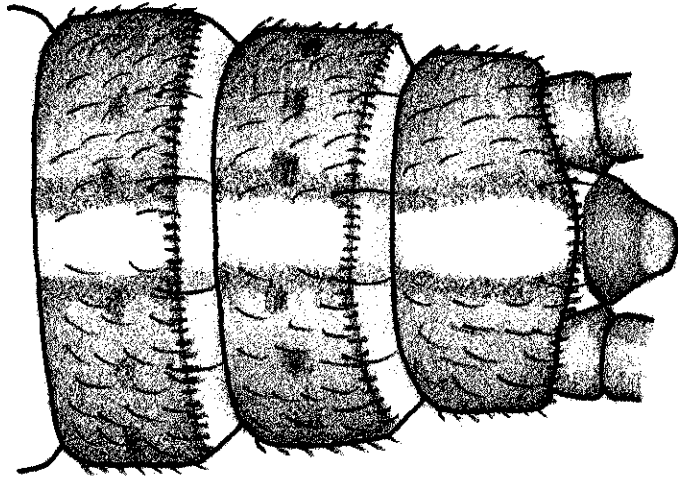


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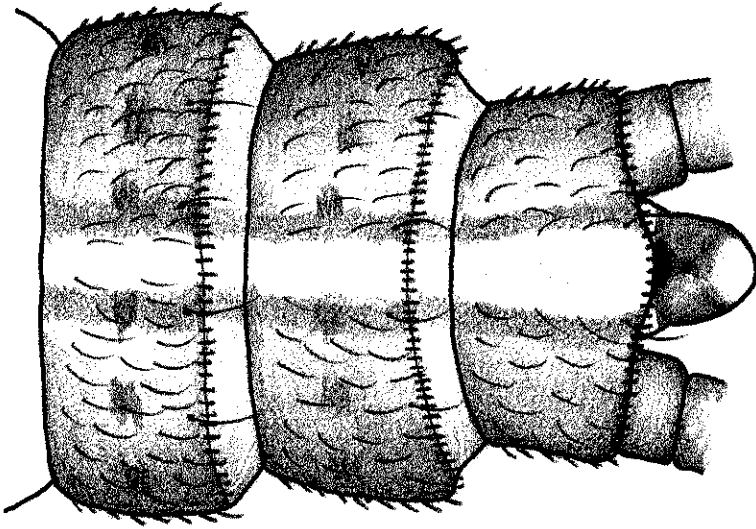
Fig. 4. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx burksi nymph.

Fig. 5. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx maura nymph.

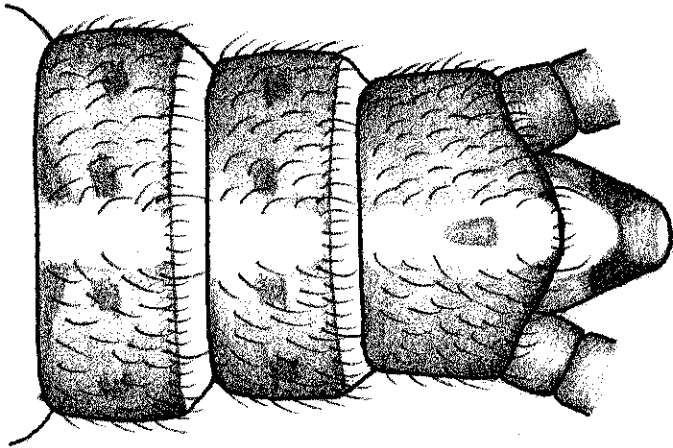
Fig. 6. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx metequi nymph.



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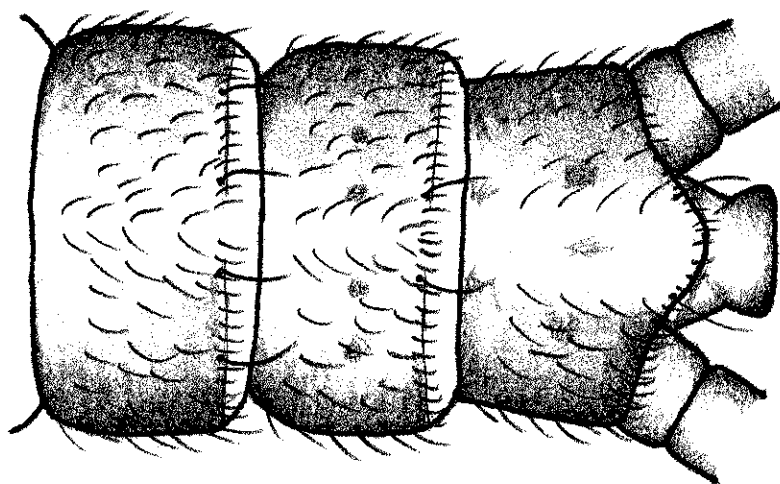


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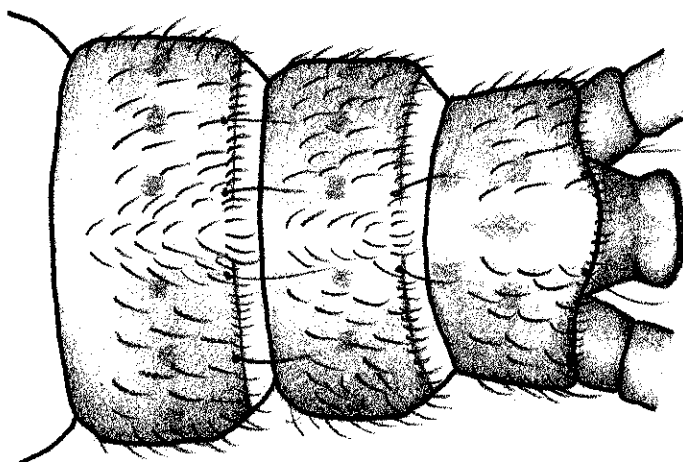
Fig. 7. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx starki nymph.

Fig. 8. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx lita nymph.

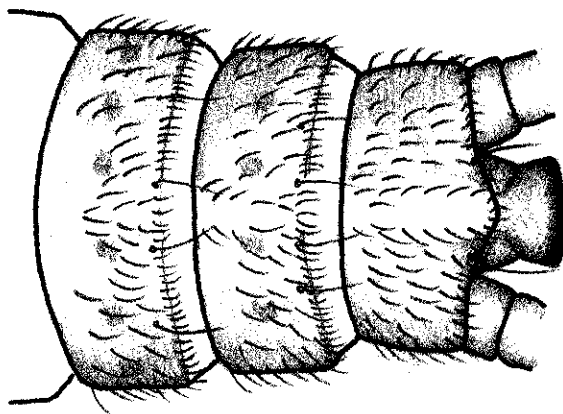
Fig. 9. Dorsal abdominal setal pattern and developing epiproct of mature male Taeniopteryx lonicera nymph.



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CHAPTER III

RESULTS

Genus Taeniopteryx Pictet 1841

Adults of the genus bear a membranous circular area on each coxa, a remnant of nymphal coxal gills. All males have single segmented cerci, paraprocts concealed beneath the ninth sternum, and there may or may not be a vesicle present on the ninth sternum. The female subgenital plate is much reduced, and there are usually two membranous lobes behind the subgenital plate.

Both nymphs and adults have the first and second tarsal segments approximately equal in length. The nymphs possess a three segmented coxal gill which is telescopic.

Type of genus: Phryganea nebulosa Linnaeus

Key to Mature Male North American Taeniopteryx Nymphs
(Distinguished from females by presence of developing epiproct)

1. a. Thorax and abdomen without middorsal stripe
(Fig. 15) 2
- b. Thorax and abdomen with at least partial,
 yellow middorsal stripe 3
2. (1) a. Pronotum margined with yellow; dark mottlings
 on occiput; legs concolorous (Fig. 15);
 abdominal terga with long, curved setae and
 occasional fine hairs, and developing epiproct
 triangular when viewed dorsally, terminating
 in a bulbous knob (Fig. 3)
 Taeniopteryx parvula p. 42

- b. Only lateral edges of pronotum light-margined; occiput without dark mottlings or if present they are indistinct; apex of femora yellow (Fig. 14); abdominal terga with short, blunt bristles and occasional long hairs; developing epiproct triangular when viewed dorsally, with no terminal bulbous knob (Fig. 2)
 Taeniopteryx nivalis p. 37

- 3. (1) a. Conspicuous, yellow, middorsal stripe extending length of thorax and abdomen, sometimes onto head capsule 4
- b. Middorsal stripe faint on abdomen, sometimes incomplete on pronotum, and consisting of only light middorsal patches on posterior meso- and metanota; distinct, broad V-shaped yellow patch between eyes, narrowed posteriorly into fine yellow middorsal line (Fig. 16); very long, curved setae and occasional fine hairs on abdominal terga (Fig. 3). Taeniopteryx ugola p. 46

- 4. (3) a. Middorsal stripe extending onto head capsule as yellow area between eyes 5
- b. No yellow area between eyes; faint mottlings sometimes present on occiput, but it is usually dark, concolorous; abdominal terga with faint, yellow spots
 Taeniopteryx nivalis p. 37

- 5. (4) a. Fronto-clypeal area almost entirely dark; broad yellow ring around each eye; occiput with a wide, light middorsal band, interspersed with irregular mottlings; apex of femur, most of tibia and first two tarsal segments yellow (Fig. 13); abdominal terga with long, curved setae and an occasional long hair; developing epiproct triangular when viewed dorsally (Fig. 6)
 Taeniopteryx metequi p. 33
- b. Fronto-clypeal area mostly light, with pair of black, triangular or rectangular spots near inner anterior corner of eyes; yellow ring around eyes, if present, narrow; leopard-like mottlings across light or dark occiput 6

6. (5) a. Narrow, light middorsal stripe bordered by dark brown, extending forward on head to between compound eyes (Fig. 10); abdominal terga with slender bristles, those on the posterior margins short and blunt, with an occasional long hair; developing epiproct triangular when viewed dorsally, terminating in a knob (Fig. 4, 5) 7
- b. Middorsal stripe not bordered by dark brown, extending onto head capsule as thin stripe that bulges to a rectangular-shaped area between compound eyes; fronto-clypeal area largely light with two dark rectangular bars just in front of eyes (Fig. 11); abdominal terga with long, curved setae and an occasional long hair; developing epiproct appearing rectangular when viewed dorsally (Figs. 7, 8, 9) 8
7. (6) a. Inner margin of hind femur with developing femoral spur of the adult
. Taeniopteryx burksi or maura
- b. Developing femoral spur absent
. Taeniopteryx burksi
8. (6) a. Small, less than 7.6 mm; with developing twisted cerci sometimes visible through exuvium Taeniopteryx lonicera
- b. Larger, less than 8.0 - 9.5 mm; developing cerci not twisted
. Taeniopteryx lita and T. starki

Species Accounts

Taeniopteryx burksi Ricker and Ross

Taeniopteryx burksi Ricker and Ross, 1968:1425.

Type locality: Urbana, Champaign Co., Illinois (INHS).

New distribution records: Adults - IOWA, Storey Co.; MARYLAND, Washington Co., Licking Creek and C. + O. Canal; MISSOURI, Ripley Co., Little Black River; OHIO, Warren Co., Todd's Fork; OKLAHOMA, Choctaw Co., Clear Creek; PENNSYLVANIA, Mercer Co.; QUEBEC, Rawdon; TEXAS, Smith - Van Zandt Co. line, Neches River; VIRGINIA, Page Co., Dry Run; Rappahannock Co., Thornton River; WEST VIRGINIA, Webster Co., Williams River; WISCONSIN, Florence Co., Woods Creek.

Nymphs - INDIANA, Parke Co., Sugar Creek; MINNESOTA, Fillmore Co., Root River; MISSISSIPPI, Itawamba Co., Tombigbee River: Lauderdale Co., Small Creek at Hwy. 80; Marshall Co., Tippah River: Simpson Co., D'Lu Hwy. 49; QUEBEC, Duhamel; TENNESSEE, Cocke Co: Robertson Co., T. to Red River; TEXAS, Smith-Van Zandt Co. line, Neches River; WISCONSIN, Florence Co., Popple River: Forest Co., Pine River.

Nymphal Material Examined: Total number of specimens examined - 613; 1♂, ILLINOIS; 6♀, 1♂, INDIANA; 2♀, 1♂, KANSAS; 11♀, 8♂, MISSISSIPPI; 11♀ (1 reared), 1♂,

MISSOURI; 18♀, 10♂, NORTH CAROLINA; 208♀, 102♂, OHIO; 34♀ (11 reared), 10♂ (5 reared), OKLAHOMA; 1♂, PENNSYLVANIA; 1♀, 3♂, QUEBEC; 15♀ (4 reared), 9♂, TENNESSEE; 67♀ (10 reared), 23♂ (6 reared), TEXAS; 41♀ (2 reared), 9♂ (2 reared) VIRGINIA; 11♀, 2♂, WEST VIRGINIA; 3♀, 4♂ WISCONSIN.

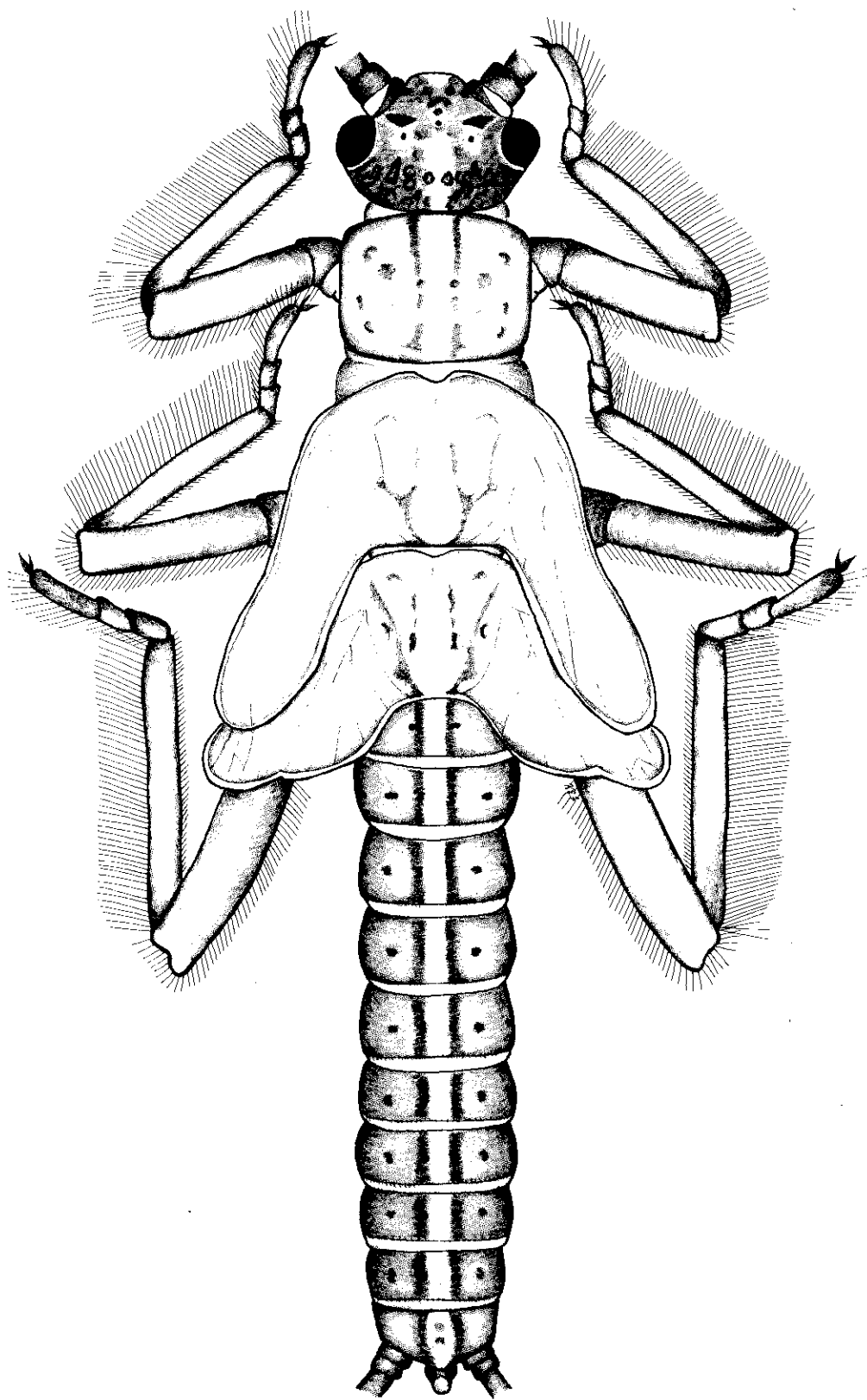
Description of Mature Male Nymphs: General color medium brown with prominent middorsal stripe bordered by dark. Venter light brown. Total length 8.7 - 9.5 mm. (Fig. 10).

Head with darker mottlings extending from back of compound eyes to posterior head margin. Frons with yellow anterior margin. Middorsal stripe extends onto head capsule as narrow yellow line that bulges to circular patch occupying central area of head. Three ocelli on yellow background; compound eyes bordered by thin yellow rings. Antennae almost as long as body; first quarter brown, remainder yellow. Mouthparts light.

Pronotum with yellow middorsal stripe bordered by dark. Meso- and meta- nota with yellow middorsal stripe bordered by dark and expanding posteriorly. Dark markings evident on all thoracic segments. Wingpads light brown. Apex of each femur yellow.

Abdomen with distinct light middorsal stripe bordered by dark bands; dark mottlings on either side of middorsal line. Terga with slender bristles; posterior margin with

Fig. 10. Mature male Taeniopteryx burksi nymph.



short blunt setae and an occasional long hair (Fig. 4). Cerci half as long as body; proximal third dark, remainder yellow. Epiproct broad at base and tapering at tip to form a knob (Fig. 4). Developing vesicle sometimes visible on ♂Ab₉ sternum, through nymphal cuticle.

Description of Mature Female Nymphs: Females exhibit generally similar setation and pigment patterns as males. Total length 10.0 - 12.0 mm. At this time I do not consider the developing subgenital plate to be a useful character.

Analysis of Nymphs:

Members of the Taeniopteryx burksi-maura complex have similar pigmentation and setation patterns. Taeniopteryx burksi can sometimes be distinguished when mature nymphs display no underlying, developing femoral spurs. The two species are readily separated from the other seven by the dark-bordered middorsal stripe and by combinations of pigmentation patterns, abdominal setation and shape of the developing epiproct.

Eggs: Eggs studied and photographed using a SEM were taken from gravid females from the Smith-Van Zandt Co. line, Texas (Fig. 17a). The chorion is highly sculptured with numerous tubular, raised ridges scattered over the surface. The egg generally resembles a "horse apple" (fruit of

Maclura pomifera, Osage Orange). There are numerous micropyles randomly spaced over the surface (Fig. 17a). The egg is round and apparently 1.2 mm. in diameter.

Taeniopteryx lita Frison

Taeniopteryx parvula, Frison, 1929:383, not Banks 1918.

Taeniopteryx lita, Frison, 1942:249-250.

Type locality: Elizabethtown, Illinois. Type deposited at INHS.

New distribution records: Adults - TEXAS, Gregg Co., Sabine River: Rusk Co., Angelina River.

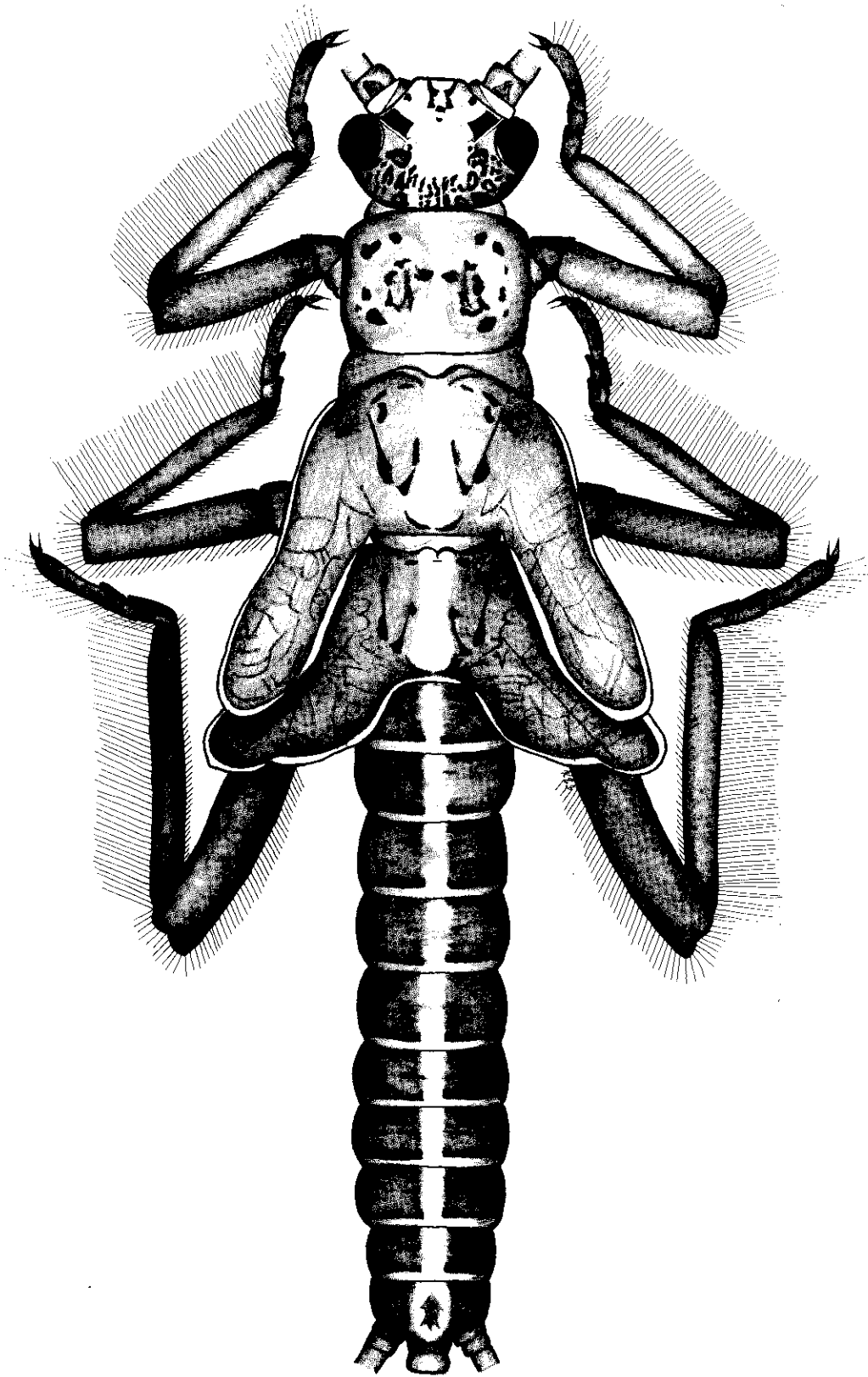
Nymphs - MISSISSIPPI, Itawamba Co., Tombigbee River; TEXAS, Gregg Co., Sabine River: Rusk Co., Angelina River.

Nymphal Material Examined: Total number of specimens examined - 23; 5 ♀, ILLINOIS; 2 ♂, 2 ♀, MISSISSIPPI; 3 ♂ (1 reared), 11 ♀ (3 reared), TEXAS.

Description of Mature Male Nymphs: General color medium brown with prominent middorsal stripe. Venter light brown. Total length 8.0 - 9.5 mm (Fig. 11).

Head with darker mottlings extending from bottom of compound eyes to posterior head margin occupying 1/3 of head. Frons with yellow anterior margin bordered by dark "horseshoe-shaped" patch. Dark rectangular spots at inner,

Fig. 11. Mature male Taeniopteryx lita nymph.



anterior corner of each eye. Large rectangular light patch occupying middle portion of head. Three ocelli bordered by yellow; compound eyes bordered by thin dark rings. Antennae three-fourths as long as body; first third brown, remainder yellow. Mouthparts light.

Pronotum with light posterior and anterior margins; prominent middorsal yellow stripe that flairs at posterior margin. Meso- and meta-nota with yellow middorsal stripe that expands posteriorly. Dark mottlings occupy all thoracic segments. Wingpads light brown. Legs yellow.

Abdomen with distinct light middorsal stripe; dark mottlings on either side of middorsal line. Tergites with long, curved bristles; posterior margin with long, curved setae and an occasional long hair (Fig. 8). Cerci one-half as long as body; proximal 11 - 12 segments dark, remainder yellow. Epiproct broad at base and tip (Fig. 8). Male nymphs possess no developing vesicle on Ab9 sternum.

Description of Mature Female Nymphs: Females exhibit generally similar setation and pigment patterns. Total length 8.3 - 10.2 mm. As in other species, the developing subgenital plate cannot be considered diagnostic.

Analysis of nymphs:

The Taeniopteryx lita-lonicera-starki nymph complex have similar pigmentation and abdominal setation patterns.

T. lita and T. starki males and females are 8.0 - 9.5 mm and 8.3 - 10.2 mm body length, respectively (front of head to tip of abdomen); T. lonicera males and females average approximately 2.0 mm less in length, and sometimes display the typical "twisted" developing cerci. Middorsal stripes of these species are not distinctly bordered with dark pigment.

Egg: Eggs were taken from females collected in the Sabine River, Gregg Co., Texas, and photographed with SEM (Fig. 17b). As in T. burksi eggs, the chorion is delicately sculptured with characteristic ridges scattered over the surface. Micropyles are not arranged in any particular pattern, but are large and numerous. The egg is almost round and approximately 1.4 mm. in diameter.

Taeniopteryx lonicera Ricker and Ross

Taeniopteryx lonicera Ricker and Ross, 1968:1427.

Type locality: Laurel Fork, south of Blountsville, Alabama.
Deposited at INHS.

New distribution records: Adults - NEW JERSEY, Ocean Co., Manasquar River.

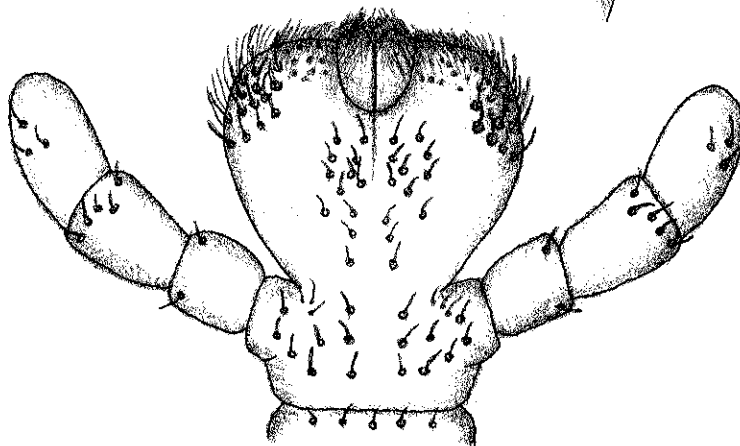
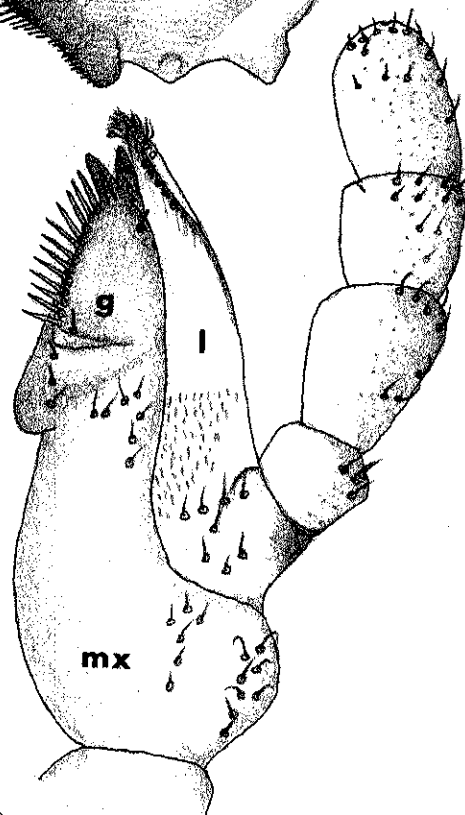
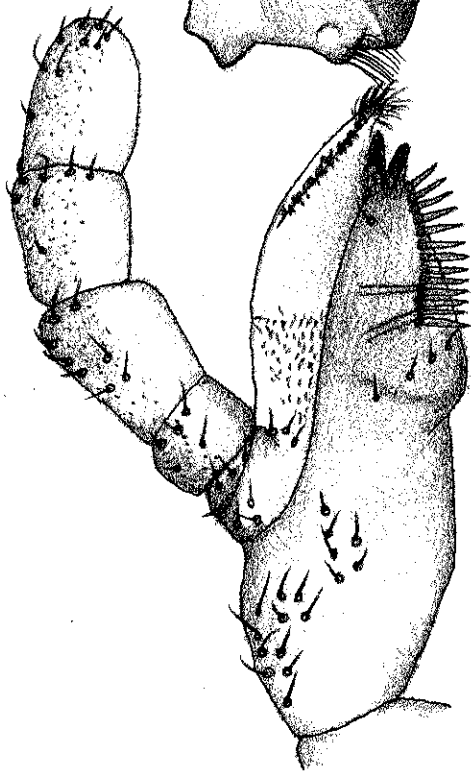
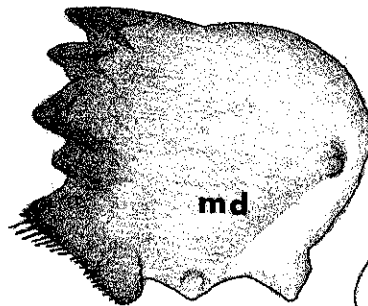
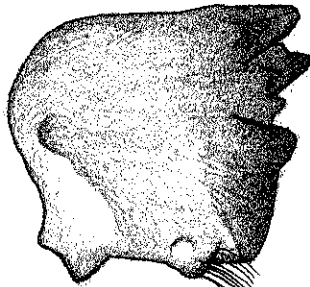
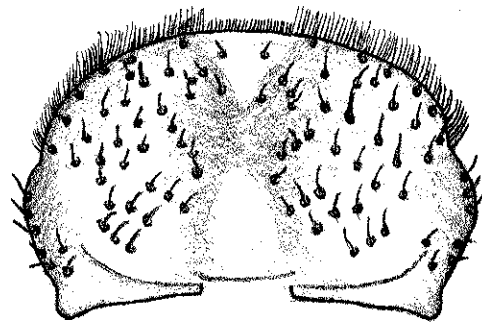
Nymphs - MISSISSIPPI, Lauderdale Co., Tallshatta Creek; Newton Co., Chunky River; Pike Co., Tangepahoa River; NEW JERSEY, Ocean Co., Manasquar River.

Nymphal Material Examined: Total number of specimens examined - 36; 6♂ (2 reared), 9♀ (2 reared), MISSISSIPPI; 8♂, 11♀, NEW JERSEY, 1♂ (1 reared), 1♀ (1 reared), TEXAS.

Description and Analysis of Mature Male and Female Nymphs: Same as lita and starki, except approximately 2 mm. shorter. Developing vesicle absent on Ab₉ sternum.

Frison (1929) illustrated and described the mouthparts of a mature male Taeniopteryx burksi nymph. Mouthparts of all 9 species I examined were morphologically similar to Frison's illustrations and the T. lonicera ♂ nymph mouthparts in Fig. 12. Basically, the labrum is a flattened, setaceous plate. The mandibles are heavily sclerotized, with four large teeth on the right mandible and five pronounced teeth on the left mandible; beneath toothed areas, there is a well-developed hair-fringed molar area on each mandible. The maxillae have five segmented palpi; the lacinia usually has 2-3 prominent apical teeth, three sub-apical teeth and 11-13 stiff spines on the inner side (the number of apical teeth and spines is highly variable). The galea extends slightly beyond the lacinia and tapers to a pointed apex that is covered by a dense tuft of hairs. The labium has three segmented palpi; the glossae are much

Fig. 12. Mouthparts of mature male Taeniopteryx lonicera nymph (ventral view). md = mandible, mx = maxillae, ga = galea, l = lacinia.



smaller than the paraglossae. There are numerous long hairs on the apex of the labium.

Taeniopteryx maura (Pictet 1841)

Nemoura maura Pictet, 1841.

Taeniopteryx maura, Ricker and Ross, 1968: 1429.

Type locality: Pennsylvania. Type missing.

New distribution records: Adults - MISSISSIPPI, Lauderdale Co., Small Creek at Hwy. 80; TENNESSEE, Cumberland Co., Falls Creek; Morgan Co., Rock Creek; WEST VIRGINIA, Wayne Co., Beech Fork.

Nymphs - MISSISSIPPI, Alcorn Co.; NORTH CAROLINA, Jackson-Transylvania Co. line, Whitewater River; TENNESSEE, Cumberland Co., Falls Creek; Morgan Co., Rock Creek.

Nymphal Material Examined: Total number of specimens examined - 45; 1♂, 1♀, GEORGIA; 11♂, 19♀, MISSISSIPPI; 1♀, NORTH CAROLINA; 5♂ (1 reared), 3♀ (3 reared) TENNESSEE; 1♂ (1 reared), TEXAS; 3♀, VIRGINIA.

Description and Analysis of Mature Male and Female Nymphs:

Taeniopteryx maura (Pictet) nymphs were similar to T. burksi, except that the spur on the hind femora could be seen through the exuvium (sometimes absent in burksi). The developing vesicle was sometimes visible through the Ab₉ sternum cuticle.

Taeniopteryx metequi Ricker and Ross

Taeniopteryx metequi Ricker and Ross, 1968:1431.

Type locality: Hayes Creek, Glendale, Illinois. Deposited at INHS.

New distribution records: Adults - PENNSYLVANIA, Bedford Co.; VIRGINIA, Fairfax Co.: Fauquier Co.: Rappahannock Co.

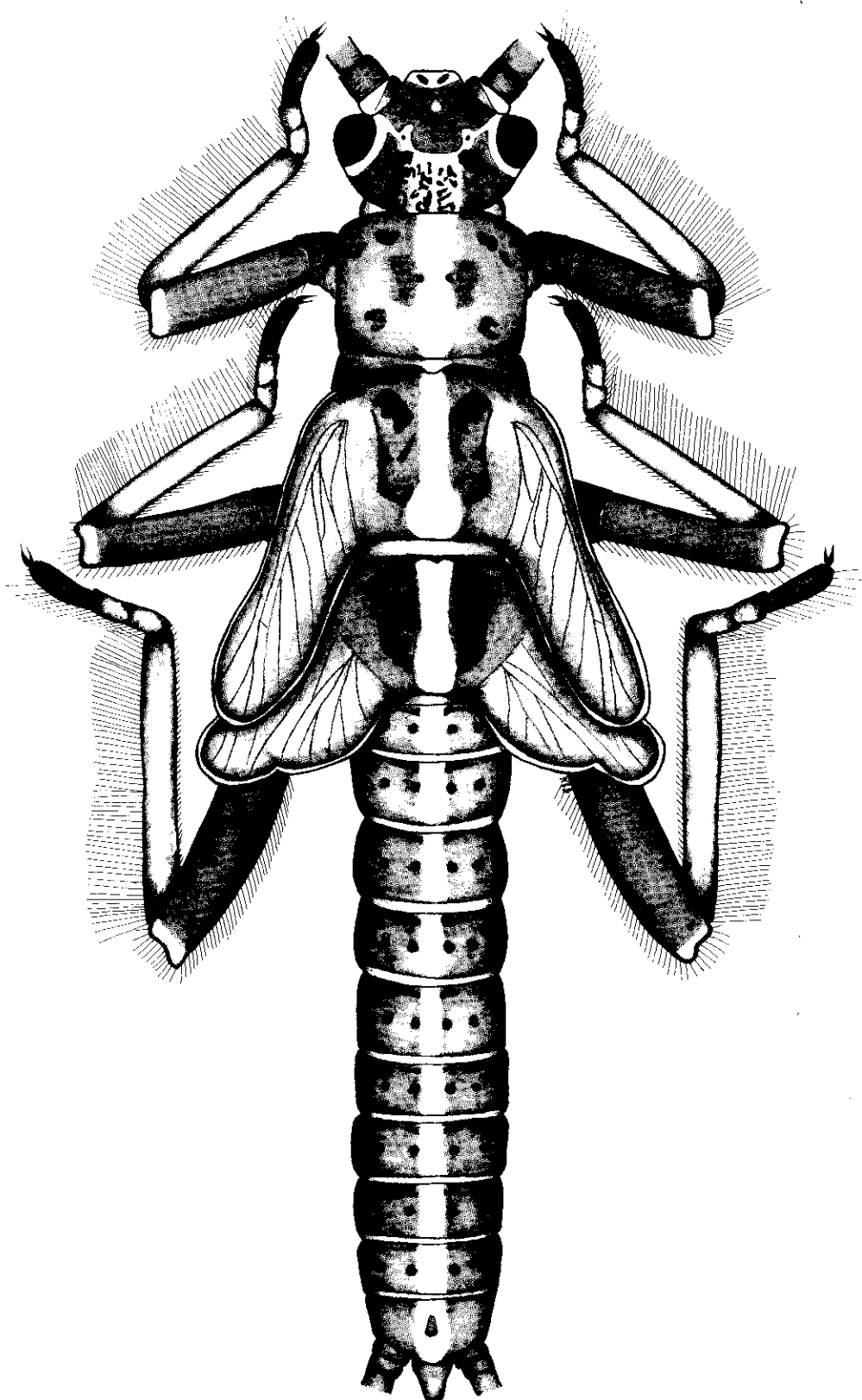
Nymphs - OHIO, Geauga Co., Stebbins Gulch.

Nymphal Material Examined: Total number of specimens examined - 9; 1♂, MISSISSIPPI; 1♀, OHIO; 3♀, ONTARIO; 1♂, 3♀ (1 reared), TENNESSEE.

Description of Mature Male Nymphs: General color medium brown with prominent middorsal stripe. Venter light brown. Total length 7.5 - 8.1 mm. (Fig. 13).

Head with darker mottlings in occipital area; occupying one-half of head. Frons with light anterior margin containing two oblique dashes. Middorsal stripe extends onto head capsule as wide yellow band occupying about one-half of bottom portion of head. Three ocelli surrounded by yellow; compound eyes bordered by thick rings of yellow. Antennae $\frac{3}{4}$ as long as body; first third brown, remainder yellow. Mouthparts light.

Fig. 13. Mature male Taeniopteryx metequi nymph.



Pronotum with yellow middorsal stripe. Meso- and meta-nota with yellow middorsal stripe that expands posteriorly. Dark mottlings occupy all thoracic segments. Wingpads light brown. Legs with yellow ring on each femur; yellow tibia and first two tarsal segments.

Abdomen with distinct middorsal stripe; dark spots on either side of middorsal line (not so conspicuous in some specimens). Tergites with long, curved setae and an occasional long hair on posterior margin. Cerci $3/5$ as long as body; proximal 8-9 segments brown; remainder yellow. Epi-proct broad at base and tapering slightly towards the tip (Fig. 6).

Description of Mature Female Nymphs: Females exhibit generally similar setation and pigment patterns. Total length 10.0 - 11.0 mm. At this time, use of the developing subgenital plate as a diagnostic character is doubtful.

Analysis:

Taeniopteryx metequi nymphs are easily distinguished from the other eight species in North America by the large, dark band of pigment covering the fronto-clypeal area, and the broad yellow rings around each eye.

Taeniopteryx nivalis (Fitch 1847)

Nemoura nivalis Fitch, 1847.

Taeniopteryx nivalis; Ricker and Ross, 1968:1434.

Type locality: New York State. Type missing.

New distribution records: Adults - OREGON, Baker Co.: Clackamas Co., 2 mi. N. Marquam: Clatsop Co., Nehalem River: Columbia Co., Dairy Creek: Washington Co.; WISCONSIN, Florence Co., Popple River and Wood Creek: Forest Co., Pine River.

Nymphs - MINNESOTA, Fillmore Co., Root River; WISCONSIN, Walworth Co., Sugar Creek.

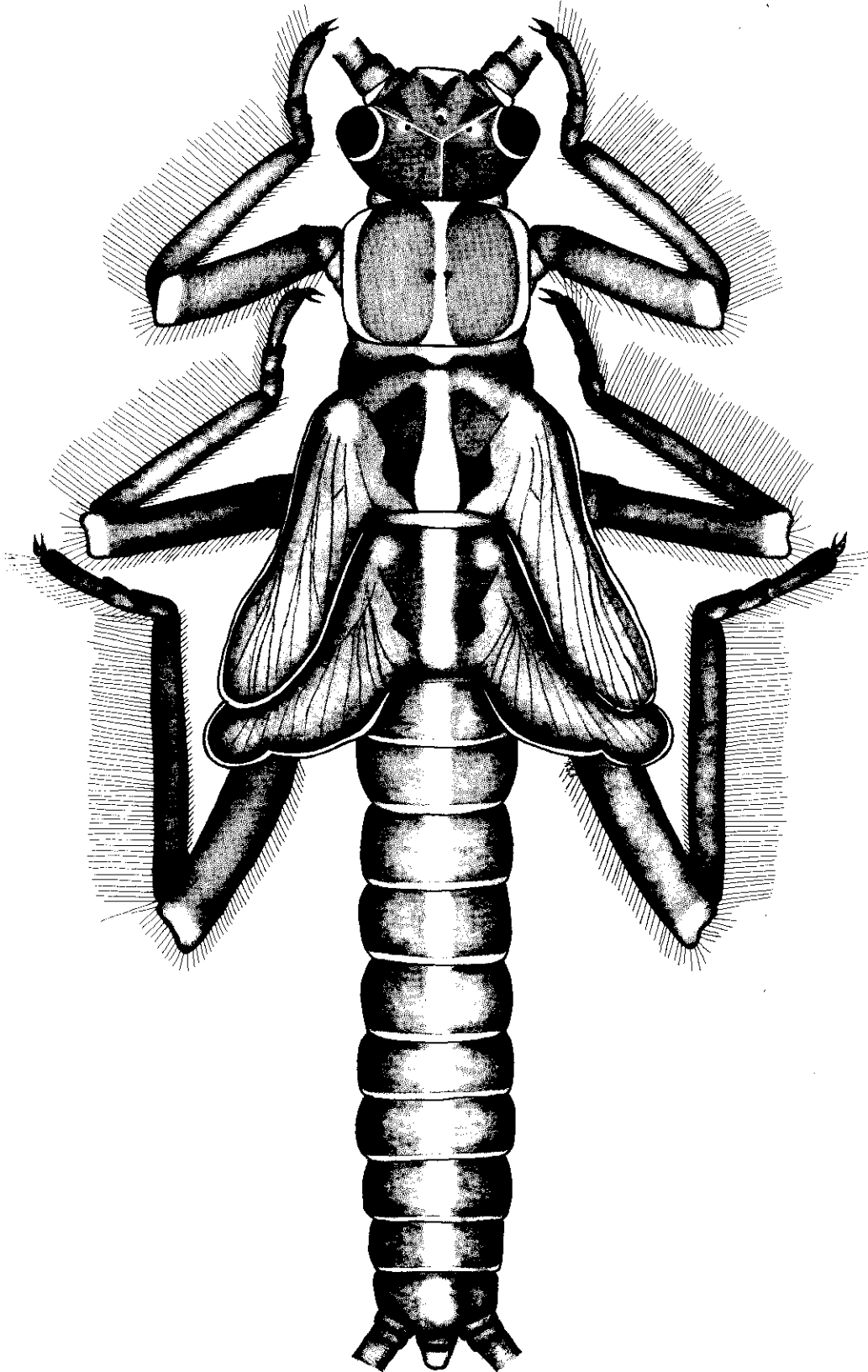
Nymphal Material Examined: Total number of specimens examined - 19; 1♂ (1 reared), ILLINOIS; 1♂, 1♀, MINNESOTA; 5♂, 5♀, ONTARIO; 1♂ (1 reared), OREGON; 1♂ (1 reared), 4♀ (2 reared), WISCONSIN.

Description of Mature Male Nymphs:

General color medium brown with or without yellow mid-dorsal stripe (character highly variable). Middorsal line represented by interrupted dashes or posterior yellow dot on last abdominal segment. Venter light and somewhat golden. Total length 9.3 - 10.7 mm. (Fig. 14).

Head without dark mottlings. Frons with light anterior margin bordered by two dark oblique dashes. Middorsal never extends onto head capsule. Three ocelli surrounded by yellow; compound eyes bordered by yellow rings. Antennae as long as body; first fifth brown, remainder yellow. Mouthparts brown dorsally and light ventrally.

Fig. 14. Mature male Taeniopteryx nivalis nymph.



Pronotum with prominent yellow lateral edges, middorsal stripe may or may not be present; usually represented by anterior and posterior yellow patches. Meso- and meta-nota with or without middorsal stripe; usually represented by posterior patch of yellow. Dark mottlings only in mesothorax. Legs with yellow ring on each femur; wingpads light.

Abdomen with or without middorsal yellow stripe; if present, extending entire length of abdomen. When absent, represented by yellow dot on posterior margin of each tergite or sometimes completely absent except for small yellow spot on tergite 10. Dark mottlings on either side of middorsal line. Tergites with short, blunt bristles and an occasional long hair on posterior margin. Cerci $3/5$ as long as body; proximal sixth brown, remainder yellow. Epiproct broad at base and slenderizing towards tip (Fig. 2). Developing vesicle sometimes visible through Ab_9 sternum cuticle.

Description of Mature Female Nymphs: As in other species of Taeniopteryx, females generally have similar setation and pigment patterns. Total length 10.3 - 14.0 mm. The developing subgenital plate is obscured by the nymphal cuticle and should not be used as a diagnostic character.

Analysis:

Taeniopteryx nivalis nymphs may or may not have a yellow middorsal stripe. Those specimens that have a middorsal stripe are easily distinguishable from other striped Taeniopteryx species by the yellow lateral margins on the prothorax and the thin, Y-shaped light lines along the ecdysial suture on a generally dark head (Fig. 14).

Nymphs that lack a middorsal stripe could be generally confused with T. parvula and T. ugola nymphs that also sometimes lack distinct yellow middorsal stripes, but the wide lateral pronotal bands are sufficient for separation (T. parvula nymphs have a narrow pronotal band on all four sides and concolorous legs). Unlike T. nivalis, parvula nymphs also have long, curved setae on their abdominal terga. Taeniopteryx nivalis nymphs are easily separated from T. ugola by the thin Y-shaped ecdysial lines.

Egg: Eggs studied and photographed using a SEM were taken from gravid females from the Popple R., Florence Co., Wisconsin (Fig. 17c). They are almost identical to eggs of T. lita. The usual sculptured chorion is quite evident as well as the characteristic tubular, raised ridges and randomly spaced micropyles. The egg is round and approximately 1.2 mm. in diameter.

Taeniopteryx parvula Banks

Taeniopteryx parvula Banks, 1918:

Type locality: Peach Grove Hill, Virginia. Deposited at Museum of Comparative Zoology, Harvard University.

New distribution records: Adults - TENNESSEE, Cumberland Co., Daddy's Creek; WISCONSIN, Florence Co., Pine River and Woods Creek; VIRGINIA, Fairfax Co., Rocky Run: Faquier Co.: Prince William Co., Bull Run.

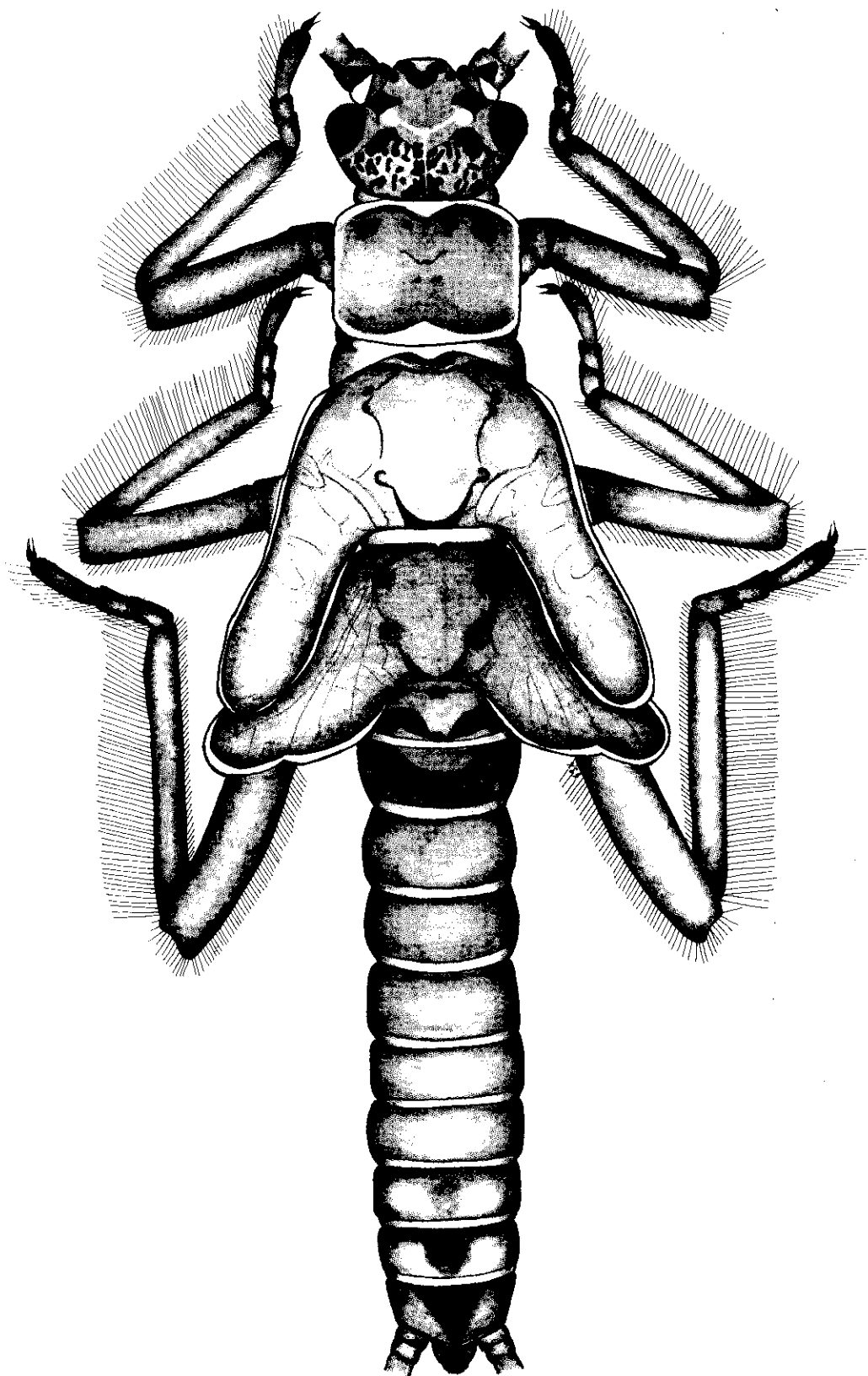
Nymphs - MICHIGAN, Washtenaw Co.; NEW YORK, Tompkins Co., Fall Creek; PENNSYLVANIA, Luzerne Co., Meadow Run - tributary to Bear Creek.

Nymphal Material Examined: Total number of specimens examined - 32; 2♀, GEORGIA; 1♂, 9♀, ILLINOIS; 1♂, MARYLAND; 5♀, MICHIGAN; 8♀, NEW YORK; 1♀, PENNSYLVANIA; 5♀, WISCONSIN.

Description of Mature Male Nymph: General color medium brown lacking a middorsal stripe. Venter light brown. Total length 6.8 mm. (Fig. 15).

Head with many dark mottlings, extending from bottom of compound eyes to posterior margin of head. Frons with dark "horseshoe-shaped" patch on anterior edge bordered by two small lateral dark spots. Three ocelli surrounded by yellow; dark patch located anterior to each compound eye.

Fig. 15. Mature male Taeniopteryx parvula nymph.



Antennae $3/4$ as long as body; all segments brown. Mouth-parts brown.

Pronotum with yellow anterior and posterior edges; no dark mottlings or middorsal stripe. Meso- and meta-nota also lacking middorsal stripe; dark mottlings. Legs and wingpads brown.

Abdomen brown throughout; in older specimens, dark mottlings. Tergites with long, curved setae and an occasional long hair on posterior margin. Cerci $3/5$ as long as body; brown throughout. Epiproct triangular when viewed dorsally; one male examined with nipple on tip (Fig. 3). No developing vesicle on Ab_9 sternum.

Description of Mature Female Nymph: Females exhibit generally similar setation and pigment patterns. Total length 7.3 - 12.3 mm. At this time, I do not consider the developing subgenital plate to be a useful character.

Analysis:

Taeniopteryx parvula specimens examined lacked a middorsal stripe which distinguishes them from all other North American species, except T. nivalis or T. ugola that sometimes also lack the stripe. The narrow yellow band on all four sides of the pronotum and the medium brown legs with a distinct yellow ring around each femur are sufficient for separation. T. nivalis nymphs also have short, bristle-like setae on their abdominal tergites.

Taeniopteryx starki Stewart and Szczytko

Taeniopteryx starki Stewart and Szczytko, 1974:451.

Type locality: Coryell Co., Texas. Types deposited at USNM #73057.

New distribution records: None.

Nymphal material examined: Total number of specimens examined - 34; 9♂, 25♀, TEXAS.

Description and Analysis of Mature Male and Female Nymphs:

Taeniopteryx starki Stewart and Szczytko nymphs were indistinguishable from T. lita (Fig. 7, 11) (See T. lita section). They were distinguishable from T. lonicera only in being approximately 2 mm. longer.

Taeniopteryx ugola Ricker and Ross

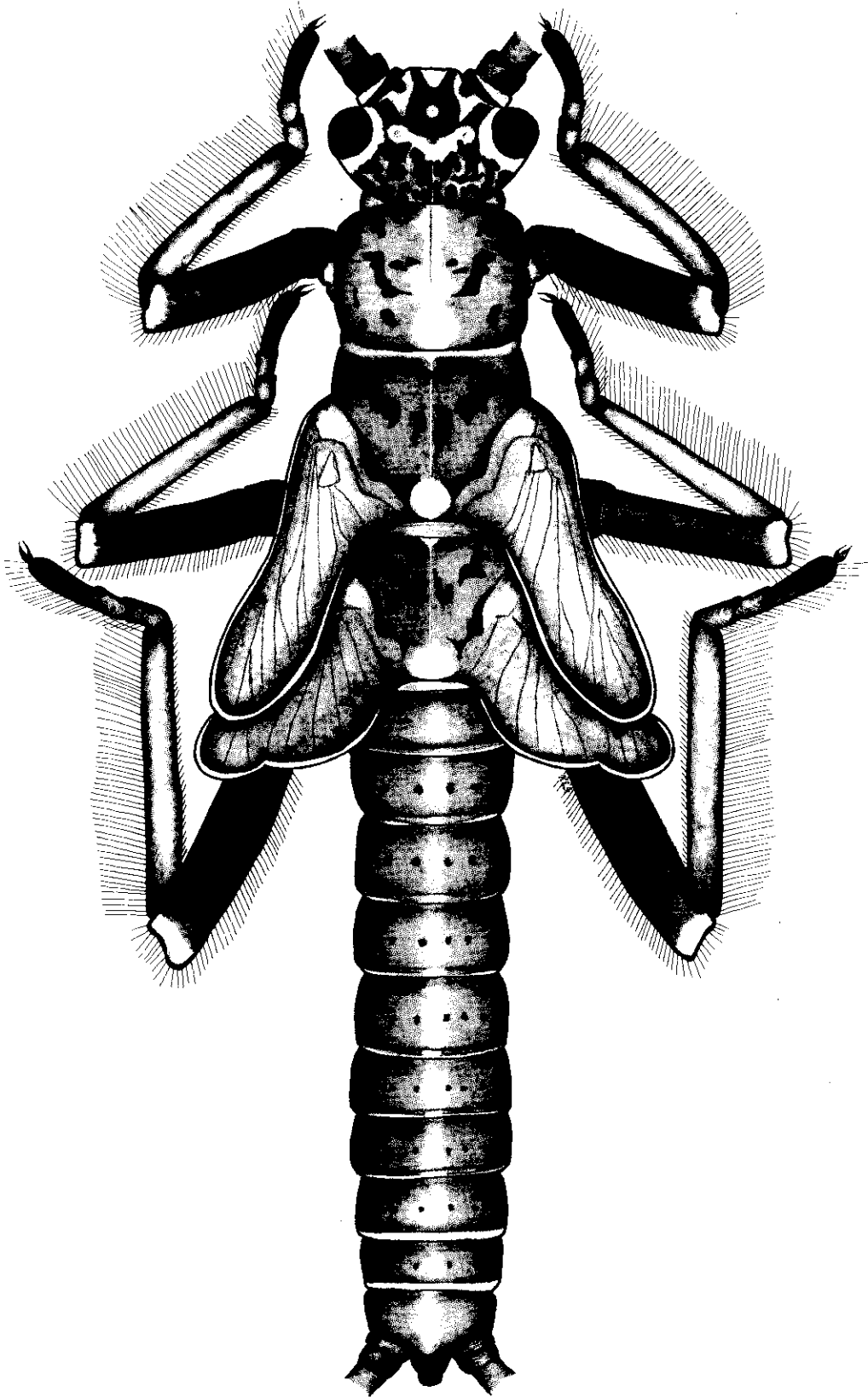
Taeniopteryx ugola Ricker and Ross, 1968:1437.

Type locality: Fellowsville, West Virginia. Deposited at INHS.

New distribution records: Adults - TENNESSEE, Loudon Co., Polecat Creek; WEST VIRGINIA, Nicholas Co., Little Creek.

Nymphs - GEORGIA, Rabun Co., Chattanooga River; TENNESSEE, Robertson Co., Tributary to Red River; WEST VIRGINIA, Nicholas Co., North Fork Cherry River.

Fig. 16. Mature male Taeniopteryx ugola nymph.



Nymphal Material Examined: Total number of specimens examined - 28; 1♀, GEORGIA; 7♂ (6 reared), 18♀ (14 reared), TENNESSEE; 2♀, WEST VIRGINIA.

Description of Mature Male Nymphs: General color medium brown with many dark mottlings dorsally. Venter light brown. Total length 7.6 mm. (Fig. 16).

Head with dark mottlings in occipital area, occupying one-half of head. Frons with light anterior margin surrounded by dark "horseshoe-shaped" patch and lateral spots at base of each antennae. Stem of ecdysial suture a fine yellow line that opens into wide "V-shaped" yellow arms in middle of head. Two posterior ocelli surrounded by yellow and anterior ocelli surrounded by light brown; compound eyes surrounded by light rings with large dark patches located anterior to each eye. Antennae brown; mouthparts light.

Pronotum with yellow middorsal stripe that may or may not extend entire length of prothorax. Meso- and meta-nota with yellow middorsal patch on posterior margin of each segment. Dark mottlings occupy all thoracic segments. Wingpads light brown or yellow; legs with yellow ring on each femur; yellow tibia and first two tarsal segments.

Abdomen with middorsal stripe represented as light area in middle of each tergite and small yellow patch on posterior margin of each abdominal segment; dark mottlings on either

side of middorsal line. Tergites with very long, curved setae and an occasional long hair on posterior margin. Cerci with first 11-12 segments brown; remainder yellow. Epiproct broad at base but slenderizing to thin knob on tip (Fig. 1).

Description of Mature Female Nymphs: Setal and pigment patterns are similar to males of this species. Total length 7.0 - 9.7 mm. As in other species, the developing subgenital plate cannot be considered a diagnostic character.

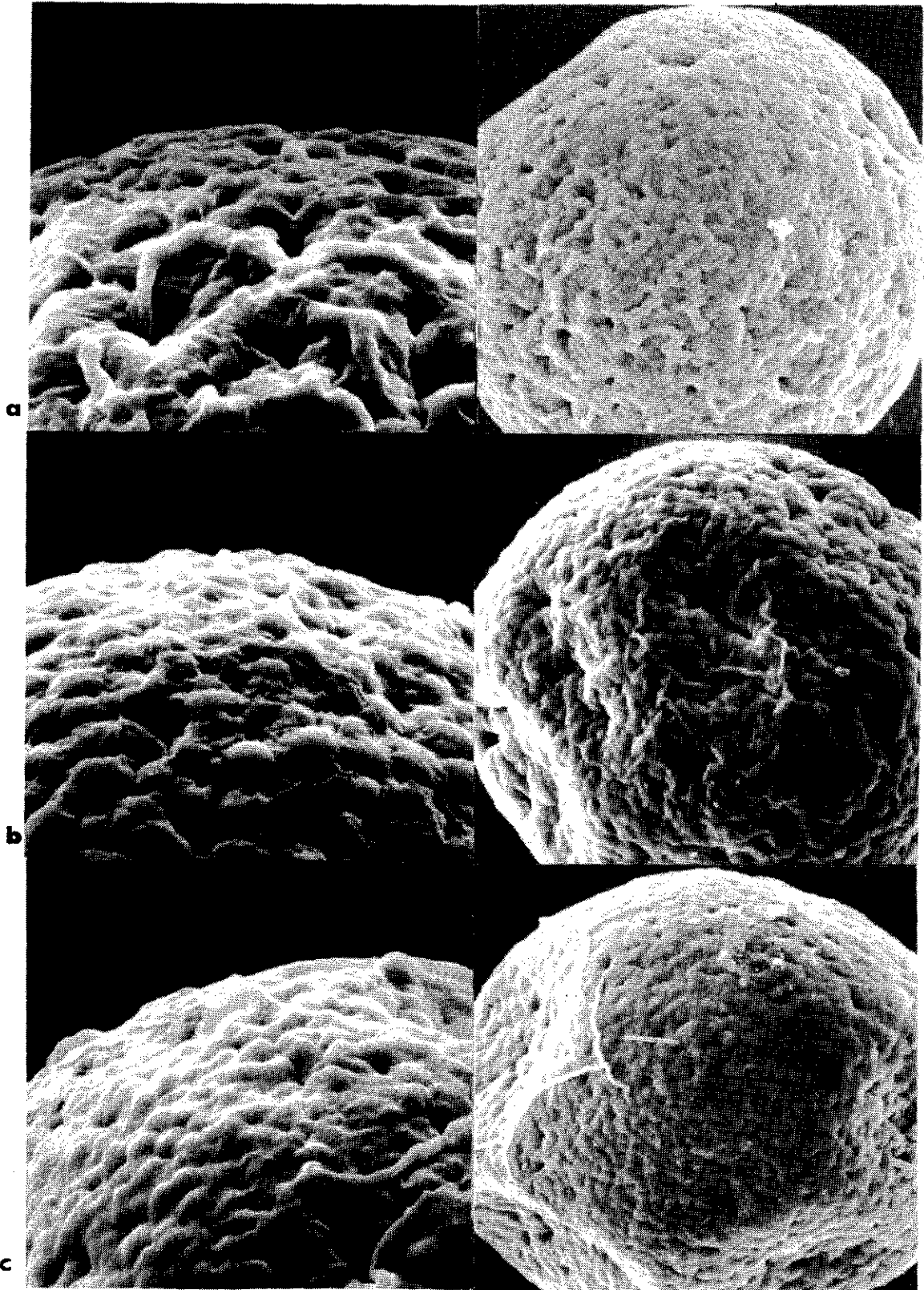
Analysis:

Taeniopteryx ugola nymphs are easily distinguishable from the other eight species in North America by the pigment pattern (Fig. 16). None of the other species exhibit the fine ecdysial light stem and the broad Y-shaped arms in the center of the head.

Fig. 17a. Taeniopteryx burksi egg 2000 and 700X.
mp = micropyle

b. Taeniopteryx lita egg 2000 and 700X.
mp = micropyle

c. Taeniopteryx nivalis egg 2000 and 700X.
mp = micropyle



CHAPTER IV

DISCUSSION

Taeniopteryx are winter-emerging stoneflies with a univoltine life cycle. The adults begin to emerge about the first of January and continue emerging until April in the northern sections of the continent. Emergence reaches a maximum in Texas between mid-January and mid-February. During the warmer times of the day, adults may be captured on bridges, tree trunks or other objects near slow running, sometimes sluggish, permanent or intermittent streams.

T. lita was collected on submerged broken tree limbs that had a fine accumulation of decaying allocthanous leaves.

Being essentially detritivores, nymphs live in submerged vegetable debris, particularly old leaves. The nymphs are to be found in streams ranging from size from large sluggish rivers, like the Sabine R., to small ditches running parallel with highways in East Texas. It is often necessary to collect a series of microhabitats in a stream system to secure Taeniopteryx nymphs. They are found around roots at the base of submerged trees, amongst submerged leaf packs and algal mats, under medium sized rocks covered with algae in riffles.

Except for T. burksi (613 specimens), the number of mature Taeniopteryx nymphs available for study from major

personal, museum and university collections was disappointingly small. Nineteen to 45 individuals, including males and females, were studied for each of the other species, except T. metequi, where only 2♂ and 7♀ were available. As each species was successfully reared, its respective nymphal representatives were searched from the available study material, named, and studied. The small numbers, representing relatively few localities precluded a meaningful attempt to analyze potential geographic morphological variations. However, little variation in pigment patterns within species was evident, except in T. nivalis (with or without middorsal stripe and with variation in abdominal and head pigmentation) and T. burksi (with variation in head markings).

Hoped-for characters, such as setal, spinule arrangements of mouthparts, were not diagnostic in Taeniopteryx nymphs. Frison (1935), after examining and comparing T. parvula and T. nivalis mouthparts, concluded that they were "identical." Neither hind coxal gill segment ratios or individual gill segment measurements were diagnostic. Their fragility and variable degree of telescoping made measurement difficult.

The homogeneity of nymphs necessitates use of the multiple characteristics of pigment pattern, abdominal setal pattern, shape of the developing epiproct, and sometimes

presence or absence of a developing vesicle on the Ab₉ sternum. Harper and Hynes (1971) suggested that separations by color pattern alone of the 5 Canadian species should be based on examination of a series of nymphs. Pigment patterns are often indistinct in young nymphs, and obscured by underlying adult pigments in mature nymphs. Use of multiple characters for this homogeneous group of stonefly nymphs necessitated a less concise key than usually desired.

The absence of a middorsal stripe in T. parvula was first mentioned by Frison (1929) in a brief description of cast exuviae from Oakwood, Illinois. Claassen (1931) gave a vague written description of two male nymphs from Plummer's Island, Maryland. Frison (1935) gave a habitus illustration of a nymphal female lacking a middorsal stripe, and no further descriptions of nymphs were added until the study of Taeniopteryx nymphs by Harper and Hynes (1971).

Taeniopteryx nivalis nymphs may or may not have a prominent middorsal stripe. Its first description and illustration was by Claassen (1931). His female nymph habitus drawing exhibited a light middorsal stripe, not continuing onto the head, and his description of the head was "yellow or brown with darker mottled areas over the occiput." Nymphs described were from Ithaca and Clinton, New York and Illinois. Harper and Hynes (1971) made no

mention of the dark head mottlings on Canadian specimens. My specimens from Minnesota and Wisconsin displayed mottled areas on the occiput that were less distinct than in other Taeniopteryx nymphs. I found abdominal setal patterns to correspond with those reported by Harper and Hynes (1971).

Taeniopteryx metequi is the only species in which the middorsal stripe extends onto the head capsule as a thick, yellow band. Harper and Hynes (1971) gave an excellent description of nymphs from Eastern Canada. Nymphs I examined from Arkansas, Pennsylvania, Tennessee and Virginia corresponded closely to their description.

Taeniopteryx ugola nymphs were previously unknown, and I was able to successfully collect 25 nymphs in three different counties in Tennessee in February, 1977. Six males and 14 females were reared. The only other specimens obtained through loans were one female nymph from Georgia and two females from West Virginia; none had been reared. Pigment patterns, given in the key and nymph description sections, are distinctive.

Collections examined and the literature on Taeniopteryx, including the revision by Ricker and Ross (1968), indicate that T. burksi is the most common species in North America. Nymphs were first described by Frison (1929) under the name T. nivalis, obvious because of the extension of the middorsal stripe onto the head capsule. The habitus female presented

by Frison (1935) under the name T. nivalis, which should have been T. burksi, is of doubtful identification because the middorsal stripe did not appear bordered with darker pigment. Specimens studied by Harper and Hynes (1971), and all that I examined, had the yellow middorsal stripe bordered with dark brown or black. The middorsal stripe extends onto the head capsule either as a narrow stripe or as a thinner line that bulges to occupy a circular, yellow area between the compound eyes.

The pigment and setal patterns of T. maura were identical to those of T. burksi, and it was first described by Claassen (1931). He noted that ". . . the tooth of the femora can readily be seen in the male." Those nymphs were not located in the Illinois Natural History Survey, although adults from Plummer's Island that I examined, had distinct femoral spurs. The separation of these two species only on the basis of length of the femoral spur (Ricker and Ross 1968) perhaps should be re-examined in light of wide variations in this character being found. Certainly separation of nymphs by this character, which may not be completely manifested even in late instar nymphs, is questionable. Total absence of a spur in mature nymphs would suggest that the species is T. burksi, partial spur development could fit either T. burksi or T. maura and a femoral spur longer than half the femoral width should indicate T. maura. Harper and

Hynes (1971) noted that the few nymphs they examined from Plummer's Island were in poor condition. I have examined 45 late instar T. maura nymphs, correlated by both rearing and dissection, and all specimens had developing hind femoral spurs. B. P. Stark (personal communication) has noted that one specimen examined from eastern Oklahoma had long spurs, typical of T. maura, and all others from different localities were without spurs, and therefore typically burksi.

Nymphs of the three species, T. lita, T. lonicera and T. starki are separable only on the basis of geography-size considerations. All three lack a developing male Ab₉ vesicle, and their mouthparts, setal arrangements, shape of the developing male epiproct and pigment patterns are similar. This was expected because of the difficulty in separating adults of these same species, except by male genitalia. Although Frison (1929) included T. lita from Elizabethtown and Grayville, Illinois with other specimens of T. parvula, his nymphal descriptions refer to T. parvula, since they lack a middorsal stripe. Frison (1942) separated T. lita as a new species, based on adult characters, therefore T. lita nymphs have not previously been described. The previously unknown nymphs of T. starki and T. lonicera are described here for the first time. I collected T. starki nymphs for study from the type locality in the Leon River, Texas in January, 1976.

Further nymphal studies of stonefly genera are needed to establish keys, giving taxonomic credibility to aquatic ecological studies in North America.

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APPENDIX I

Nine species of Taeniopteryx occur in North America. All previously published and new county records based on adults and nymphs are shown in Figures 18-26.

Fig. 18. Distribution of Taeniopteryx burksi.

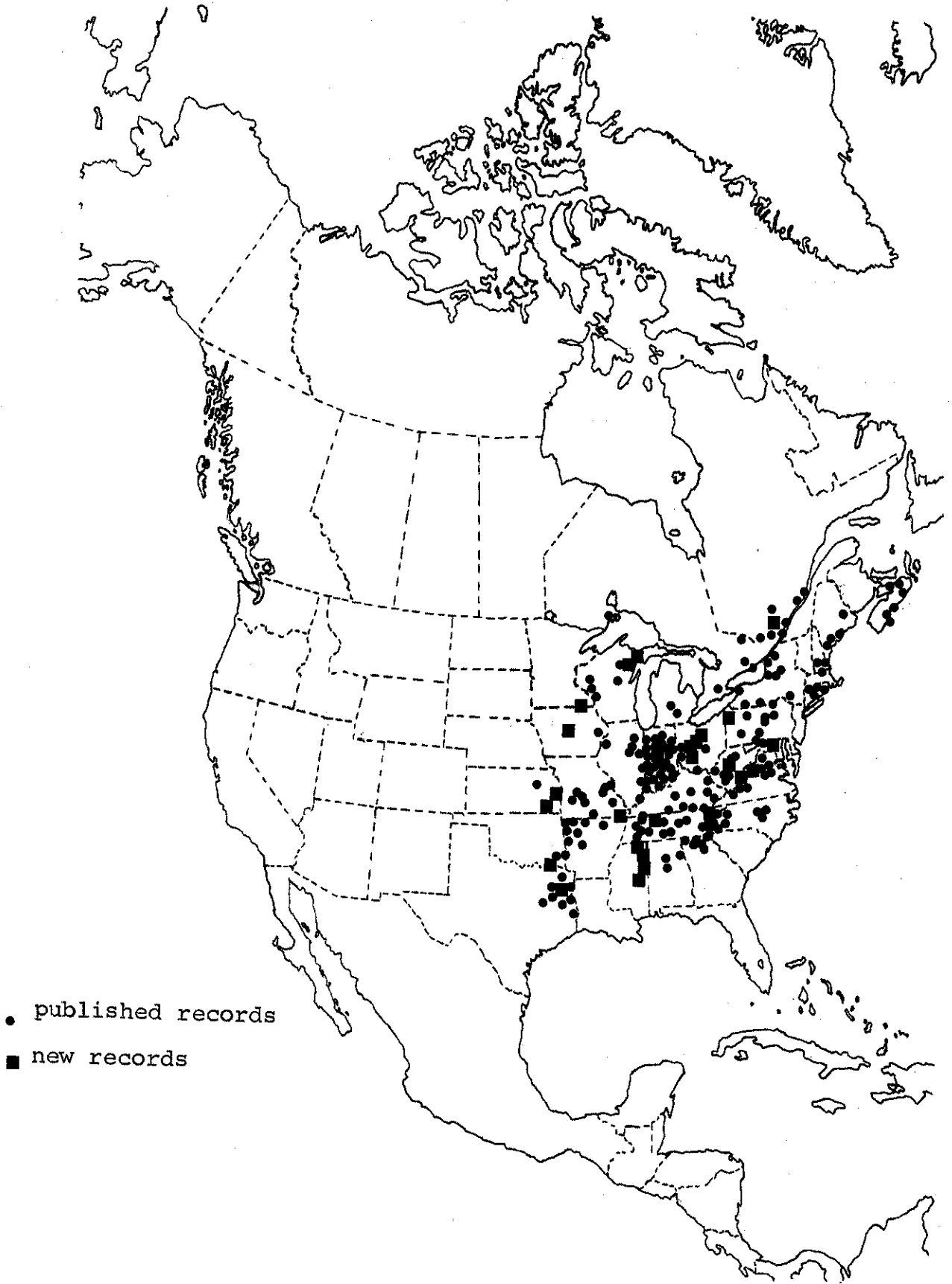


Fig. 19. Distribution of Taeniopteryx lita.

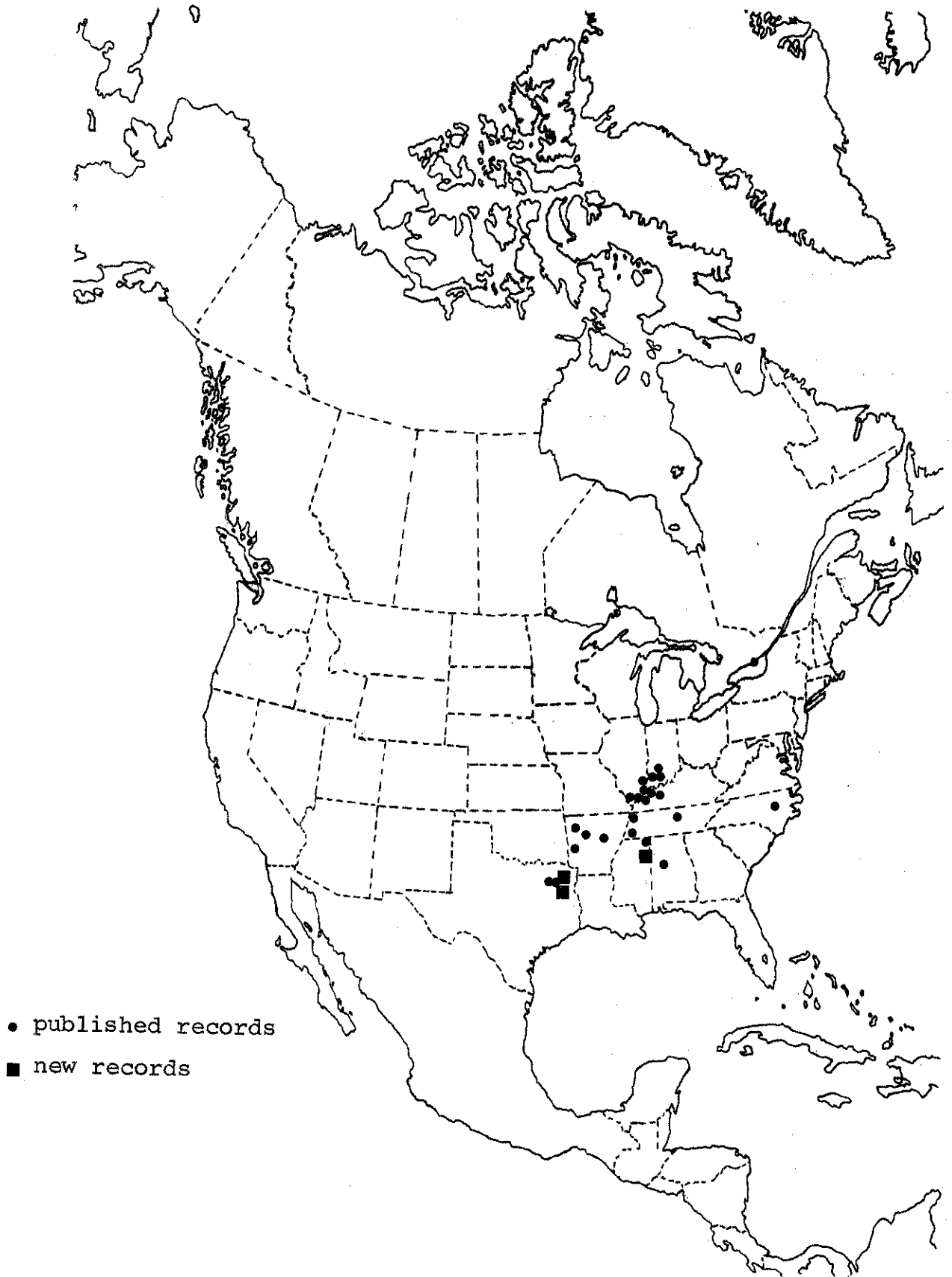
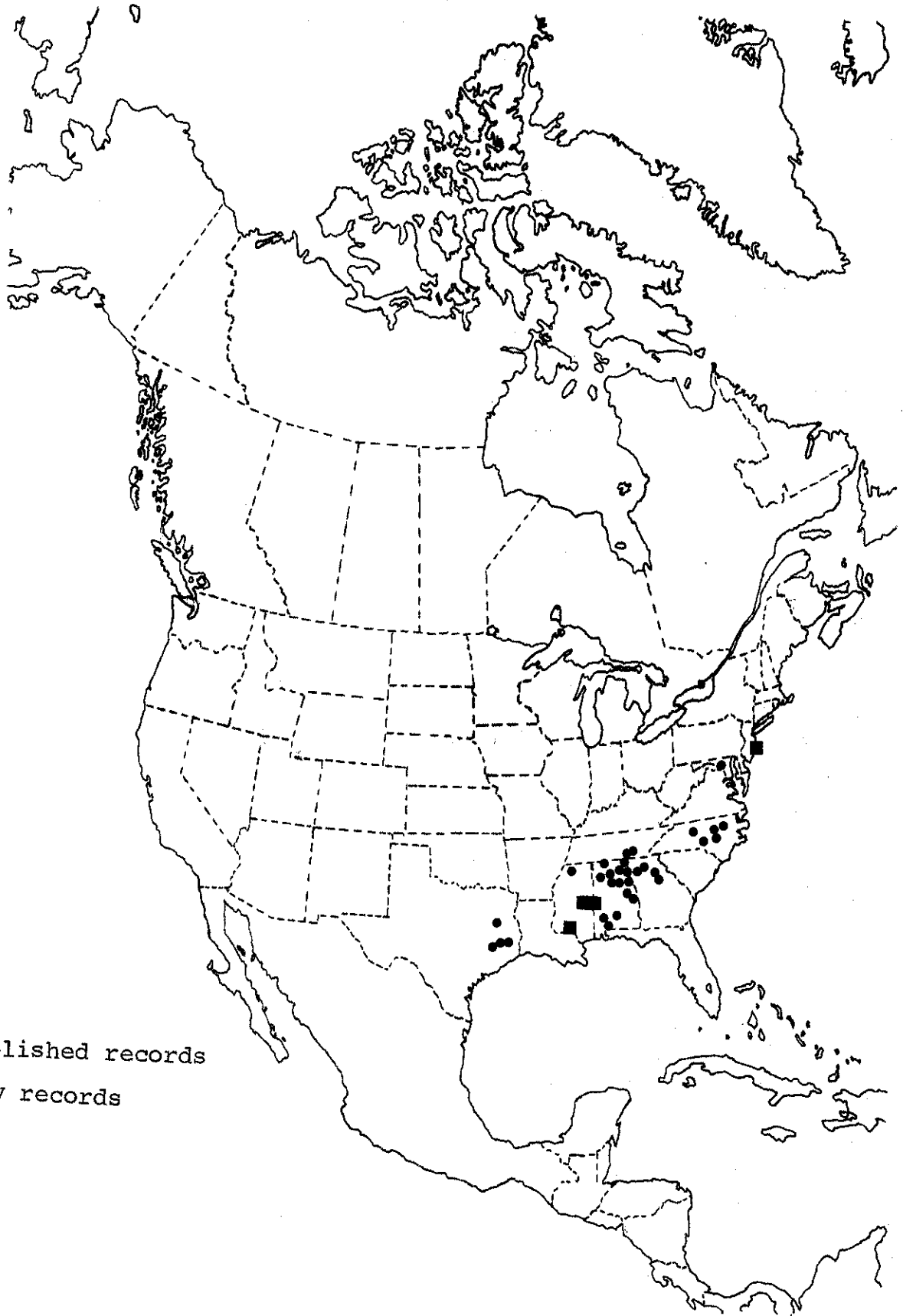


Fig. 20. Distribution of Taeniopteryx lonicera.



● published records

■ new records

Fig. 21. Distribution of Taeniopteryx maura.

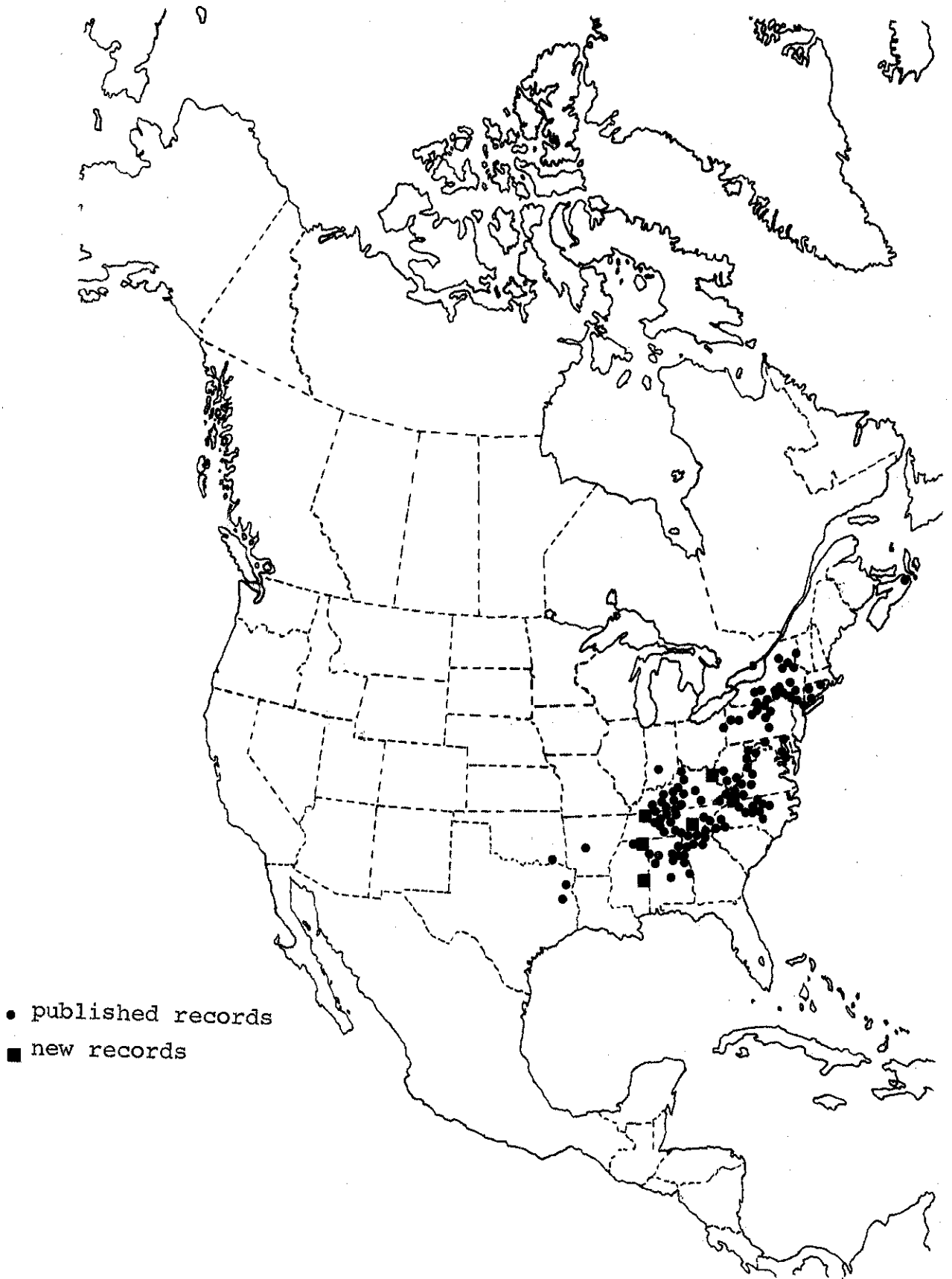
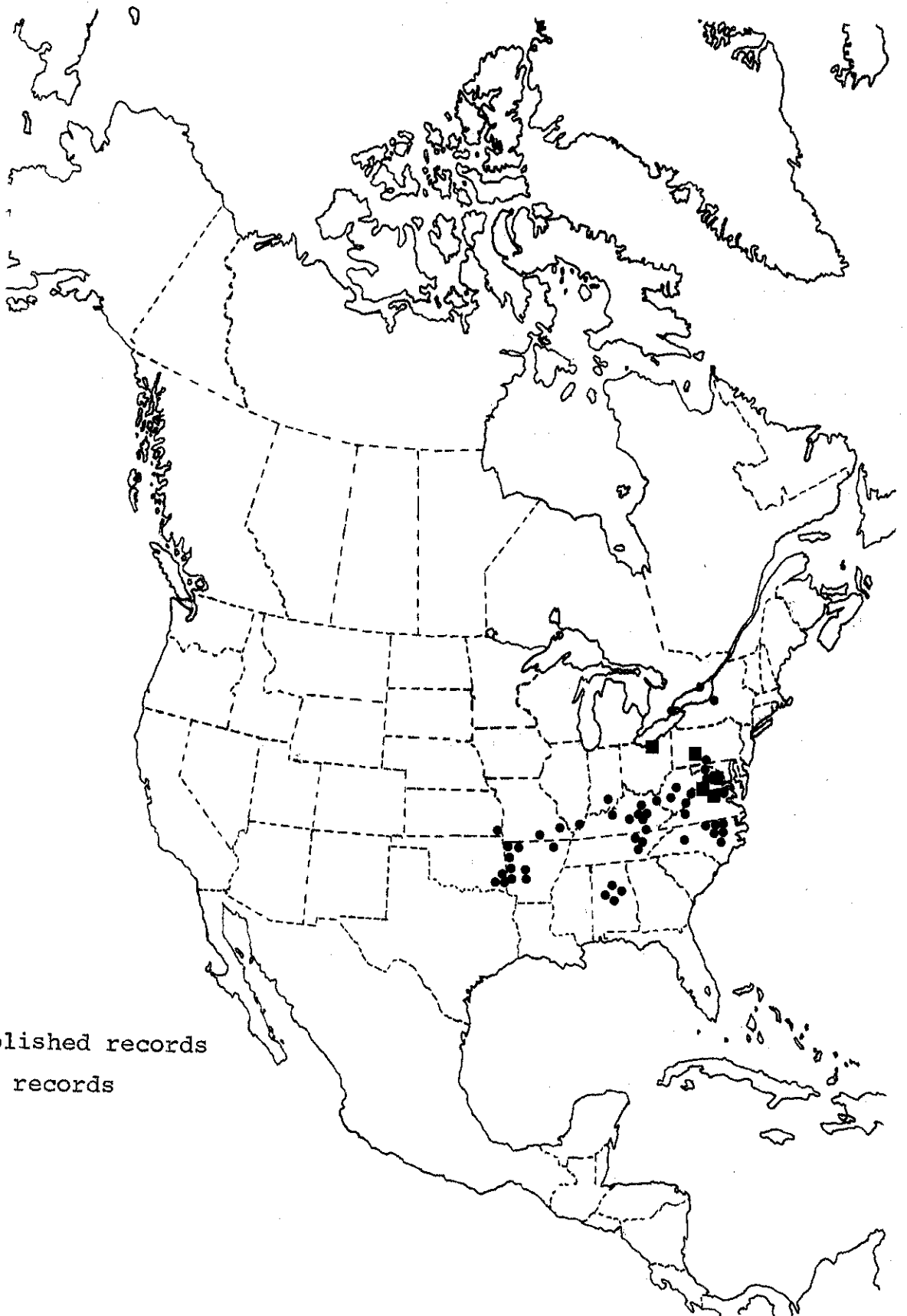
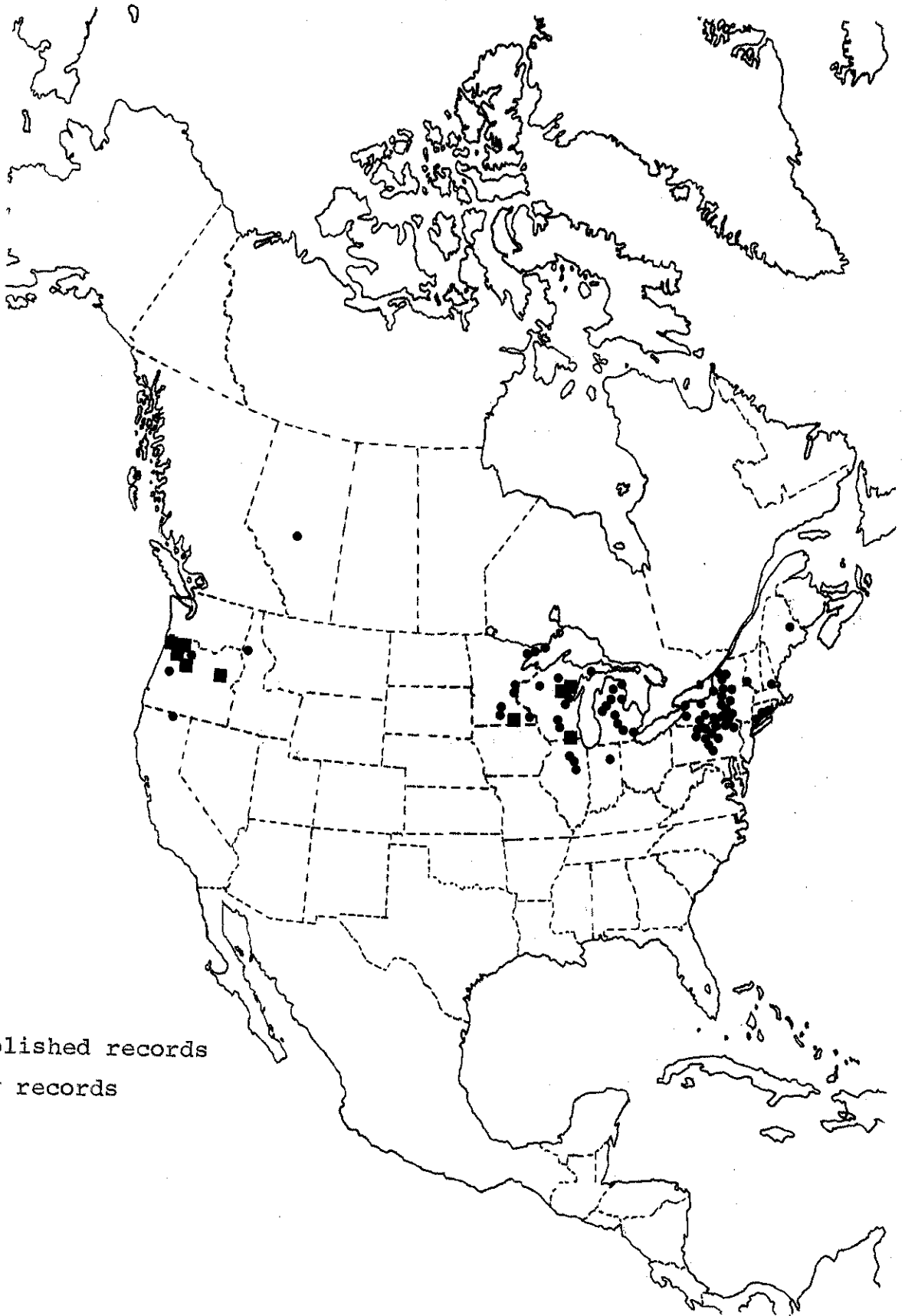


Fig. 22. Distribution of Taeniopteryx metequi.



● published records
■ new records

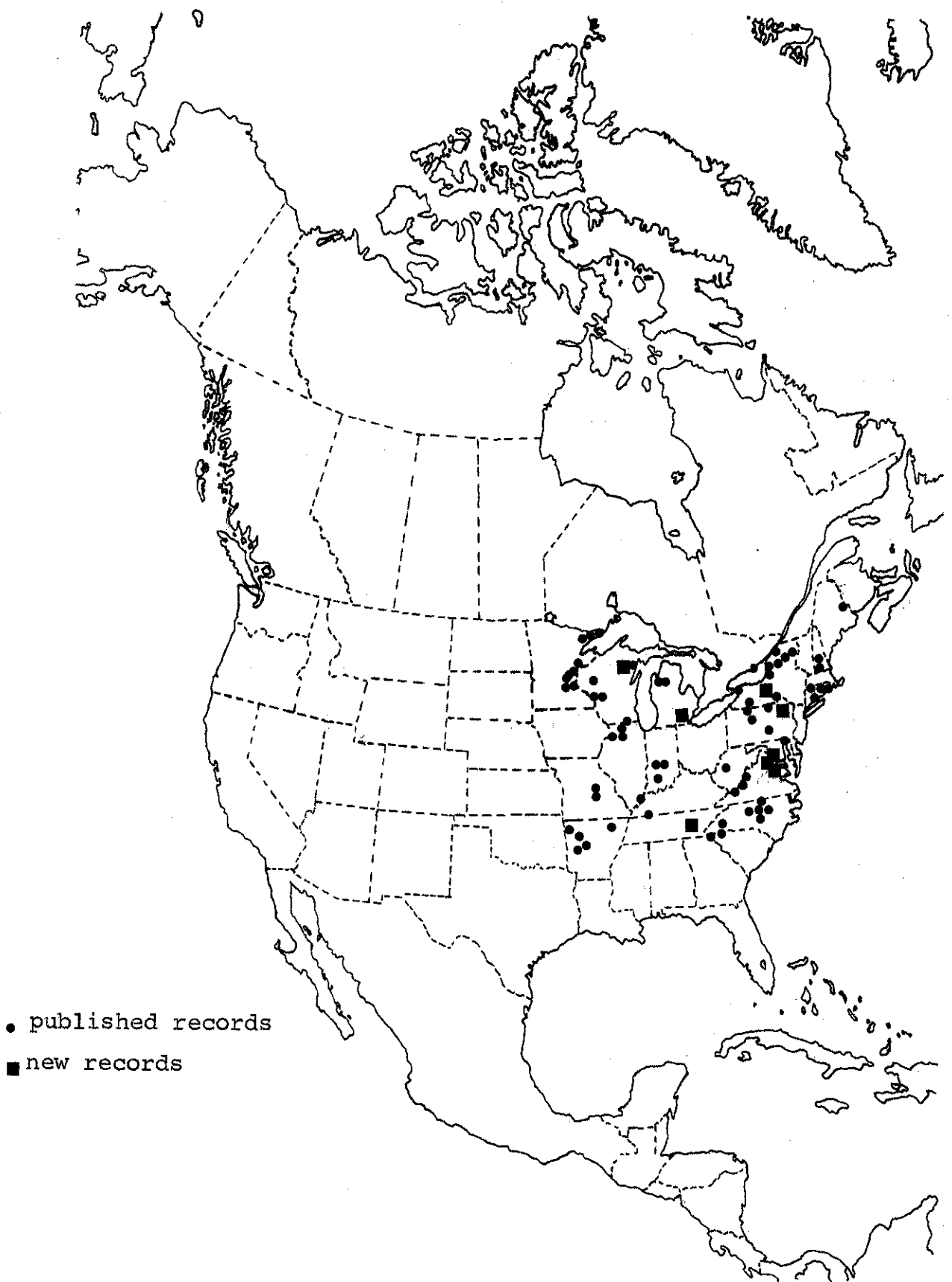
Fig. 23. Distribution of Taeniopteryx nivalis.



● published records

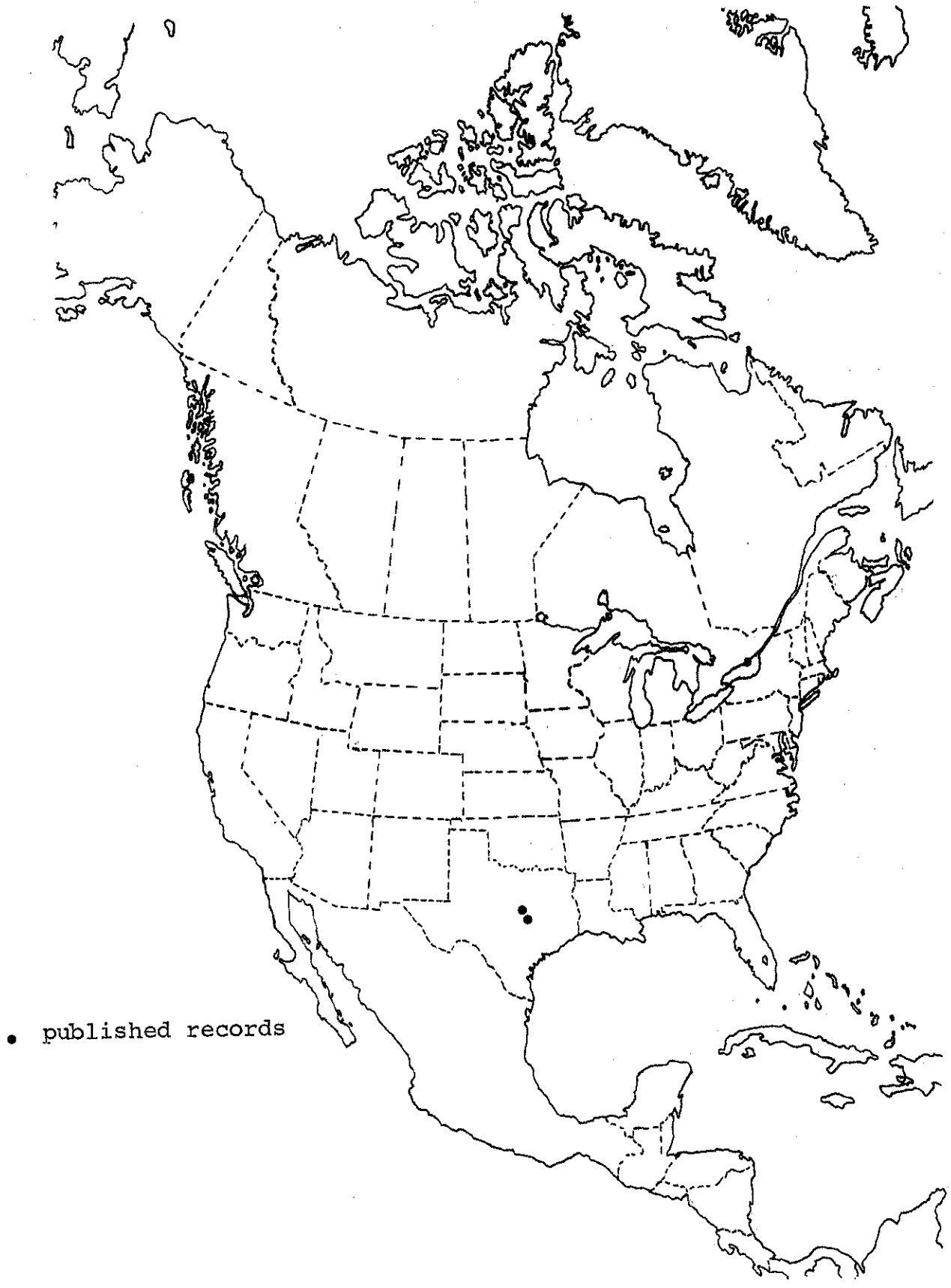
■ new records

Fig. 24. Distribution of Taeniopteryx parvula.



● published records
■ new records

Fig. 25. Distribution of Taeniopteryx starki.



• published records

Fig. 26. Distribution of Taeniopteryx ugola.

