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LARVAE OF NEARCTIC DIXIDAE (DIPTERA):  
DESCRIPTIONS AND KEY FOR IDENTIFICATION

A Thesis Presented

by

RICHARD W. SAVARY

Submitted to the Graduate School of the  
University of Massachusetts in partial fulfillment  
of the requirements for the degree of

MASTER OF SCIENCE

September 1992

Department of Entomology

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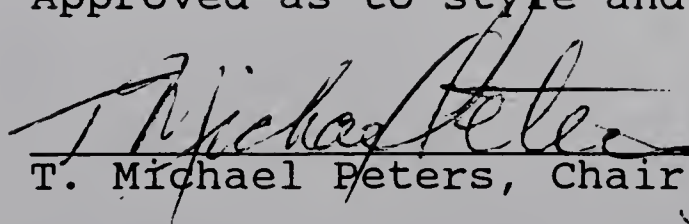
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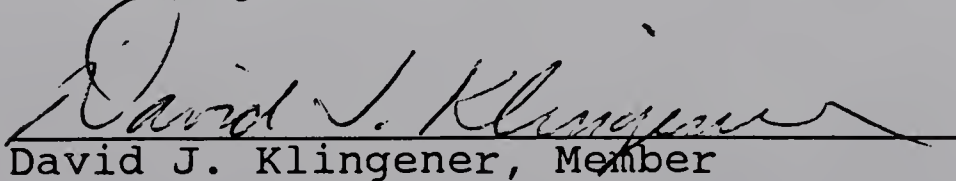
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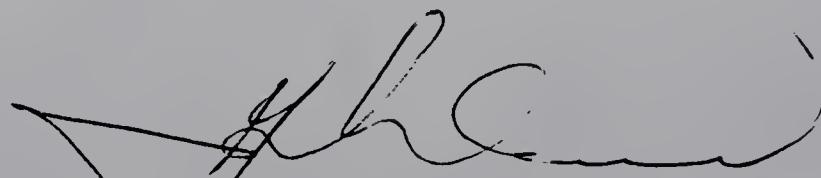
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DEDICATION

To my wife Holly Horton,  
without whose support and encouragement  
this project would not have been possible.

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CHAPTER I  
INTRODUCTION

The Dixidae are a family of small nematocerous flies with aquatic larvae. The family name was derived from the Greek *dixoos* (forked), in reference to forks of the radius and media veins of the wing.

The Dixidae are similar in appearance to the Culicidae. Imaginal Dixidae may be distinguished from mosquitoes by a strongly arched wing vein  $R_{2+3}$ , complete lack of scales along the wing veins, and a short, apparently disfunctional proboscis. The pupa, which very closely resembles that of the Culicidae, can be distinguished by conspicuous submedian transverse ridges on the abdominal tergites. The larva bears a strong similarity to the Culicidae with regard to many structures including general shape and segmentation, head capsule with labral brush and one segmented antenna, organization of spiracular plate and chaetotaxy (Belkin 1968, Harbach and Knight 1980). Dixid larvae are elongate and cylindrical, with a distinct, strongly sclerotized head capsule, distinct thoracic and abdominal segments, paired abdominal prolegs and strongly sclerotized terminal respiratory apparatus and caudal structures (Figs. 1-12). Dixid larvae most closely resemble mosquitoes of the genus Anopheles, which similarly lack a respiratory siphon. Larval Dixidae are easily distinguished from larval Culicids by the

presence of abdominal prolegs and ambulatory combs (Figs. 10-12, 48).

The biology of the Dixidae is described by Nowell (1951), Belkin (1970), Hubert (1953) and Peters (1981 and 1987). The genera of Dixidae diverge with respect to type of aquatic habitat preferred. Among the Nearctic dixids, Dixa and Meringodixa are usually associated with fast and slow lotic waters, respectively, whereas Dixella are primarily associated with lentic sites (Nowell 1951). Substantial overlap in larval habitat among genera has been noted (Peters 1987); Dixella in particular is reported to occupy both streams and ponds (Nowell 1951).

Morphological differences in larvae between genera are believed to be associated with particular conditions of the chosen aquatic habitat (Nowell 1951). These include presence or absence of dorsal coronae, relative development of long setae of both prothorax and anal segments and the number of ambulacral combs and pairs of prolegs. Dorsal hydrophobic coronae may contribute buoyancy to dixine larvae in turbulent lotic waters, which is unnecessary to paradixine larvae in calm lentic situations (Waters 1962). Long prothoracic and caudal setae may assist paradixine larvae to disperse in lentic habitats, a process which is accomplished by passive or active drift in streams (Waters 1962). A reduced number of prolegs, as well as reduced development of

the caudal ambulacral comb, as seen in the Meringodixinae, as well as the reduced number of ambulacral combs seen in some genera of Dixinae (e.g. Nothodixa, Paleodixa and Mesodixa), may be related to a reduced tendency of larvae of these taxa to climb (Nowell 1951).

The larvae of Dixidae are sometimes called "meniscus midges", due to their habit of climbing upward into the meniscus at the edge of a water body. The larva climbs into the meniscus by assuming an inverted U-shaped position at the meniscus, gripping the substrate with the now downwardly directed spines of the ambulacral combs and crochets of the prolegs, and alternately raising the prolegs and ambulacral combs each above the other. The larva rests in the inverted U-shaped position up to several inches above the water, always covered with an aqueous film.

Relative and absolute density of dixids varies dramatically between sites and with time, varying from rare to very abundant and dominant (Nowell 1951). Nowell also noted an apparent relationship between dixid abundance and water pollution, i.e. that waters subject to oil pollution from logging or associated with human habitation or industry either lacked or supported very small populations of dixids, whereas remote sites produced large populations of the flies. It is believed that species-level knowledge of larval Dixidae is desirable to permit detailed ecological research

on the family to proceed, and that larval Dixidae have the potential to become very useful indicators for the biological evaluation of water quality.

Dixid larvae are collector-gatherers and possibly filterers, feeding on fine particulate organic matter (FPOM, particles  $<10^3$  microns across) (Merritt and Cummins 1984). Larvae feed mostly at the water's surface, using the labral brushes (figs. 1-3) to produce water currents carrying food to the mouth (Peters 1981). Larger larvae are also known to dive and scrape microorganisms from submerged surfaces (Peters 1981).

The Dixidae have four larval instars, the last of which can be distinguished from the earlier instars by the distinctly more elongate, "mature" shape of the anal process; that of the earlier instar larva is recognizably more truncate. The greatest part of the life of a dixid is spent in the larval stage, which may last as little as 18 days under favorable conditions (Peters 1981), or about 30 days at  $16^{\circ}\text{C}$  (Nowell 1951), to much longer in the case of overwintering.

Although the pupa is capable of survival and eclosion while afloat in the water, it is usually found fastened upright within a couple of inches above the water's surface, to an emergent plant or other substrate, apparently by the

use of a glue. The pupal stage lasts from less than a day to about a week.

The newly eclosed adult requires about one hour for the cuticle to harden and for the wings to become extended (Peters 1981). Within the first four hours the terminalia rotate  $180^{\circ}$  between segments V and VIII, before which copulation probably does not occur (Peters 1981). Once sexual maturity has been achieved, mating may occur in one of two ways: either at dusk in swarms composed only of males, which females enter to mate (Nowell 1951, Hubert 1953), or in daylight without swarming (Hubert 1953). Eggs are laid within a gelatinous mass directly in the water, sink and adhere to the substrate, and hatch at least four days after oviposition (Peters 1981).

Adult dixids are not hematophagous, do not bite and are therefore not disease vectors, a fact which doubtless accounts for their obscurity relative to the mosquitoes. Although Hubert (1951) concluded that adults feed and drink, these observations have not been repeated and it is likely that they do not. Adult dixids live approximately 2-3 days (Nowell 1951).

The first identifiable references to these flies were made by Reaumur (1714), who described a larva of Dixa as a species of worm, and DeGeer (1776), who described Dixella

amphibia within the genus Tipula (Nowell 1951). The family Dixidae, as a distinct group, was first recognized by Schiner (1868), with Dixa the type genus. The Holarctic genera Dixa and Dixella were established by J. W. Meigen (1818), type species Dixa maculata, and Dyar and Shannon (1924), type species Dixella lirio, respectively.

The taxonomic history of the family is complex, having at various times been assigned to the Tipulidae, Culicidae, Ptychopteridae, Mycetophilidae, Chironomidae and Psychodidae (Nowell 1951), and its status is in some dispute even today. It is the opinion of most taxonomists that the group merits family status, within the superfamily Culicoidea, infraorder Culicomorpha (Hennig 1973; Wood and Borkent 1989).

The larval stage is important in classifying the Dixidae. Classifications based on imaginal morphology sometimes conflict with those based on larval morphology. In a major study, Martini (1931) examined the morphology of larval Dixidae, and found that they could be divided into several distinct types not reflected in any classification. These types are clearly recognizable in the Nearctic region.

Although 42 species of Dixidae have been described as larvae worldwide (many inadequately), only 8 of the 45 known species of Nearctic Dixidae have been described as larvae. Johannsen (1903) was the first to describe a Nearctic dixid

larva, that of Dixa modesta. Smith (1928) described the larvae of Dixa modesta, Dixella aliciae, D. cornuta and D. indiana [Dixa fusca Smith not Loew (Johannsen 1934)], as well as 6 presumed species which remain unidentified. Johannsen (1934) redescribed these species and a fifth unnamed species which was probably Meringodixa chalonensis. Nowell (1951) established the Nearctic genus Meringodixa with a description of M. chalonensis, including the larva. Peters and Barbosa (1970) described Dixella alexanderi, imago and larva. Peters and Adamski (1982) described the larva of Dixella nova, and in 1987 Peters described Dixa adleri, including the imago and larval forms. Some other authors have described larvae strictly in terms of family and generic level characters.

All these reports suffer to some extent from the poor state of knowledge of larval Dixidae. Many species descriptions, lacking a sufficient taxonomic context, describe genus or even family level characters. Another problem is that in many cases unstable characters have been used, e.g. color and morphometric relationships between mobile characters, which depend upon consistent mounting technique and good color preservation for utility. In cases where truly species-level characters are discussed, the descriptions often remain too vague for discrimination of similar species.

The first attempt to present a taxonomic key to larvae of the Nearctic Dixidae was made by Smith (1928). This key includes reference to the three named and six unnamed species cited above. Johannsen (1934) revised Smith's 1928 key to include these named and unnamed species plus another unnamed species, probably Meringodixa chalonensis.

The present research was conducted for the purpose of improving knowledge of larval Dixidae. It is anticipated that increased taxonomic information will be of utility in future systematic and aquatic ecology research. Although the imagos of most of the Nearctic Dixidae have been described (Peters and Cook 1966, 1987, Peters and Barbosa 1970) most of the larvae have remained to be described, and no adequate key has been available for their identification.

The subject of this study was an extensive collection of larval Dixidae, mostly determined by rearing to adulthood, housed at the University of Massachusetts at Amherst. The products of the research are taxonomic descriptions of 12 species of Nearctic Dixidae previously unknown as larvae, as well as redescription of 7 species, and a key to larvae of 19 species, most of which were previously unidentifiable.

CHAPTER II  
METHODS AND MATERIALS

Specimens used in this study were obtained from the T. Michael Peters collection of Dixidae, Department of Entomology, University of Massachusetts, Amherst. This collection, containing about 450 specimens in fluids and 420 specimens on slides, was created over the past 30 years by T. Michael Peters. Specimens were collected by Peters and several other investigators. The collection includes specimens of nineteen species of larval Nearctic Dixidae, in three genera, collected from locations across the United States. A total of 159 specimens were examined.

Most specimens consisted of last (fourth) instar larval exuviae associated with pupal exuviae and adult males, from which determinations were made. In a few cases determinations were based on adult females. Last instar exuviae can easily be distinguished from third instar skins by a pronounced difference in the shape of the anal process, which is generally elongate in the last instar, but distinctly truncate in the third and earlier instars. In some cases specimens were authoritatively identified at some time in the past by either T.M. Peters or A.A. Hubert, although associated adults are now missing. In several cases intact larvae associated with reared specimens by common source (collection site) and verifiable as to identity were used as

supplementary sources of data. In a single case authoritatively identified (Peters) larvae, without associated reared specimens was used (Dixa pullogruma).

Specimens in the collection had previously been mounted or preserved in several different ways. Specimens on permanent slides usually had been mounted in Canada balsam. Some slides had been mounted in methyl cellulose. Specimens in fluids had usually been preserved in ethanol.

Before the study began the collection was curated. Microscope slides and specimens in fluids were organized separately. Slides were organized in slide boxes and given an alphanumeric collection address number on the reverse, a letter indicating the box and a number indicating the slot within each box, which subsequently served as the specimen number used throughout the study (specimens previously used several different specimen numbering systems, or lacked specimen numbers). A sub-selection containing most slides under examination was created for convenience (these slides indicated by RI and RII, identifying the slide box); specimens of species which were numerous in the collection received their own boxes. Specimens in fluids were provided with new vials and fresh 70% ethyl alcohol. Labels were restored and/or new labels were affixed to each vial, incorporating the new specimen number. Specimen numbers for

specimens examined are given at the end of each species description.

For this study, specimens in fluids from the collection were sometimes mounted permanently on slides in Canada balsam. Other specimens were examined in temporary mounts, made with glycerine on a shallow well slide with a cover glass, particularly when very few specimens of a species were available.

Information associated with specimens was stored on an electronic spreadsheet for convenient permanent reference. Data recorded in association with each specimen, when available, included date collected, state, county, town and water body where collected, name(s) of collector and person responsible for rearing and determining the specimen, gender, stage, genus and species. Separate spreadsheets were maintained for specimens on slides and in fluids.

Geographic variability was incorporated into the study to the extent permitted by the specimens available. Specific information on the sources of specimens is given after each species description.

Characters for examination were initially suggested by the practices of earlier investigators. For example, Johannsen (1934) used characters including shape of large

mandibular teeth, coloration (infuscation) of the head capsule, pattern of ventral prothoracic setae, arrangement of pectinate spines of the anterolateral process, relative length of posterolateral and anal process and shape of the anal process. Disney (1975) used characters including arrangement of the apical sensilla of the antenna, shape and proportions of the dorsal median plate, proportions and size of the metaspiracular plate relative to spiracular diameter and proportions and microtrichiation of posterolateral and anal process. Some of these characters were found to be of greater utility than others (see discussion). Other characters for study were selected on the basis of observed physical and color stability from specimen to specimen, such that specimens with highly variable orientation and placement on the slide and state of preservation (especially color) would yield useful data. Morphometric relationships involving structures mobile relative to each other (e.g. whether postanal process extends beyond apex of posterolateral process) were avoided. Color characters which might fade or become bleached in preserved specimens (especially cleared specimens) or which might differ in fresh specimens from exuviae used in studies involving reared larvae were avoided or used as supplementary characters.

Data initially were recorded on prepared data sheets. All major morphological features were monitored for

potentially useful taxonomic characters. As the study progressed it became clear that certain characters initially selected for study were less suitable for making species distinctions than was expected. Some characters were found to be distinctive only at the genus level, such as presence of a collar at the occiput of the head and shape of antenna. The median plates of the ambulacral combs assumed several distinctive forms (Fig. 43) but were highly variable within as well as between species; all forms were found in both Dixella and Dixa, but were found to be consistently distinctive only in the case of Meringodixa chalonensis (Fig. 44). Other characters, including the apical sensilla of the antenna and the number of crochets of the prolegs, were found to be either too difficult to see with the light microscope, or too variable to be of practical taxonomical value. In cases where reasonably reliable interpretation could be achieved, and differences were detected, these data were included in species descriptions (e.g. numbers of crochets); in some cases reliable interpretation was not possible and the character was eliminated from consideration (e.g. apical sensilla of the antenna). Other characters were detected to have some taxonomic potential, and were added to the data sheets (e.g. microtrichiation of the integument).

Specimens were examined with the aid of a Wild M-5 dissecting microscope and a Zeiss Standard 18 interference contrast compound microscope. The Wild was fitted with an

ocular micrometer to facilitate making measurements. The Zeiss was fitted with a camera lucida for making accurate drawings. The data consisted mostly of measurements made with the Wild, drawings made with the Zeiss, and enumeration of repetitive characters.

Data were stored and analyzed with the aid of a personal computer and software including spreadsheet program (Quattro-Pro), word processor (MS-WORD) and statistical package (Statistix).

In most cases, fourth instar larvae and exuviae were quite variable in size, particularly comparing larvae and exuviae. To reduce variation due to different specimen type, age and nutritional factors affecting the size of larvae, measurements were expressed as ratios only. Ratios represent either the relationship of a dimension of one morphological structure to a dimension of another structure, or of one dimension of a morphological structure to another of the same structure. The ratio numbers given in the descriptions are the first character given divided by the second. The means and standard errors of ratios for each species were used as characters in the development of descriptions and the taxonomic key.

Characters which do not lend themselves well to numerical analysis, e.g. shapes of structures, were recorded

in drawings made with the camera lucida. Species were compared and character states assigned. The most important non-numerical character states are illustrated in the Figures.

Certain characters, such as numbers of crochets of prolegs and numbers of spines (Fig. 48) in ambulacral combs were enumerated. In a few cases color was used as a supporting character where it appeared stable and likely to represent the natural condition.

Chaetotaxy was recorded in drawings made with the camera lucida. Due to the variable condition of the specimens with regard to orientation, distortion and clarity, this study does not attempt to locate, characterize and identify every seta. Rather, effort has been made to provide useful taxonomic information on the larger setae and more distinctive setal patterns.

Setae described are denoted by numbers following Belkin et al. (1970). Segmental location of setae is indicated by a prefix capital letter or Roman numeral (e.g. setae C10 and IX13 are seta 10 of the cephalon and seta 13 of [abdominal] segment 9 respectively; see Figs. 1-12). When the prefix is omitted in description, the segment may be assumed to be the same as that last cited. Reference should be made to the

Figures for setal positions characteristic of each genus described.

Setae are denoted as large, medium, small, very small and minute, with references to relative thickness sometimes given. Relative sizes of setae are consistent within but not (necessarily) between species, i.e. the largest setae of one species would be "large" for that species, whereas in another species the same size seta may be "medium", if another seta of that species was typically larger. The relative positions of setae within characteristic groupings is measured in basal (alveolar) diameters, abbreviated henceforth as "b.d".

Genus descriptions contain information which is common to the genus for the specimens under study. Species descriptions contain information which varies within the genus for at least one of the species under study. In cases where reference to a character is omitted in species descriptions, the character may be assumed to conform to the genus description. In those cases in which a character is not described in either genus or species descriptions, it was not observed. In a few cases a structure was missing or destroyed among the specimen(s) available, making description impossible; in these cases notice has been given in the text. Terms used in descriptions follow Peters and Adamski (1982) unless otherwise stated.

A dichotomous key is provided for convenient determination of the larval Dixidae examined. Some species were extremely similar, so are identified by ratio characters only, which are of unknown reliability. Several species were found to be indistinguishable (as larvae) with the data available.

## CHAPTER III

### GENUS AND SPECIES DESCRIPTIONS

#### Meringodixa Nowell

Type species chalonensis Nowell, is the only species of this genus yet discovered and described, thus genus and species descriptions are combined below.

#### M. chalonensis Nowell

Larva.     Head: Ovoid, mean length : width ratio = 0.81 (S.E.= 0.01). Occiput narrower than head; collar weakly to well developed (Fig. 1). Pigmentation at occiput a narrow, even band. Setae C4 and 5 close together, separated by less than 1/2 the distance between setae C4. Seta C7 large, thick (Figs. 1 and 47). Setae C6, 9 and 10 in posterior half of head capsule; seta C6 5-6 b.d. from frontal ecdysial suture. Seta C10 thick proximally, asymmetrically fan-like (Harbach and Knight 1980) in distal half (Figs. 1 and 47). Bases of setae C12 and 13 adjoining. Seta C16 located directly on collar ventrally. A crescent of small triangular spines extends between setae C7 and 10, anterior to the eye (Fig. 47) Antenna: Long, mean length : length of head = 1.0 (S.E.= 0.1). Seta A1 located laterally, about 0.85 of shaft length from base. Shaft naked dorsally with sparse short triangular spines ventrally; mesal cluster of long hair-like

spicules absent. Apices with several long sensilla. Thorax: Ventral prothoracic setae very short (rel. to other genera), mean ratio length of head capsule : length of longest setae = 1.7 (S.E.= 0.1); setae arranged 1:1:4:1::1:4:1:1, setae P4, 7 and 9-12 longer, larger in diameter; setae P3, 5 and 6 smaller, finer (Fig. 13); seta P14 of moderate length and diameter; one of P9-12 subequal to others in length and diameter. Setae P, M and T 1 and 2 widely separated; setae M and T 2 and 3 with bases adjoining. Abdomen: Dorsum of AII-VII with coronae of complex shape (Fig. 10), of long and short aciculate spicules. One pair setal tufts located laterally on each of segments AII-VI. Setae 1 and 2 of segments AI-II widely separated; setae 2 and 3 of AI and II with bases adjoining. Paired prolegs on AI only, small with approximately 7-14 crochets/row. Crochets triordinal (Peterson 1959), with 2 ranks dark, stout hooks cephalad and longer, fragile hooks caudad; crochets directed cephalad. Ambulacral combs located ventrally on V-VII of stout, relatively erect curved spines, alternating with smaller more recumbent spines (Fig. 48). V and VI with 4-5 large spines; VII with 1 or 2 large spines, sometimes none. Median plates of combs very broad, oval in shape (Fig. 44). Seta 3 of VIII large and thick relative to 4 and 5. Spiracular Apparatus: Spiracles small and very widely spaced; postspiracular process small, lanceolate; metaspiracular lobe small (Fig. 4). Paraspiracular setae 4 and 5 located close to spiracle, widely separate from 3, which is located

close to metaspiracular lobe. Paraspiracular seta 5 undivided below midpoint; setae 3 and 4 multiply branched at and above base; seta 3 relatively large and broad. Seta IX13 located on the median plate. Median plate indented moderately posteriorly, anterior edge convex; clear area around seta IX13 large, sometimes nearly dividing plate into three parts, the lateral parts continuous with the posterolateral process (Fig. 17); the median area of plate clothed with short, simple microtrichia. Anterolateral plates large with a single row of 18-20 simple pectinate spines along the posterior edge (Fig. 31); seta IX1 located near dorsocaudal corner of plate, simple or forked. Posterolateral process very elongate, mean width : length ratio = 0.16 (S.E. = 0.03), rounded apically, without points. Anal Segment: X a cone-shaped saddle, reduced ventrally, continuous with a spindle-shaped postanal process. The unit minutely microtrichiose, tapering evenly posteriad, without a terminal point and with 3 pairs large setae apically. Terminal setae X1-3 short, mean ratio length of saddle plus postanal process : length of longest of setae X1-3 = 0.87 (S.E. = 0.03). Setae X3 the longer and distinctly thicker of X1-3, with tips curved dorsad; setae 1 and 2 barbed. Ventro-lateral plate subrectangular, medium in size, continuous with saddle at anterior end (Fig. 34). Seta 4a originates on the plate, 4b on the dorsal edge of the plate and 4c originates near the ventral edge of the saddle,

dorsally to the plate. Seta 4a much thicker and longer than 4c, of medium size; 4b small (Fig. 34).

Specimens Examined. Six 4th instar larvae, Garberville, California, collected VIII-25-1951 (A51-56) and six 4th instar larvae from Del Norte Co., Calif., collected VIII-26-51 (A57-62). Specimens collected and determined by A.A. Hubert.

### Dixella Dyar and Shannon

Larva. Head: Ovoid in shape; occiput usually narrower than head capsule, usually with collar distinct (Fig. 2). Clypeus with 3 pairs simple setae, C4-6; setae C4 and 5 close together, distance between C4 and 5 less than 1/2 that between setae C4. Seta 6 located 1-3 b.d. from frontal ecdysial suture. Labrum bearing a pair dense brushes of fine hairs and 4 pairs setae: C0 (C zero) simple, very small; 1 usually long, flattened, with a square, serrate apex; 2 simple, long; 3 usually lanceolate. Genae with 3 pairs small, simple setae, C7, 9 and 10; seta 8 minute, simple. Venter with 5 pairs setae, C11 small, simple or forked, 12 and 13 small, simple, 1-2 b.d. apart; C14 and 15 very small to minute, fan-like. Seta C16 medium in size, located caudad of ventral edge of occiput; seta C17 minute, located caudad of C16, or apparently absent. Antenna: More curved, slender and tapered than Dixa (Fig. 2), spinose ventrally usually

with a ventromesal cluster of long, hair-like spicules and a single seta (A1) laterally, usually about 2/3 of distance from base to apex. Thorax: Dorsum usually moderately to densely microtrichiose, microtrichiae usually small, simple. Venter usually without microtrichiae to lightly microtrichiose, microtrichiae small, simple. Ventral prothoracic setae P4, 7, 9-12 and 14 (sometimes also P5 and 6) large, long (Figs. 13 and 14), ratio length of head : length of large setae less than 0.55 (n = 12 species). Abdomen: Dorsum usually moderately microtrichiose, microtrichiae small, simple. Venter of I-IV usually without microtrichiae, of V-VIII usually lightly to densely microtrichiose, microtrichiae small, simple. Dorsal coronae absent (Fig. 11). Two pairs ventral abdominal prolegs (Fig. 11), one pair near anterior margin on each of AI and II, equal in size. Prolegs with to about 25 strongly sclerotized and curved, usually triserial (Peterson 1959) and triordinal crochets per row, directed cephalad. Crochets size graded, two ranks short and medium size, pigmented hooks cephalad and longer, frail and colorless crochets caudad (Fig. 45). Ambulacral combs present ventrally on V-VII, composed of stout, erect and curved spines alternating with smaller more recumbent spines, directed caudad (Fig. 48); row divided into two lateral parts by a small pigmented median plate, T-shaped (slender becoming very broad posteriorly) to subrectangular (Fig. 43). Spiracular apparatus: Paired spiracles dorsally on VIII large, closely set relative to

Meringodixa; located in base of lanceolate to round-ended postspiracular process (Figs. 24 and 25); seta VIII7 usually much smaller than adjoining spicules. Between spiracles a cross row of six dendritic paraspiracular setae (Figs. 26-29), a raised median metaspiracular lobe dividing them into two groups; seta 3 close to metaspiracular lobe, setae 4 and 5 located laterally, with bases adjoining, sometimes on a small sclerite. On IX a broad, pigmented dorsal median plate (Figs. 15-19), variously microtrichiose, continuous posteriorly with pair of posterolateral processes with distinct triangular points apically (Fig. 5). Paired anterolateral plates, located ventrally of the posterolateral processes, with a single seta at mid-level in caudal end of the plate, and one large, usually trident pectinate spine ventrocaudad and numerous medium to small single to multi-pointed pectenate spines along posterior edge (Fig. 33). Anal Segment: X a conical saddle-shaped process, incomplete ventrally, separated by a usually distinct suture from a spindle shaped postanal process (Figs. 37-40). Process variously microtrichiose, with six large and long, lightly barbed apical setae (X1-3), ratio length of saddle plus postanal process : length of longest of setae X1-3 less than 0.55 (n = 12 species). Ventrolateral plates large, triangular, separate from saddle, sometimes indistinct (Fig. 35). Setae X4a-c large and similar in size, directed posteriad and arranged in dorsoventral line within posterior edge of plate.

D. alexanderi Peters

Larva. Head: Mean ratio length : width = 0.99 (S.E. = 0.11). Occiput distinctly narrower than head capsule; collar well developed. Pigmentation at occiput a narrow, even band. Labral setae normal. Seta C6 located within 2 b.d. of frontal ecdysial suture; seta 11 forked near apex. Bases of setae C12 and 13 separated by about 2 b.d. Labial setae C14 and 15 very small, fan-like. Antenna: Moderately long, mean ratio length : length of head = 0.64 (S.E. = 0.08). Without microtrichiae dorsally with 25-30 prominent spines ventrolaterally. Setae A1 located about 2/3 the length from base, opposite ventromesal cluster of hair-like spicules. Thorax: Microtrichiation typical. Ventral prothoracic setae long; large setae arranged 1:1:4:1::1:4:1:1 (Fig. 13). Setae P3, 5 and 6 small, fine; setae P4, 7, 9-12 and 14 much longer and larger in diameter. Setae P, M and T 1 and 2 widely separate; setae M and T 2 and 3 at least 2 b.d. apart. Abdomen: Microtrichiation typical. AI-V setae 1 and 2 separated by about 3 b.d.; bases of setae 2 and 3 adjoining on AI-IV; on V setae 2 and 3 separated by about 2 b.d. Sensillum laterally of setae 2 and 3 on AII-IV; between 2 and 3 on V. Prolegs each with approximately 10-25 crochets/row, triserial and triordinal. Ambulacral comb on V with 16-17 large spines, on VI with 18-19 large spines, on VII with 14 large spines. On V setae 11 and 13 both small;

on VI 11 small, 13 much larger; on VII 11 small, 13 much larger than on VII. Setae 4 and 5 on VIII about one setal base apart and arising from a distinct small subtriangular sclerite; setae 5 about as far apart as 3 and 4. Spiracular Apparatus: Postspiracular process rounded laterally (Fig. 25); seta VIII7 minute. Metaspiracular lobe of medium size, ratio length of lobe : length of postspiracular process = 0.47 (n = 1). No data available on median plate.

Paraspiracular setae fan-like, branches beginning about half way up strongly tapered shaft (Fig. 28). Anterolateral plate with seta 1 simple. Posterolateral process relatively broad and short, width : length ratio = 0.44 (n = 1). Anal

Segment: Saddle very short relative to postanal process, ratio length saddle : length postanal process = 0.78 (n = 1). Postanal process long, tapered, slightly wider distad, ratio width : length = 0.32 (n = 1), with terminal point and entirely microtrichiose.

Specimens Examined. Two paratype 4th instar exuviae, Clearwater Co., Minnesota; collected VII-9-63, reared and determined by T. Michael Peters (RI79 and 81).

#### D. aliciae (Johannsen)

Larva. Head: Mean ratio length : width = 0.82 (S.E. = 0.02). Occiput moderately narrower than head capsule; collar typical, sometimes vestigial. Pigmentation at occiput a

moderately broad, even band. Seta 11 simple, C6 at least 2 b.d. from frontal ecdysial suture. Bases of setae 12 and 13 separated by about 2 b.d. Seta C16 located caudad of posteroventral edge of occiput. Antenna: Moderately short, mean ratio length : length of head = 0.58 (S.E. = 0.04). Seta A1 located laterally, nearly 2/3 of length from base, proximal to ventromesal cluster of spicules. Thorax: Dorsum of prothorax densely microtrichiose, microtrichiae small, longer laterally, simple. Mesothorax and metathorax with scale-like microtrichiae dorsally in central area of each segment, simple microtrichiae laterally. Venter entirely without microtrichiae. Ventral prothoracic setae arranged 1:1:1:1:4:1::1:4:1:1:1:1 (Fig.13). Setae P4-14 (except 8) large. Setae P1 closer together than 1 and 2. Abdomen: Dorsum with scale-like microtrichiae in central area of segments, simple microtrichiae laterally; microtrichiae arranged in cross rows of 2-4. Venter virtually without microtrichiae. AI-VII with setae 1 and 2-3 separated by at least 4-5 b.d.; bases of setae 2 and 3 adjoining on AI-IV, separated by 2-3 b.d. on V-VII; Sensillum located laterally of seta 2 and 3 on AII-VII. Prolegs of AI with approximately 23 crochets/row, triserial and triordinal. Ambulacral comb on V with approximately 13-15 large spines, on VI with approximately 13-15 large spines, on VII with approximately 10-12 large spines. Spiracular Apparatus: Postspiracular process squarish to slightly lanceolate laterally (Figs. 23, 24); seta VIII7 large, broader than adjoining spicules.

Metaspiracular lobe large, mean ratio length of lobe : length of postspiracular process = 0.67 (S.E. = 0.04). Paraspiracular setae 3 and 4 fan-like, multiply forked about 1/3-1/2 up strongly tapered shaft (Fig. 28); seta 5 not tapered (Fig. 27), a single fork about 1/3-1/2 up shaft, further divided above. Median plate moderately indented posteriorly, anterior edge straight across or slightly concave, angular; clear area around seta IX13 small (Fig. 15). Anterolateral plate with seta IX1 simple. Posterolateral process of medium proportions, mean width : length ratio = 0.35 (S.E. = 0.02), with microtrichiae present ventrally. Anal Segment: Saddle long relative to postanal process, mean ratio length saddle : length postanal process = 1.14 (S.E. = 0.11). Ventrolateral plates, setae 4a-c normal. Postanal process very broad relative to length (Fig. 38), mean ratio width : length = 0.52 (S.E. = 0.04), with terminal point and entirely microtrichiose.

Specimens Examined. Four larvae from Santa Clara Co., California, collected VI-21-51 (RI90, 92, 94 and 96); three larvae from San Benito Co., Calif., collected IV-23-51 (RI88, 89 and 91); one larva each from San Bernadino, Monterey and Sierra Counties, California, collected IV-2-51, VII-22-51 and VIII-1-51 respectively (RI95, 97 and 93). All specimens collected and determined by A.A. Hubert.

D. californica (Johannsen)

Larva. Head: Average ratio length : width = 0.87 (S.E. = 0.06). Occiput distinctly narrower than head capsule; collar typical, sometimes vestigial. Pigmentation at occiput a narrow to moderately broad, even band. Bases of setae C12 and 13 separated by 1-2 b.d.. Labial setae C14 and 15 small, compound. Seta C17 very small, mesal to seta 16. Antenna: Of moderate length, mean ratio length : length of head = 0.59 (S.E. = 0.02). Setae A1 located about 2/3 length from base; ventromesal cluster of long spicules absent. Thorax: Microtrichiation typical. Large ventral prothoracic setae long, arranged 1:1:4:1::1:4:1:1 (Fig. 13). Setae P4, 7, 9-12 and 14 long and large in diameter, setae P3, 5 and 6 small, fine. Setae P2 and 3 widely separate, M and T 1 and 2 less widely separate; setae M and T 2 and 3 at least 2 b.d. apart. Abdomen: Lightly microtrichiose dorsally and laterally of ambulacral combs, venter otherwise without microtrichiae. AI with seta 1 separated from 2-3 by about 4 b.d.; setae 2 and 3 with bases adjoining; no sensillum present. AII-IV with seta 1 about 2-3 b.d. from setae 2-3; setae 2 and 3 with bases adjoining; sensillum located about 2-3 b.d. laterally of setae 2 and 3. V-VII with space between setae 1 and 3 about 2-3 b.d., more between 1 and 2; setae 2 and 3 separated by about 4 b.d. with sensillum located between. Prolegs each with approximately 16 crochets/row, tetraserial and tetraordinal, a distinct row

of short and tiny crochets, in addition to those usually seen, cephalad to the others. Ambulacral comb on V with approximately 16 large spines, on VI with approximately 14-16 large spines, on VII with approximately 11-15 large spines; median plates narrow becoming broad posteriad, wedge shaped. V-VI with seta 13 small, V and VI with setae 10 and 11 medium size; VII with setae 10 and 11 large. On VIII setae 5 farther apart than 3 and 4; setae 4 and 5 about one b.d. apart, located on a distinct subtriangular sclerite.

Spiracular Apparatus: Postspiracular process rounded to slightly lanceolate laterally (Figs. 10b, c); seta VIII7 minute. Metaspiracular lobe small, mean ratio length of lobe : length of postspiracular process = 0.45 (S.E. = 0.02). Median plate not or hardly indented posteriorly, anterior edge rounded, convex; clear area around seta IX13 small (Fig. 16). Paraspiracular setae 3 and 4 fan-like, basal part tapered, multiple branching about half way up seta; seta 5 less fan-like, basal part not tapered and with fewer branches distad; setae 4 and 5 with bases adjoining, on a small basal sclerite. Posterolateral process relatively broad and short, mean width : length ratio = 0.42 (S.E. = 0.02). Anal Segment: Saddle short relative to postanal process, mean ratio = 0.86 (S.E. = 0.05). Postanal process very broad relative to length (Fig. 38), mean ratio width : length = 0.46 (S.E. = 0.04), with terminal point and entirely microtrichiose.

Specimens Examined. Twelve larvae collected various dates 1951, UC campus, Berkeley, California (RII4-7, 9, 12-15, 17, 19 and 20); three larvae collected Sonoma Co., Calif. IV-22-51 (RII8, 10 and 11) and two larvae from Contra Costa Co., Calif., collected VI-17-51 (RII16 and 18). Specimens collected and determined by A.A. Hubert.

D. clavata (Loew)

Larva. Head: Mean ratio length : width = 0.92. Occiput distinctly narrower than head capsule; collar well developed. Pigmentation at occiput a narrow, even band. Bases of setae C12 and 13 separated by 1-2 b.d. Antenna: Moderately long, ratio length : length of head = 0.67. Setae A1 located laterally, about 3/4 of shaft length from base, opposite ventromesal cluster of hair-like spicules. Thorax: Lightly to moderately microtrichiose dorsally, without microtrichiae to very lightly microtrichiose ventrally; microtrichiae small, simple. Large ventral prothoracic setae arranged 1:1:4:1::1:4:1:1 (Fig. 13). Setae P4, 7, 9-12 and 14 long, large in diameter, setae P3, 5 and 6 small, fine. Abdomen: Microtrichiation similar to thorax. No data on prolegs, crochets or ambulacral combs. Spiracular Apparatus: Postspiracular process rounded laterally (Fig. 25); seta VIII7 minute. Metaspiracular lobe medium size, ratio length of lobe : length of postspiracular process = 0.58. Margin of median plate not indented posteriorly,

anterior edge convex, rounded; clear areas around setae IX13 small (Fig. 16). Paraspiracular setae typical. Anterolateral plate with seta 1 simple. Posterolateral process moderately narrow and long, width : length ratio = 0.32. Anal Segment: Saddle long relative to postanal process, ratio = 1.07. Ventrolateral plates undefined, setae 4a-c normal. Postanal process relatively broad (Fig. 39), ratio width : length = 0.4, with terminal point; dorsum entirely microtrichiose, venter without microtrichiae except for a small patch of microtrichiae distad.

Specimens Examined. One larval exuviae, collected V-22-66 Hampshire Co., Massachusetts, reared and determined by T. Michael Peters (V349).

#### D. cornuta (Johannsen)

Larva. Head: Mean ratio length : width = 0.82 (S.E. = 0.08). Occiput distinctly narrower than head; collar well developed. Pigmentation at occiput a narrow, even band. Seta C6 about 1 basal diameter from frontal ecdysial suture. Bases of setae C12 and 13 separated by 2-3 b.d. Antenna: Long, mean ratio length : length of head = 0.69 (S.E. = 0.06). Setae A1 located laterally, about 0.7 of length from base, opposite ventromesal cluster of hair-like spicules. Thorax: Lightly to moderately microtrichiose dorsally, microtrichiae small, simple; virtually without microtrichiae

ventrally. Ventral prothoracic setae arranged 1:1:1:4:1::1:4:1:1 (Fig. 13). Setae P4, 7, 9-12 and 14 large. Setae P3, 5 and 6 small, fine; setae P1-3 small, approximately equidistant, setae P1 about 5X as far apart as equidistant 1-2, 2-3; M and T 1 and 2 half as far apart as on P; setae M and T 2 and 3 about 3-4 b.d. apart. Abdomen: Lightly microtrichiose dorsally, microtrichiae small, simple; virtually without microtrichiae ventrally. AI with seta 1 separated from 2-3 by about 2-4 b.d.; setae 2 and 3 with bases adjoining; no sensillum present. AII-IV with seta 1 about 2-3 b.d. from setae 2-3; setae 2 and 3 with bases adjoining; sensillum located about 2-3 b.d. laterally of setae 2 and 3. V-VII with setae 1-3 about equidistant, 3-6 b.d. apart; sensillum located laterally to setae 2 and 3. Prolegs with approximately 19-25 crochets/row on AI; triserial and triordinal. Ambulacral comb on V with approximately 13-19 large spines, on VI with approximately 11-19 large spines, on VII with 13-19 large spines; median plates T-shaped (Fig. 43). V-VII with seta 13 small; V with seta 10 medium-small, 11 small, VI with setae 10 and 11 medium-size and VII with setae 10 and 11 large. On VIII setae 5 farther apart than 3 and 4; setae 4 and 5 about one setal base apart and located on a subtriangular sclerite. Spiracular Apparatus: Postspiracular process rounded laterally (Fig. 25); seta VIII7 minute. Metaspiracular lobe of medium size, mean ratio length of lobe : length of postspiracular process = 0.52 (S.E. = 0.01). Margin of

median plate slightly to moderately indented posteriorly, anterior edge convex, rounded; clear areas around setae IX13 large, sometimes nearly dividing plate into three parts (Fig. 17). Paraspircular setae 3-5 fan-like, setae 4 and 5 with bases adjoining. Anterolateral plate with seta 1 forked apically. Posterolateral process relatively broad and short, mean width : length ratio = 0.43 (S.E. = 0.02). Anal Segment: Saddle short relative to postanal process, mean ratio = 0.83 (S.E. = 0.14). Postanal process long, tapered, slightly wider distad, mean ratio width : length = 0.30 (S.E. = 0.04), with terminal point and entirely microtrichiose.

Specimens Examined. Two larval exuviae from Ramsey Co., Minnesota, collected IX-14-62 and VI-31-63 (RI62 and 69); two larval exuviae from Franklin Co., Massachusetts, collected V-22-66 (RII30 and 31), and one larval exuviae collected Dakota Co., Minnesota V-9-63 (V193). Specimens collected, reared and determined by T. Michael Peters.

#### D. deltoura Peters

Larva. Head: Mean ratio length : width = 0.98 (S.E. = 0.01). Occiput distinctly narrower than head; collar well developed. Pigmentation at occiput a narrow, even band. Labral seta 3 with apex rounded. Seta C11 with several forks near apex. Bases of setae C12 and 13 separated by 2-3 b.d.

Antenna: Moderate in length, mean ratio length : length of head = 0.59 (S.E. = 0.01). Seta A1 located laterally about 2/3 of shaft length from base, opposite ventromesal cluster of hair-like spicules. Thorax: Moderately to densely microtrichiose dorsally and ventrally; microtrichiae simple, rather long. Large ventral prothoracic setae arranged 1:1:1:1:4:1::1:4:1:1:1:1 (Fig. 14). Prothoracic setae 4-14 (except 8) large; seta 2 much smaller, of medium size, about 1 1/2X as large as 3; seta 1 not observed. Abdomen: Moderately to densely microtrichiose dorsally and ventrally; microtrichiae small, simple, some rather long. AI-IV with seta 1 and 2 approximately 4-5 setal bases apart, setae 2 and 3 adjoining. V with setae 1-3 approximately equal distances apart. Prolegs AI with approximately 10-13 crochets/row, AII with 12-13/row, triserial and triordinal. Ambulacral comb on V with 4-10 large spines, on VI with approximately 10 large spines, on VII with approximately 7-8 large spines; no data on median plates. V with setae 10, 11 and 13 small, similar in size; VI with these setae larger, subequal in size; VII with seta 12 very close to 11, seta 11 medium, setae 10, 12 and 13 large. On VIII seta 4 and 5 with adjoining bases. Distance between setae 5 about 2X that between 3 and 4. Spiracular Apparatus: Postspiracular process rounded laterally (Fig. 25); seta VIII7 minute. Metaspiracular lobe very large, mean ratio length of lobe : length of postspiracular process = 0.90 (S.E. = 0.06). Median plate deeply divided lengthwise into three parts

(independent of setae IX13), two broad lateral plates associated with posterolateral processes and a separate, slender medial part; clear areas around setae IX13 small (Fig. 18). Paraspiracular setae 3 and 4 fan-like (Fig. 28), seta 5 less fan-like, basal part not tapered and with fewer branches distad (Fig. 27); setae 4 and 5 on a small sclerite. Anterolateral plate with seta 1 simple or forked. Posterolateral process relatively broad and short, mean width : length ratio = 0.41 (S.E. = 0.01); microtrichiae located ventrally, simple, single or arranged in cross rows of 2-4. Anal Segment: Suture between saddle and postanal process ill-defined or absent. Postanal process (Fig. 40) virtually untapered, without terminal point and entirely microtrichiose.

Specimens Examined. Two paratype 4th instar larval exuviae, determined 1964, collected and reared by T. Michael Peters (V1 and 3).

#### D. dorsalis (Garrett)

Larva. Head: Mean ratio length : width = 0.88 (S.E. = 0.06). Occiput distinctly narrower than head; collar well developed. Pigmentation at occiput a narrow, even band. Bases of setae C12 and 13 separated by about 2 b.d. Seta 17 very small, caudad of 16. Antenna: Moderately long, mean ratio length : length of head = 0.67 (S.E. = 0.04). Setae A1

located about 0.7 of shaft length from base, opposite ventromesal spicule cluster. Thorax: Lightly to moderately microtrichiose dorsally, microtrichiae small, simple; virtually without microtrichiae ventrally. Large ventral prothoracic setae long, arranged 1:1:4:1::1:4:1:1 (Fig. 13). Setae P3, 5 and 6 small; setae P4, 7, 9-12 and 14 much longer and larger in diameter. Setae 1 and 2 small; seta 8 present; setae P1 at least 2X as far apart as 2 and 3. Setae M and T 1-3 about equidistant, 5-8 b.d. apart. Abdomen: Lightly microtrichiose dorsally, microtrichiae small, simple; virtually without microtrichiae ventrally. AI with seta AI1 separated from 2-3 by about 2-4 b.d.; setae 2 and 3 with bases adjoining. AII-IV with seta 1 about 2-3 b.d. from setae 2-3; setae 2 and 3 with bases adjoining; at least on III and IV, sensillum located about 2-3 b.d. laterally of setae 2 and 3. V-VII with setae 1-3 about equidistant, 3-6 b.d. apart; sensillum located laterally to or between setae 2 and 3. Prolegs AI with approximately 15-20 crochets/row and AII with approximately 13-23/row, triserial and triordinal. Ambulacral comb on V with approximately 13-16 large spines, on VI with 11-15 large spines, on VII with 10-16 large spines; median plates T-shaped to subrectangular. V-VII with seta 13 small; V with seta 10-12 small, VI with setae 10 and 11 medium size and VII with setae 10 and 11 large. On VIII setae 5 farther apart than 3 and 4; seta 4 and 5 about one setal base apart and located on an irregular oval sclerite. Spiracular Apparatus: Postspiracular process

rounded laterally (Fig. 25); seta VIII7 minute.  
Metaspiracular lobe small, mean ratio length of lobe :  
length of postspiracular process = 0.46 (S.E. = 0.08).  
Median plate slightly to moderately indented posteriorly,  
anterior edge convex, rounded; clear areas associated with  
setae IX13 large, sometimes nearly dividing plate into three  
parts (Fig. 17). Paraspiracular setae 3-5 all fan-like, seta  
5 less strongly tapered, with fewer branches than 3 and 4.  
Anterolateral plate with seta IX1 simple or forked apically.  
Posterolateral process relatively broad and short, mean  
width : length ratio = 0.40 (S.E. = 0.04). Anal Segment:  
Saddle moderately short relative to postanal process, mean  
ratio = 0.90 (S.E. = 0.16). Postanal process long, tapered,  
slightly wider distad (Fig. 37), mean ratio width : length =  
0.34 (S.E. = 0.03), with terminal point, entirely  
microtrichiose, or dorsum microtrichiose and entire or  
proximal 2/3-3/4 of venter without microtrichiae.

Specimens Examined. Two larval exuviae from Anoka Co.,  
Minnesota, coll IX-14-62 (RI43 and 55); one larval skin and  
six larvae from Clearwater Co., Minn., collected VI and VII  
1963 (RII32-36, 52 and V318a). Specimens collected, reared  
and determined by T. Michael Peters.

D. indiana (Dyar)

Larva. Head: Mean ratio length : width = 0.91 (S.E. = 0.03). Occiput distinctly narrower than head; collar well developed. Pigmentation at occiput a narrow, even band. Labral seta C3 relatively small. Seta C6 about 2 b.d. from frontal ecdysial suture. Bases of setae C12 and 13 separated by 2-3 b.d. Antenna: Moderately short, mean ratio length : length of head = 0.55 (S.E. = 0.05). Seta A1 located about 0.6 of shaft length from base, proximal to or opposite ventromesal spicule cluster. Thorax: Moderately to densely microtrichiose dorsally and ventrally, microtrichiae small, simple. Large ventral prothoracic setae long, arranged 1:1:1:1:4:1::1:4:1:1:1:1 (Fig. 14). Prothoracic setae 4-14 (except 8) large; setae 2 much smaller, of medium size, about 1 1/2X as big as 3. Setae P1 closer than 1 and 2; seta M and T 1 about or more than 2X as far from 2 and 3 as 2 and 3 are apart, about 3-4 b.d. Abdomen: Moderately to densely microtrichiose dorsally and ventrally, microtrichiae small, simple, some rather long. AI-IV with setae 1 and 2 approximately 4-5 b.d. apart, setae 2 and 3 adjoining; on AII-IV sensillum located 2-3 b.d. laterally of setae 2 and 3. V with setae 1-3 approximately equal distances apart; sensillum within 2-3 b.d. and laterally of seta 2. Prolegs AI with 11-15 crochets/row, AII with approximately 15/row. Ambulacral comb on V with 9-10 large spines, on VI with 10-12 large spines, on VII with 7-8 large spines; median plates

subrectangular to wedge shaped. V with setae 10 medium size, 11 and 13 small; VI with these setae larger, subequal in size; VII with seta 12 present close to 11, setae 10-13 large. Setae 4 and 5 of VIII with bases adjoining; distance between setae 5 about 2X that between 3 and 4. Spiracular Apparatus: Postspiracular process rounded to slightly lanceolate laterally (Figs. 24, 25); seta VIII7 minute. Metaspiracular lobe very large, mean ratio length of lobe : length of postspiracular process = 0.77 (S.E. = 0.07). Median plate deeply divided lengthwise into three parts (independent of setae IX13), two broad lateral plates associated with posterolateral processes and a separate, slender medial part; clear areas associated with setae IX13 small (Fig. 18). Anterolateral plate seta 1 simple or forked. Posterolateral process relatively broad and short, mean width : length ratio = 0.42 (S.E. = 0.04); inconspicuous microtrichiae ventrally, usually in cross rows of 2-4. Anal Segment: Saddle longer than postanal process, mean ratio = 1.14 (S.E. = 0.11). Postanal process virtually untapered (Fig. 40), mean ratio width : length = 0.38 (S.E. = 0.04), without terminal point, entirely microtrichiose.

Specimens Examined. Six larval exuviae and three larvae from Winona Co., Minnesota, collected VII-1-62 (H1-8, RI77), and one larva from Anoka Co., Minn., collected V-5-56 (H9). Specimens collected, reared and determined by T. Michael Peters.

D. marginata (Loew)

Larva. Head: Mean ratio length : width = 0.95. Occiput distinctly narrower than head; collar well developed. Pigmentation at occiput a narrow, even band. Seta C6 about 1-2 b.d. from frontal ecdysial suture. Bases of setae C12 and 13 separated by about 1 b.d.; seta C13 2X as long and thick as seta 12. Labial setae C14 and 15 large relative to other species of Dixidae, longer than antennal diameter, fan-like. Antenna: Relatively untapered, of medium length, ratio length : length of head = 0.62. Seta A1 located 0.77 of shaft length from base; ventromesal cluster of long spicules absent. Thorax: Dorsal microtrichiae small-medium in size, simple, moderately distributed; venter lightly microtrichiose; microtrichiae small-very small, simple. Large ventral prothoracic setae arranged 1:1:4:1::1:4:1:1 (Fig. 13). Prothoracic setae 4, 7, 9-12 and 14 large; setae 3, 5 and 6 small, slender. Setae P1, 2 and 3 widely separate; setae M and T 1 and 2 closer, setae M and T 2 and 3 about 2 b.d. apart. Abdomen: Microtrichiation similar to thorax dorsally; I-IV virtually without microtrichiae ventrally, V-VIII lightly microtrichiose; venter of VIII and bases of ambulacral combs with microtrichiae in cross rows of 3-5. AI-IV with seta 1 separated from 2-3 by about 4 b.d.; setae 2 and 3 with bases adjoining; sensillum located laterally of setae 2 and 3 at least on III and IV. V-VII with setae 1-3 arranged in a wide triangle (almost in a

line), about 3-4 b.d. apart; sensillum located laterally of or nearly between setae 2 and 3. Prolegs each with approximately 15 crochets/row. Ambulacral combs with about 10-13 large spines each, median plates subtriangular, broader caudad. V and VI with setae 11 and 13 small and slender; VII seta 13 very small, setae 11 and 12 of medium size. On VIII setae 3-4-5 medium, large and medium-large respectively. Setae VIII5 more than 2X as far apart as 3 and 4; setae 4 and 5 less than 1 b.d. apart, without a basal sclerite. Spiracular Apparatus: Postspiracular process rounded laterally (Fig. 25); seta VIII7 minute. Metaspiracular lobe small, ratio length of lobe : length of postspiracular process = 0.45. Median plate about as long as wide; caudal edge not indented relative to seta 13, anterior edge rounded, convex; clear area associated with seta 13 large, nearly separating plate into 3 parts (Fig. 19). Paraspiracular seta 3 fan-like; seta 4 assymmetrically fanlike (forking occurs closer to base mesally than laterally); seta 5 longer than 3 and 4, basal half without branches. Setae 4 and 5 without basal sclerite. Anterolateral plate with large pectinate spine four-pointed; seta IX1 forked. Posterolateral process relatively broad and short, width : length ratio 0.42. Anal Segment: Saddle long relative to postanal process, ratio = 1.29. Ventrolateral plate with only anterior 1/3 pigmented, otherwise indistinct; setae 4a-c typical. Postanal process broad relative to length (Fig. 39), ratio width to length = 0.48,

with a broad terminal point, microtrichiose dorsally and without microtrichiae ventrally except a few microtrichia distad.

Specimen Examined: One 4th instar exuviae from Hampshire Co., Massachusetts, collected VI-26-84, reared and determined by T. Michael Peters (V363).

D. naevia (Peus)

Larva. Head: Mean ratio length : width = 1.02 (S.E. = 0.0). Occiput distinctly narrower than head; collar well developed. Pigmentation at occiput a narrow, even band. Seta C6 about 1 basal diameter from frontal ecdysial suture. Bases of setae C12 and 13 separated by 2-3 b.d. Antenna: Moderate in length, mean ratio length : length of head = 0.63 (S.E.= 0.04). Seta A1 located about 2/3 of shaft length from base, opposite to or marginally proximal to ventromesal cluster of hair-like spicules. Thorax: Moderately microtrichiose dorsally, microtrichiae small-medium size, simple; venter of prothorax moderately microtrichiose, mesothoracic and metathoracic segments lightly microtrichiose ventrally, microtrichiae small, simple. Large ventral prothoracic setae arranged 1:1:4:1::1:4:1:1 (Fig. 13). Setae P3, 5 and 6 small, fine; setae P4, 7, 9-12 and 14 much longer and larger in diameter. Setae P1 about same distance apart as 1 and 2, P2 and 3 about half as far apart;

M and T 1 and 2 6-8 b.d. apart; setae M and T 2 and 3 3-4 b.d. apart. Abdomen: Microtrichiation similar to thorax dorsally; venter of I-IV without microtrichiae, V-VII densely microtrichiose on bases of ambulacral combs, VIII entirely microtrichiose ventrally, microtrichiae fine, simple. AI with seta AI1 separated from 2-3 by about 2-4 b.d.; setae 2 and 3 with bases adjoining; no sensillum present. AII-IV with seta 1 about 2-4 b.d. from setae 2-3; setae 2 and 3 with bases adjoining; sensillum located about 2-3 b.d. laterally of setae 2 and 3. V-VII with seta 1 about 3-5 b.d. from 2 and 3, setae 2 and 3 about 2 b.d. apart; sensillum located within 2-3 b.d. laterally of setae 2 and 3. Prolegs of AI with approximately 16-19 crochets/row. Ambulacral comb on V with approximately 16 large spines, on VI with approximately 16 large spines, on VII with 15 large spines; median plates subrectangular. V-VII with seta 13 small; V with seta 10 medium-small, 11 small; VI with setae 10 and 11 medium size, seta 12 small; VII with setae 10 and 11 large, seta 12 small. On VIII setae 5 farther apart than 3 and 4; setae 4 and 5 about one b.d. apart. Spiracular Apparatus: Postspiracular process rounded laterally (Fig. 24); seta VIII7 minute. No data on metaspiracular lobe. Median plate not indented posteriorly, anterior edge convex, rounded; clear areas around setae IX13 small (Fig. 16). Paraspiracular setae 3-5 moderately fan-like, basal part moderately tapered, especially seta 5, not very broad, branched in the distal half; setae 4 and 5 with bases about

one b.d. apart. Posterolateral process of medium proportions, width : length ratio = 0.38 (n = 1). Anal Segment: Saddle moderately long relative to postanal process, mean ratio = 0.98 (S.E. = 0.03). Postanal process tapered, wider distad, moderately wide relative to length (Fig. 37), ratio width : length = 0.40, with terminal point and entirely microtrichiose.

Specimens Examined. Two larval exuviae from Clearwater Co., Minnesota, collected VI-22-63, reared and determined by T. Michael Peters (V328 and 360).

#### D. nova (Walker)

Larva. Head: Mean ratio length : width = 0.93 (S.E. = 0.03). Occiput distinctly narrower than head; collar usually well developed. Pigmentation at occiput a narrow, even band. Seta C6 about 1 basal diameter from frontal ecdysial suture. Bases of setae C12 and 13 separated by 2-3 b.d. Seta 17 miniscule, located caudad to 16. Antenna: Moderately long, mean ratio length : length of head = 0.64 (S.E. = 0.03). Setae A1 located about 2/3 shaft length from base, opposite ventromesal cluster hair-like spicules. Thorax: Moderately microtrichiose dorsally, microtrichiae small, simple; ventral microtrichiae fine to small, lightly distributed. Ventral prothoracic setae arranged 1:1:4:1::1:4:1:1 (Fig. 13). Setae P4, 7, 9-12 and 14 large. Seta P8 miniscule,

located cephalad of P9-12; P3, 5 and 6 small, slender; setae P1 and 2 very small. Abdomen: Microtrichiation similar to thorax dorsally; venter of I-IV without microtrichiae, V-VIII moderately microtrichiose, microtrichiae small, fine, simple. V-VII with setae 1-3 small, arranged in an broad open triangle, seta 3 nearly between 1 and 2. Prolegs of AI with approximately 10-25 crochets/row, of AII with approximately 15-21/row, triserial and triordinal. Ambulacral comb on V with 14-16 large spines, on VI with 14-15 large spines, on VII with 10-14 large spines; median plates narrow becoming broad posteriad, to subrectangular. V-VII with seta 13 small; V with seta 10 medium, 11 and 12 small; VI with seta 10 large, 11 medium, 12 small; VII with setae 10 and 12 large, 11 small. On VIII setae 5 farther apart than 3 and 4; setae 4 and 5 about one setal base apart and located on a subtriangular sclerite. Spiracular Apparatus: Postspiracular process rounded to slightly lanceolate laterally (Figs. 24, 25); seta VIII7 minute. Metaspiracular lobe small, mean ratio length of lobe : length of postspiracular process = 0.43 (S.E. = 0.05). Median plate slightly to moderately indented posteriorly, anterior edge convex, rounded; clear areas associated with setae IX13 small to large, sometimes nearly dividing plate into three (Figs. 16, 17); paraspiracular setae 3 and 4 fan-like, tapered; seta 5 with basal part untapered. Anterolateral plate seta 1 simple. Posterolateral process of medium proportions, mean width : length ratio = 0.37 (S.E. =

0.03). Anal Segment: Saddle moderate in length relative to postanal process, ratio = 0.93 (S.E. = 0.17). Postanal process long, tapered, wider distad (Fig. 37), ratio width : length = 0.34 (S.E. = 0.04), with terminal point and entirely microtrichiose, or sometimes proximal 3/4 of venter without microtrichiae.

Specimens Examined. Eighteen larval exuviae (A66, 70, 72, 74 and G1-12, 16, 23 and 24) and thirteen larvae (A67-69, 71, 73, and 75-78, G13-14 and 17-18) from Clearwater Co., Minnesota, collected VI-17-63, reared and determined by T. Michael Peters.

#### D. serrata (Garrett)

Larva. Head: Mean ratio length : width = 0.8 (S.E. = 0.05). Occiput narrower than head, collar well developed. Pigmentation at occiput a narrow, even band. Seta C6 about 1 b.d. from frontal ecdysial suture. Bases of setae C12 and 13 separated by 2-3 b.d. Antenna: Long, mean ratio length : length of head = 0.68 (S.E. = 0.04). Seta A1 located about 0.7 of shaft length from base, opposite ventromesal cluster hair-like spicules. Thorax: Lightly microtrichiose dorsally, microtrichiae rather long, simple; venter very lightly microtrichiose, microtrichiae small, simple. Ventral prothoracic setae long, arranged 1:1:4:1::1:4:1:1 (Fig. 13). Setae P4, 7, 9-12 and 14 large. Setae P3, 5 and 6 small,

fine. Abdomen: Lightly microtrichiose dorsally, microtrichiae tubercule-like in central area, simple and relatively long laterally; venters of I-IV virtually without microtrichiae, V-VII lightly microtrichiose, VIII moderately microtrichiose, microtrichiae small, simple. AI with seta 1 separated from 2-3 by about 4-5 b.d.; setae 2 and 3 with bases adjoining; no sensillum present. AII-IV with seta 1 about 2-4 b.d. from setae 2-3; setae 2 and 3 with bases adjoining; sensillum located about 2-3 b.d. laterally of setae 2 and 3. V-VII with setae 1-3 arranged in almost equilateral triangle, seta 1-2, 2-3 and 3-1 about 6-7, 3-4 and 3-4 b.d. apart, respectively; sensillum located 2-3 b.d. laterally of setae 2 and 3. Prolegs of AI with approximately 24 crochets/row, of AII with approximately 21-24/row, triserial and triordinal. Ambulacral comb on V with approximately 17 large spines, on VI with approximately 19 large spines, on VII with approximately 16 large spines; median plates T-shaped (Fig. 43). V-VII with seta 13 small; V with seta 11 small; VI with setae 10 and 11 medium, 12 small; VII with setae 10 and 11 large. On VIII setae 5 farther apart than 3 and 4; setae 4 and 5 about one setal base apart and located on a small subtriangular sclerite.

Spiracular Apparatus: Postspiracular process rounded to slightly lanceolate laterally (Figs. 24 and 25); seta VIII7 minute. Metaspiracular lobe small, ratio length of lobe : length of postspiracular process = 0.38. Median plate not to slightly indented posteriorly, anterior edge convex,

rounded; clear area associated with seta IX13 small to large, sometimes nearly dividing plate into three (Figs. 16, 17). Paraspiracular setae 3-4 fan-like, 5 less tapered. Anterolateral plate seta 1 simple. Posterolateral process relatively broad and short, width : length ratio = 0.40 (S.E. = 0.01). Anal Segment: Saddle very short relative to postanal process, mean ratio = 0.76 (S.E. = 0.15). Postanal process long and slender, tapered, broadest distad (Fig. 37), ratio width : length = 0.29 (S.E. = 0.01), with terminal point and entirely microtrichiose.

Specimens Examined. Two 4th instar larval exuviae from Malheur Co., Oregon, collected VIII-15-62 (RI66 and V194); one larval exuviae from Butte Co., South Dakota, collected VIII-11-62 (V361), reared and determined by T. Michael Peters.

#### D. techana Peters

Larva. Head: Ratio length : width = 0.9. Occiput narrower than head; collar well developed. Pigmentation at occiput a narrow, even band. Seta C6 about 3 b.d. from frontal ecdysial suture. Bases of setae C12 and 13 separated by about 2 b.d. Labial seta 15 not observed. Antenna: Moderate in length, ratio length : length of head = 0.61 (n = 1). Seta A1 located about 0.53 of shaft length from base, proximal to ventromesal hair-like spicule cluster. Thorax:

Moderately to densely microtrichiose dorsally, microtrichiae scale-like in central area of M and T, simple on P and laterally. Venter finely to lightly microtrichiose, microtrichiae small, simple. Ventral prothoracic setae long, arranged 1:1:1:1:4:1::1:4:1:1:1:1 (Fig. 14). Prothoracic setae 4-14 (except 8) large; seta 3 of medium size.

Abdomen: Moderately to densely microtrichiose dorsally, microtrichiae scale-like in central area of each segment, small, simple laterally, venter without microtrichiae to lightly microtrichiose. No data available on crochets or prolegs. Ambulacral comb on V with 12 large spines, on VI with 14 large spines, on VII with 10 large spines; median plates T-shaped. On VIII, setae 4 and 5 with adjoining bases; distance between setae 5 about 2X that between 3 and 4. Anterolateral plate with seta 1 simple. Spiracular

Apparatus: Postspiracular process rounded to slightly lanceolate laterally (Figs. 24, 25); seta VIII7 as long as adjoining spicules, not broad. Metaspiracular lobe of medium size, ratio length of lobe : length of postspiracular process = 0.58. Median plate rather deeply indented posteriorly, anterior edge approximately straight across or slightly concave, angular laterally (Fig. 15); clear area associated with seta IX13 small (Fig. 15). Paraspiracular setae 3 and 4 fan-like, seta 5 less fan-like, basal part not tapered, with fewer branches distad; setae 4 and 5 on a small sclerite. Anterolateral plate seta 1 simple. Posterolateral process relatively narrow and long, mean

width : length ratio = 0.28 (n = 1), venter covered with simple microtrichiae, longer along lateral and mesal edges.

Anal Segment: Postanal process missing.

Specimen Examined. One larval exuvia from Bandera Co., Texas, collected IV-19-62, reared and determined by T. Michael Peters (RI2).

### Dixa Meigen

Larva. Head: Ovoid in shape, genae usually tapering to an occiput narrower than head capsule, never with a collar, usually with acute posterolateral corners (Fig. 3); pigmentation at occiput usually very broad laterally, tapering and much narrower dorsally and ventrally. Labrum bearing a pair of dense brushes of fine hairs and 4 pairs of setae: C0 simple, very small; 1 usually long, flattened, with a pointed to square apex; 2 simple, long; 3 usually lanceolate (Fig. 3). Clypeus with setae C4 and 5 close together, distance between less than 1/2 that between setae C4; seta C6 about 6-8 b.d. from frontal ecdysial suture. Genae with 3 pairs small, simple setae, C7, 9 and 10, seta C8 minute. Venter with 5 pairs setae, C11-15; C11 medium in size; C12 and 13 small, simple, with bases adjoining; C14 and 15 very small and fan-like. Seta C16 medium in size, located caudad of ventral edge of occiput. Antenna: Straight and thick relative to Dixella (Fig. 3), practically

untapered, with venter spinose, with a single seta (A1) located laterally about 2/3 of shaft length from base; ventromesal hair-like spicule cluster absent. Thorax: Dorsum of M and T with microtrichiae scale-like in central areas; P and lateral areas with microtrichiae usually simple. Ventral prothoracic setae 4, 7, 9-12 and 14 large, short, ratio length head : length setae more than 0.55; setae arranged 1:1:4:1::1:4:1:1; setae 5 and 6 small, fine; seta 8 minute (Fig. 13). Abdomen: Dorsal coronae present on AII-VII, composed of a ring of long aciculate macrotrichiae (Fig. 12). Microtrichiae scale-like within coronae, usually with simple microtrichiae outside coronae dorsally; venter without microtrichiae to lightly microtrichiose. Two pairs ventral abdominal prolegs, one pair on each of AI and AII, equal in size, with numerous (to about 28/row) strongly curved, triserial and triordinal crochets directed cephalad. Crochets size graded, with two ranks short and medium size, pigmented hooks cephalad and longer, frail and colorless crochets caudad (Fig. 45). Setae 1-3 of AII-VI located laterally among coronal spicules, of VII located caudad among coronal spicules. Ambulacral combs present on V-VII, composed of relatively large and erect spines alternating with smaller more recumbant spines, directed posteriorly; row divided into two lateral parts by a pigmented median plate, subtriangular (T-shaped) to subrectangular, variable (Fig. 43). VIII with seta 3 medium to large in size, setae 4 and 5 much smaller and slender, with bases adjoining (Fig.

6). Spiracular Apparatus: Paired spiracles dorsally on VIII large, closely set relative to Meringodixa, located in base of lanceolate lateral postspiracular processes (Figs. 24); seta VIII7 minute. Between spiracles a small, raised median metaspiracular lobe, ratio length metaspiracular plate : length postspiracular process less than 0.42 (n = 42 specimens, 5 species), divides a row of six dendritic paraspiracular setae (Fig. 6). On IX the broad, pigmented dorsal median plate is deeply indented along the posterior edge, with a usually bilobate median protrusion; anterior edge convex, sometimes with moderately deep notches laterally; clear areas around seta IX13 always small (Fig. 20). Paired posterolateral processes, continuous with the median plate posteriorly, without ventral microtrichiae and without terminal points (Fig. 6). Paired anterolateral plates, located ventrally to posterolateral processes, with a single row of similar, small to medium simple pectinate spines along the caudal edge (Fig. 32), seta IX1 simple or forked. Anal Segment: X a conical saddle-shaped process, unsclerotized ventrally, continuous with a spindle shaped postanal process (Fig. 41, 42). Process usually darkly pigmented, finely microtrichiose, usually with apical point and six large and relatively short, very lightly barbed terminal setae (X1-3); ratio of length of saddle plus postanal process : length of longest terminal seta between 0.63 and 0.83. Ventrolateral plate small, elongate oval to

diamond-shaped and distinct from saddle. Setae X4a-c differ sharply in size and do not all originate on plate (Fig. 36).

D. adleri Peters

Larva.      Head: Mean ratio length : width = 0.79 (S.E. = 0.04). Genae tapering to a narrow occiput, collar absent; posterolateral corners of head capsule acute (Fig. 3). Pigmentation typical (Fig. 3). Antenna: Moderately short, ratio length : length of head = 0.57 (S.E. 0.02). Thorax: Microtrichiation typical, dorsally and ventrally. Setae P1-3 small, equidistant across dorsum. Setae M and T 1 and 2 small, nearly as far apart as on P; setae M and T 2 and 3 with bases adjoining. Abdomen: Microtrichiae within coronae scale-like, often small, tubercle-like (Torre-Bueno 1950); microtrichiae simple laterally and between coronae and on VIII dorsally; venter without microtrichiae to very lightly microtrichiose. AI with setae 1 widely spaced, about 2X as far apart as 1-2, setae 2 and 3 with bases adjoining. AII-IV with seta 1 about 2-3 b.d. from setae 2; setae 2 and 3 with bases adjoining. V-VI with setae 1-2-3 nearly in line across dorsum, 3-4 b.d. apart; VII with setae 1-3 arranged in a wide triangle, with setae 1 and 2 about 12-15 b.d. apart and setae 1 and 3 about 2-3 bases apart. Prolegs of AI with approximately 19-23 crochets/row, of AII with approximately 17-22/row. Ambulacral comb on AV with approximately 10-12 large spines, on AVI with approximately 10-13 large spines,

on AVII with approximately 10-12 large spines. On V-VI setae 9 and 12 very small, setae 11 and 13 small, seta 10 small-medium. VII with seta 9 very small, setae 12 and 13 small, setae 10 and 11 slightly larger and longer. Ventral setae similar in size on V-VI, setae 10-13 somewhat larger and longer on VII. VIII with setae 3 medium-large in size, setae 5 about 2X as far apart as 3 and 4. Spiracular Apparatus: Median plate typical. Paraspircular setae 3-5 relatively slender; setae 3 and 4 with forks irregular, at several levels; seta 5 without major branches (fine branches only). Anterolateral plate with pectinate spines variable, sometimes forked and trident; seta IX1 with several forks. Posterolateral process relatively narrow and long, width : length ratio = 0.29 (S.E. 0.01). Anal Segment: Anal unit typical (Fig. 41).

Specimens Examined. Four 4th instar larval exuviae collected VII-26-52, VII-6-82 and VIII-30-82 (RII21-24) and two paratype larval exuviae from Center Co., Pennsylvania, collected VII-15-81 (not numbered). Specimens collected by P.H. Adler, determined by T.M. Peters.

#### D. fluvica Peters

Larva. Head: Mean ratio length : width = 0.78 (S.E. = 0.07). Genae taper to narrow occiput, collar absent; posterolateral corners of head capsule acute (Fig. 3).

Pigmentation at occiput typical (Fig. 3). Seta C6 about 7 b.d. from frontal ecdysial suture. Labial setae C14 and 15 fan-like, may appear simple. Antenna: Moderately short, mean ratio length : length of head = 0.58 (S.E. 0.01).

Thorax: Microtrichiation typical dorsally and ventrally. Setae P1-3 small, about equally spaced across dorsum. Setae M1 and 2 small, nearly as far apart as P1 and 2, M2 and 3 with bases adjoining; Setae T1 and 2 small, closer than on prothorax, T2 and 3 with bases adjoining. Abdomen: Dorsal and ventral microtrichiation typical. AI with setae 1 widely spaced, about 2X as far apart as 1-2, setae 2 and 3 with bases adjoining. AII-IV with setae 1 and 2 about 2 b.d. apart; setae 2 and 3 with bases adjoining. V-VI with setae 1-3 about equidistant, in a row, 2 b.d. apart. VII with setae 1-3 arranged in a wide triangle, with setae 1 and 2 about 12-15 b.d. apart and setae 1 and 3 about 2-3 bases apart. Prolegs of AI with approximately 10-20 crochets/row, of AII with approximately 9-20/row. Ambulacral comb on AV with approximately 12-14 large spines, on AVI with approximately 12-15 large spines, on AVII with approximately 8-11 large spines; median plates T-shaped to subrectangular. On V-VII seta 9 very small; seta 12 small. On V setae 11-13 small, seta 10 small-medium. On VI setae 12 and 13 small, setae 10 and 11 small-medium. On VII seta 12 small, setae 10, 11 and 13 small-medium. Setae 9, 10 and 12 (independently) similar in size on V-VII. Setae 11 and 13 similar in size on V, seta 11 larger than 13 on VI, setae 11

and 13 similar in size on VII. VIII with seta 3 medium-large in size, setae 5 about 2X as far apart as 3 and 4.

Spiracular Apparatus: Dorsal median plate typical (Fig. 20). Paraspiracular setae 3 and 4 with forks irregular, at several levels; seta 5 without basal branches. Anterolateral plate seta IX1 simple or with several forks. Posterolateral process relatively narrow and long, width : length ratio = 0.31 (S.E. 0.02). Anal Segment: Anal unit typical (Fig. 41).

Specimens Examined. Nine 4th instar larval exuviae from Clearwater Co., Minnesota, collected VII-8-63 (RII25-27 and I2-7); twenty three larvae from Washinton Co., Minn., collected VII-3-62 (I18-23, 26, 28, 35-40, 44, 46-49, 51-52 and 54-55) by T.M. Peters or X-24-59 by T. Waters; reared and determined by T. Michael Peters.

#### D. lobata Garrett

Larva. Head: Ratio length : width = 0.8. Genae tapering to a narrow occiput; collar absent, posterolateral corners of head capsule acute (Fig. 3). Pigmentation at occiput typical (Fig. 3). Labral seta C3 relatively small. Seta C6 about 7 b.d. from frontal ecdysial suture. Antenna: Moderate in length, ratio length : length of head = 0.62. Thorax: Scale-like microtrichiae present dorsally; venter without microtrichiae to lightly microtrichiose. Thoracic

setae P-T 2-3 small with adjoining bases. Abdomen: Scale-like microtrichiae present within coronae, microtrichiae simple laterally of and between coronae; venter without microtrichiae to very lightly microtrichiose. Prolegs of AI with approximately 26-28 crochets/row, AII with approximately 21+/ row. Ambulacral comb on AV with approximately 12 large spines, on AVI with approximately 12 large spines, no data on AVII; median plates narrow becoming broad posteriad. On VIII setae 3 medium-large, 4 and 5 small, slender, with adjoining bases; setae 5 about 2X as far apart as 3 and 4. Spiracular Apparatus: Median plate with moderately deep notches laterally. Paraspiracular setae 3 and 5 relatively untapered; setae 3 with forks at several levels; seta 5 with forks in distal half only; seta 4 very small, dendritic, about 1/3 as long as 3 and 5 (Fig. 30). Anterolateral plate with pectenate spines small to medium, simple to trident; seta IX1 with several forks. Posterolateral process relatively narrow and long, width : length ratio = 0.27. Anal Segment: Anal unit typical (Fig. 41).

Specimen Examined. One last instar larval exuviae from Grant Co., Oregon, collected VIII-16-62, reared and determined by T. Michael Peters (RI38).

D. pullogruma Peters

Larva.     Head: Mean ratio length : width = 0.84 (S.E. = 0.04). Genae tapering to a narrow occiput; collar absent, posterolateral corners of head capsule acute (Fig. 3) or rounded. Pigmentation at occiput typical (Fig. 3). Seta C6 about 7 b.d. from frontal ecdysial suture. Labial setae C14 and 15 fan-like, may appear simple.     Antenna: Moderately short, mean length : length of head = 0.56 (S.E. 0.03).

Thorax: Dorsal prothoracic microtrichiae simple; dorsal microtrichiae of M and T small, scale-like; venter without microtrichiae to finely microtrichiose. Setae P2 and 3 small; M and T with setae 2 and 3 small, bases adjoining. T with seta 1 about 6-7 b.d. mesal of 2 and 3.     Abdomen: Microtrichiae scale-like within coronae, simple laterally; venter without microtrichiae or finely microtrichiose. AI with setae 1 and 2 about 10 b.d. apart, setae 2 and 3 with bases adjoining. AII with setae 1 and 2 about 2 b.d. apart, setae 2 and 3 with bases adjoining. III with setae 1-3 arranged in a small triangle, seta 1 about 2-3 b.d. (b.d.) from 2, setae 1 and 2 about 3-4 b.d. from 3. IV with seta 1 about 2 b.d. from 3, setae 2 and 3 with bases adjoining. V and VI with setae 1-3 in a row, about 2 b.d. between setal bases. VII with setae 1-3 posteriorly of the dorsal corona, arranged in a wide triangle, with setae 1 and 2 about 12-15 b.d. apart and setae 1 and 3 about 2-3 b.d. apart. Prolegs of AI with approximately 23-27 crochets/row, of AII with

approximately 19-24 crochets/row, triserial and triordinal. Ambulacral comb on AV with approximately 13-14 large spines, on AVI with approximately 12-15 large spines, on AVII with approximately 7-12 large spines; median plate subtriangular to subrectangular (Fig. 43). V with seta 9 very small, 11 and 13 small, seta 10 small-medium in size. VI with seta 9 very small, 10 small-medium, 13 small in size. VII with setae 10 and 11 small-medium, 13 small, seta 9 very small in size. VIII seta 3 large; setae 5 more than 2X as far apart as 3 and 4. Spiracular Apparatus: Median plate deeply indented posteriorly, with a median usually bilobate protrusion; anterior edge convex, rounded, usually with a prominent medial protrusion; a triangular area at center of plate darkly pigmented, especially in the area of the anterior protrusion (Fig. 21). Paraspiracular setae 3 and 4 with forks irregular, at several levels; seta 5 with only several fine branches distad. Anterolateral plate with seta IX1 simple or with several forks. Posterolateral process relatively narrow and long, width : length ratio = 0.30 (S.E. 0.02). Anal Segment: Anal unit usually with small terminal point and minutely microtrichiose.

Specimens Examined. Seven larvae from Pennington Co., South Dakota, collected IX-14-61 and determined by T. Michael Peters (RII28-29 and V11a-e).

D. xavia Dyar and Shannon

Larva.      Head: Subrectangular in dorsoventral views, mean ratio length : width = 0.8 (S.E. = 0.1), genae tapering very little to an occiput nearly as broad as the head (Fig. 46). Pigmentation at occiput a moderately broad to broad band, wider laterally than dorsoventrally. Seta C6 about 7 b.d. from frontal ecdysial suture.      Antenna: Short, mean ratio length : length of head = 0.52 (S.E. 0.06).      Thorax: Dorsum densely covered with scale-like microtrichiae except a very few simple microtrichiae laterally; venter virtually without microtrichiae. Prothoracic seta 1 small, setae M and T 1-3 small; setae 1 about equal distance apart as 1 and 2; setae 2 and 3 with bases adjoining.      Abdomen: Dorsum densely covered with scale-like microtrichiae, inside and outside coroneae and on VIII, except a few simple microtrichiae laterally. AI-VI with seta 0 minute, forked or trident; on VII seta 0 simple. AI with seta 1 about 8-9 b.d. from 2; setae 2 and 3 with bases adjoining. AII with seta 1 about 1-2 b.d. from 3; 2 and 3 with bases adjoining. III and IV with seta 1 about 1-2 b.d. from seta 2; setae 2 and 3 with bases adjoining. V-VI with setae 1-3 in a row, separated by 1-2 b.d., VII with setae 1 and 3 about 2-3 b.d. apart. Prolegs of AI with approximately 26 crochets/row, AII with approximately 12-21 crochets/row. Ambulacral comb on AV with approximately 12-13 large spines, on AVI with approximately 10-12 large spines, on AVII with approximately 8-10 large

spines; median plates T-shaped to subrectangular (Fig. 43). V with seta 9 very small, setae 10-13 small. VI with seta 9 very small, setae 12 and 13 small, 10 and 11 small-medium in size. VII with setae 10, 11 and 13 small-medium, seta 12 small in size. VIII with seta 3 large, seta 4 medium and 5 small, slender; setae 5 about 3X as far apart as 3 and 4. Spiracular Apparatus: Cephalic edge of median plate with moderately deep notches laterally. Paraspiracular setae 3 and 4 with forks irregular, at several levels; seta 5 without basal branches. Posterolateral process of medium proportions, width : length ratio = 0.33 (S.E. 0.03). Anal Segment: Anal unit thick relative to other Dixa (Fig. 42), with terminal point and minutely microtrichiose.

Specimens Examined. Five larvae from Lake Co., California, collected V-20-51 (RI86-87, 100; RII2 and 3); two larvae from Contra Costa Co., Calif., collected VI-16-51 (RI99 and RII51); one larva from Mendocino Co., Calif., collected VI-11-51 (RI98) and one larva from San Benito Co., Calif., collected IV-23-51 (RII1). Specimens collected and determined by A.A. Hubert.

CHAPTER IV

LARVAL KEY TO THE GENERA AND SPECIES OF NEARCTIC DIXIDAE

1. One pair prolegs only, on AI .....  
..... Meringodixa chalonensis
- 1'. Two pairs prolegs, on AI and AII (Figs. 11 and 12)....  
.....2
- 2(1'). Dorsal coronae present on abdominal II-VII (Fig. 12). Posterolateral process without terminal point (Fig. 6). (genus Dixa).....3
- 2'. Dorsal abdominal coronae absent (Fig. 11).  
Posterolateral process with conspicuous triangular point apically (Fig. 5). (genus Dixella).....7
- 3(2). Head capsule subrectangular, occiput as broad as head (Fig. 46). Postanal process thick (Fig. 42). Most dorsal thoracic and abdominal microtrichia flattened and scale-like, densely distributed.....xavia
- 3'. Head capsule ovoid, genae tapering to narrow occiput (Fig. 3). Postanal process slender (Fig. 41).....4
- 4(3'). Dorsal median plate usually with a conspicuous median lobe along cephalic margin, and/or with a triangular,

more darkly pigmented region, especially in the area of the anterior lobe (Fig. 21).....pullogruma

4'. Dorsal median plate without marginal anteromedian lobe and without triangular, more darkly pigmented region (Fig. 20).....5

5(4'). Paraspiracular seta 4 very small, approximately 1/3 as long as 3 and 5. Microtrichiae of postanal process sparse, restricted to the anterior 3/4 of dorsum (Fig. 30).....lobata

5'. Paraspiracular seta 4 approximately same size as 3 and 5. Postanal process microtrichiose over entire surface.....6

6(5'). Seta V-VI 12 about 2X as long as seta V-VI 9 .....fluvica

6'. Seta V-VI 12 about equal in length to seta V-VI 9 .....adleri

7(2'). Large prothoracic setae arranged 1:1:1:1:4:1::1:4:1:1:1:1, i.e. ventral prothoracic setae 5 and 6 large (Fig. 14). Microtrichiae single or in cross rows of 2-4 on venter of posterolateral process.....8

7'. Large prothoracic setae arranged 1:1:4:1::1:4:1:1,  
i.e. ventral prothoracic setae 5 and 6 small (Fig. 13).  
Microtrichiae absent on venter of posterolateral process.  
.....10

8(7). Dorsal median plate fully divided lengthwise into  
3 parts, the central part slender, oriented longitudinally;  
structure not associated with seta IX13 (Fig. 18). Thorax  
and abdomen with microtrichiae about equally dense dorsally  
and ventrally, never flat, scale-like.....deltoura  
.....indiana  
(species indistinguishable with available data)

8'. Dorsal median plate a unit, the caudal margin indented  
cephalad of seta 13, cephalic margin angular, concave (Fig.  
15). Flat, scale-like microtrichiae cover central areas of  
dorsum of M-VIII; venter less densely clothed than dorsum  
.....9

9(8'). Pigmentation at occiput a moderately broad band.  
Postanal process stout, about 2X as long as thick (Fig. 38).  
Seta VIII7 larger than adjoining spicules.....  
.....aliciae

9'. Pigmentation at occiput a narrow band (Fig. 2).  
Postanal process slender, about 3X as long as thick (Fig.

- 37). Seta VIII7 smaller than adjoining spicules.....  
 .....techana
- 10(7'). Antenna with mesoventral cluster of long, hairlike  
 spicules (Fig. 2)..... 12
- 10'. Antenna without a mesoventral cluster of long, hairlike  
 spicules.....11
- 11(10'). Dorsal median plate with clear areas associated  
 with seta IX13 large, breaking plate into 3 parts anteriorly  
 to the setae (Fig. 19). Large pectinate spine of antero-  
 lateral plate with 4 points, similar in size. Occiput of  
 head with a collar; pigmentation a narrow band (Fig. 2).  
 Seta C12 1/2 as long and thick as C13. Saddle longer than  
 postanal process. Microtrichiae of V-VIII in short cross  
 rows of 3-5.....marginata
- 11'. Dorsal median plate with clear areas assoc. with seta  
 IX13 small, the plate a unit (Fig. 16). Large pectinate  
 spine of anterolateral plate with 3 points (Fig. 33).  
 Occiput of head usually without a collar; pigmentation a  
 narrow to moderately broad band. Postanal process longer  
 than saddle. Ventral abdominal microtrichiae of V-VIII not  
 in cross rows.....californica

12(10). Postanal process relatively short and thick, ratio width : length usually at least 0.38. Dorsal median plate with clear areas assoc. with seta IX13 small (Fig. 16).....  
.....13

12'. Postanal process relatively long and slender, ratio width : length usually less than 0.38. Dorsal median plate with clear areas associated with seta IX13 small or large (Figs. 16 and 17).....14

13(12). Head capsule relatively long and narrow, ratio L : W approximately 1.02, and maxillary palp relatively shorter, ratio L of palp : L of antenna less than 0.57, and posterolateral process relatively broader, ratio W : L approximately 0.38, and saddle relatively moderate in length, ratio L of saddle : L of postanal process less than 1.01.....naevia

13'. Head capsule relatively short and wide, ratio L : W approximately 0.92, and maxillary palp relatively longer, ratio L of palp : L of antenna approximately 0.63, and posterolateral process relatively slender, ratio W : L approximately 0.32, and saddle relatively long, ratio L of saddle : L of postanal process approximately 1.07 .....  
.....clavata

14(12'). Head capsule relatively long, ratio L : W greater than 0.9, and setae X4 of ventrolateral plate relatively long, ratio length of anal unit : length of longest seta less than 0.72.....nova

.....dorsalis

.....alexanderi

(species indistinguishable with available data)

14'. Head capsule relatively shorter, ratio L : W less than 0.9, and setae of ventrolateral plate relatively short, ratio length of anal unit : length of longest seta greater than 0.72.....15

15(14'). Posterolateral process relatively short and broad, ratio W : L greater than 0.41.....cornuta

.....dorsalis

(species indistinguishable with available data)

15'. Posterolateral process relatively long and narrow, ratio W : L less than 0.41.....serrata

.....dorsalis

(species indistinguishable with available data)

CHAPTER V  
DISCUSSION

The shape and proportion of the head, particularly the shape and pigmentation of the occiput of the head capsule, as well as aspects of the antennae were of much utility in distinguishing species.

Typically oval in dorsal or ventral view, in Dixa the head sometimes appears subrectangular in this view (D. xavia), due to a much broader than usual occipital foramen. Care must be used in interpreting this character in mounted specimens, as flattening of the head capsule (as by cover glass) may produce a similar appearance, particularly if the clypeus has become detached. In cases where the character has been used it has been verified with specimens stored in fluids.

Proportions of the head are distinctive in many species. Here the length is represented by the combined length of the clypeus and labrum, the width is the widest part of the head. Care must be taken when measuring the width of the head particularly if the clypeus is detached and especially if the head may be flattened by cover glass.

Presence or absence of a collar at the occiput is a useful character in distinguishing the genera (see generic

descriptions) as well as several species of Dixella. In cases where the collar appears to be absent, observation must be made with care because flattening of the head capsule may disguise it, especially if the clypeus is detached.

The use of pigmentation as a character was generally avoided, except in delineating structures such as plates. Inspection of specimens revealed that certain states and methods of preservation may lead to loss of natural color resulting in incorrect evaluation. Coloration was observed to be relatively stable with respect to position, but less stable with respect to intensity. The only significant case in which pigmentation was used as a distinct character was coloration of the occiput of the head capsule; here shape and extent of incidence was the significant factor. Coloration may be a more useful character when fresh or well preserved specimens and more information are available.

The shapes of the ventral teeth of the mandible were used by Johannsen (1934) to discriminate species. In this study however these teeth were found to be quite similar in most species and sufficiently variable within species to eliminate them as a useful character. There is some evidence that the teeth may be mobile relative to each other, as the teeth are in several planes and appear variable in position.

Characters of the antenna proved useful for discrimination of the genera (see generic descriptions) and some species of Dixella. The ratio of the distance of seta A1 from the base to the overall length of the antenna was fairly constant within species, in most cases between 0.6 and 0.7. In several species the ratio differed consistently, from about 0.5-0.55 from the base.

In most species here assigned to the genus Dixella, spines located on the ventral surface of the larval antenna are much more elongate in a short region about 2/3 of the distance from the antenna base, forming a distinct cluster of long hairs (spicules) directed mesoventrad. This character has been identified by several investigators as a distinction between the genera Dixella Dyar and Shannon and Paradixa Tonnoir. Tonnoir (1924) uses presence of the antenna hair cluster to distinguish, in part, his subgenus Paradixa from the subgenus Dixa Meigen, an assignation supported by Edwards (1932). Nowell (1951) assigns larvae of the subfamily Paradixinae with antenna hairs to the genus Paradixa, those without it to Dixella; Belkin (1962) places larvae of species with the antenna hairs in the genus Paradixa, and (1968) describes Paradixa neozelandica as possessing the spicule cluster, Dixella scitula as lacking it. All but two species examined in this study, which are regarded, on the basis of imaginal characters as belonging to the genus Dixella, possess the hair cluster. These

species would on the basis of the earlier characterizations of the larva, belong to the genus Paradixa. The species californica and marginata were the only species found to lack the antenna hair cluster, thus the only ones which on the basis of this character properly belong to the genus Dixella. Edwards (1932) suggested synonymy of Dixella and Paradixa, which was asserted by Lane (1951) and accepted by Nowell (1963), Hubert (1965) and Peters and Cook (1966). Our findings support a conclusion of synonymy of the genera Dixella and Paradixa.

The relationship between the position of seta A1 and the hair cluster of the antenna when present was found to be taxonomically useful. Most often A1 is located opposite the cluster on the shaft; in several cases it was observed to be clearly proximal to it. In the case of D. indiana both conditions were observed. Apical sensilla of the antenna were expected to yield useful characters, having been used by Disney (1975). However, it was found that these were either too similar among species or too small to be interpreted dependably with the light microscope.

Patterns of microtrichiaton were useful in supporting determination of several species of Dixella and Dixa which were also otherwise distinctive, however did not contribute to separating otherwise indistinguishable species. Flat, scale-like dorsal microtrichiae were found on all Dixa

studied, but only on two Dixella, D. aliciae and D. techana. Microtrichiae were noted on the venter of the posterolateral process in four species of Dixella, the same four species which display a distinctive pattern of ventral prothoracic setae (that with setae P4 and 5 large).

These features are particularly useful in discriminating Meringodixa from the other nearctic Dixidae (see generic descriptions). The prolegs possess crochets which are quite similar in the species examined. In all cases but one where a clear observation could be made the crochets were triordinal and triserial, arranged as in Figure 44 (rows sometimes closer together). In D. californica crochets are tetraordinal and tetraserial, a fourth row of minute crochets being present (see species descriptions). Numbers of crochets appear to vary somewhat from species to species, however, they are difficult to count accurately. Counts have been included in species descriptions as an aid in confirming determinations, but must be used with caution.

The ambulacral combs consist of rows of relatively large and erect, curved spines alternating with similar numbers of smaller, straight and more recumbent spines arranged across the venters of V-VII, separated into two groups by a small pigmented median plate (Fig. 48). In the case of Meringodixa chalonensis the number of spines per

comb and shape of the median plates of the combs is distinctive relative to the other two genera discussed (see descriptions). However, in the cases of Dixella and Dixa their utility is doubtful due to similarity between and variation within species observed, in numbers of spines in the combs and variability in the shapes of the median plates of the combs. Numbers of large spines observed in the combs are included in species descriptions as a potential aid in identification.

The size and space between the spiracles is similar in Dixella and Dixa, but distinctive in Meringodixa (see descriptions). Differences in the shape of the postspiracular process are subtle but apparently consistent within species to the extent described. Differences in the form of paraspiracular setae are subtle, were often difficult to observe in preserved specimens, thus are given in species descriptions only; further work should yield information useful in determining species. Metaspiracular lobes are variable and not distinctive in shape; differences in size are broadly species specific. Previously described as the anteromedian lobe (Belkin 1970), the interspiracular disk (Disney 1975) and as the metaspiracular plate (Peters 1982, 1987), the term "metaspiracular plate" has been revised to "metaspiracular lobe", in recognition of its three dimensional character.

Characters associated with the dorsal median plate were found to be among the most useful in grouping species. The shape of the dorsal median plate as revealed by pigmentation, the depth of the median indent along the caudal edge of the plate relative to setae IX13 and the size of unpigmented areas associated with seta IX13 (whether or not they extend to or nearly to the cephalic edge of the plate), were among the most useful characters at the species level. The types of anal processes found correspond to many of those described by Martini (1931). In most cases easily visible, in a single case (D. alexanderi) this plate was not discernable, probably as a result of poor color preservation. The shape of the posterolateral process provides a useful character most easily expressed as the ratio of the width to the length; length was measured from the juncture with the anterolateral plate to the apex. Microtrichiation of the venter of this process provided a useful character in several cases. The anterolateral plates and associated pectinate spines, used by Johannsen (1934), were found to be similar among species within genera and variable within species, so were less useful in distinguishing species than expected. In the case of D. marginata the large, usually trident pectinate spine was found to have four points. Ventrolateral plates were genus specific but similar between and sometimes variable within species. A distinctive case is D. marginata the plate of which is pigmented only in the cephalic third. The several

distinctive characters cited for D. marginata suggest possible support for an argument of validity for the genus Dixapuella Dyar and Shannon.

Shape of the anal unit was found to be a very useful character, consistent within the species and easily seen. Microtrichiation of the postanal process was found to vary somewhat between species but was also sometimes variable within species and in cases where the anal unit was strongly pigmented, difficult to see.

Although the majority of specimens would be expected to produce ratios within the range indicated by the standard error (about 67% based on the sample), clearly some specimens will produce ratios outside this range, thus ratios should be used with care, as contributory evidence.

Patterns of setation might be expected to yield useful characters for species discrimination. In this study however, although genus-level differences were obvious, clear-cut differences between species within genera generally were found in few cases. This was probably due in large part to the limitations imposed by the specimens available. As most specimens were permanently mounted it was impossible to control orientation, thus impossible to account for foreshortening, necessary to accurately measure setal length. Another consequence of the inability to

control orientation was that, as most specimens were mounted dorsal or ventral side up, it was difficult to accurately determine position of setae located laterally. Because many of the best specimens were exuviae, which were compressed "accordion-like" and often otherwise distorted, only the most distinctive groups of setae could be described in terms of relative location. In addition, setae were frequently broken or missing, which further limited interpretation.

Chaetotaxic characters described include the cephalic setae, the ventral prothoracic setae, setae 1-3 of the thorax and abdomen and setae associated with the ambulacral combs, seta 7 of the postspiracular process, the paraspiracular setae and setae 3-5 ventrally on VIII, and setae 1-3 and 4a-c of the anal process. Information on setation should be considered preliminary and as contributory evidence.

Due to the sometimes suboptimal condition of the specimens used, certain of the smallest setae, e.g. post-cephalic seta 17, prothoracic seta 8 and setae 0 (zero) and 14 of the abdominal segments, were difficult to see. Failure to report these setae should not be regarded as conclusive of their absence.

Information given in species descriptions is as accurate as possible given specimens available. Reference to

specimens examined should be made to estimate how fully the information given is likely to represent the variation existing within the species.

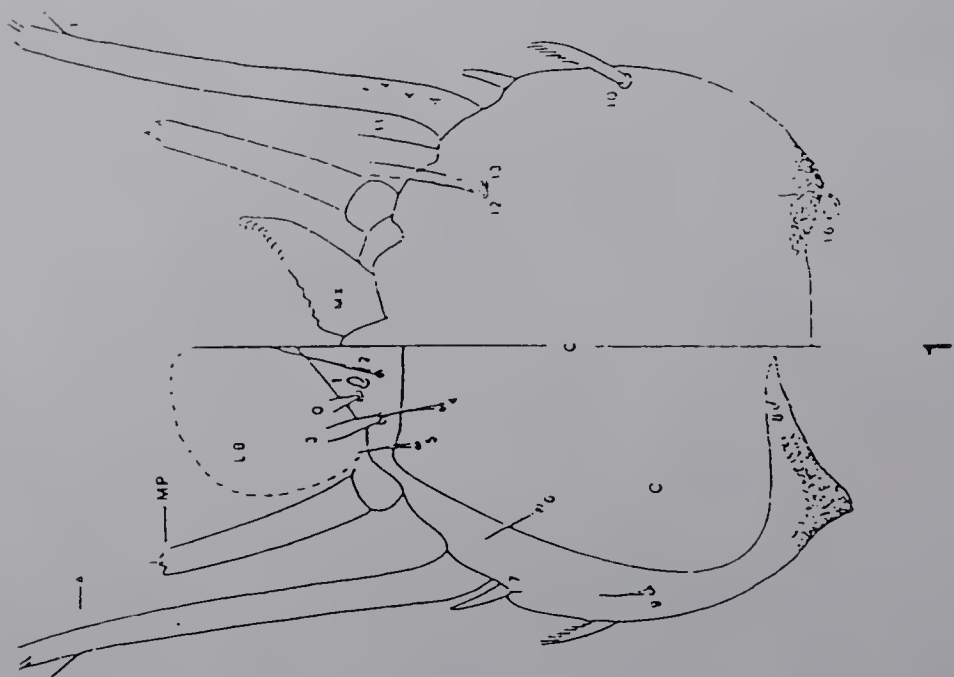
With reference to the dichotomous key provided above, in a number of cases determinations are based largely upon observed differences in proportions (ratios) of certain characters, or combinations of proportions only. These are not necessarily considered to be positively reliable characters. Species for which determination is based on such characters are segregated beyond couplet 11, and notice is given in the key. In these cases more concrete differences between the species were not identified, and further research using better preserved specimens will be necessary to learn to distinguish them with confidence.

Plate 1 Larval Head Capsules

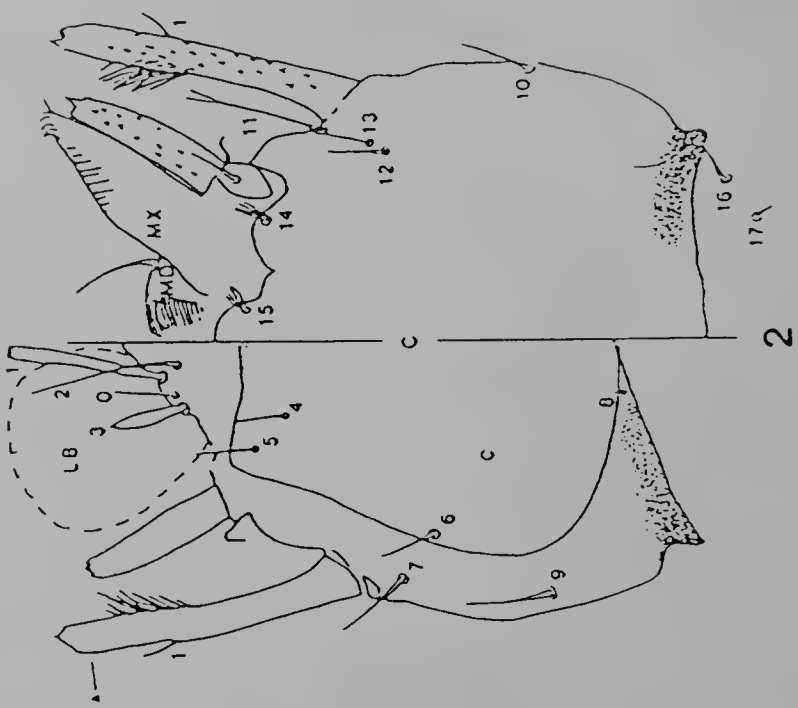
1. Meringodixa. Split drawing of head capsule.
2. Dixella. Split drawing of head capsule.
3. Dixa. Split drawing of head capsule.

Split drawings: Left is dorsal aspect, right is ventral aspect.

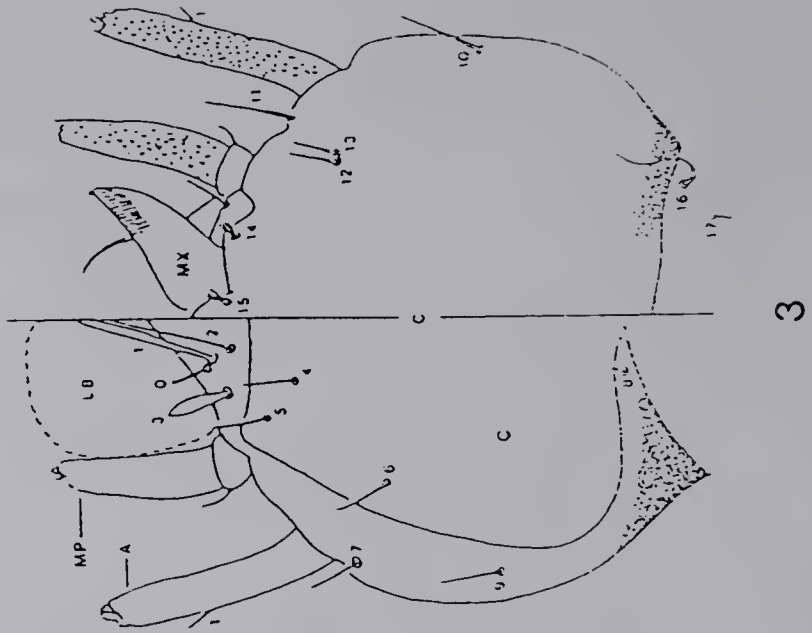
Legend - A antenna; C clypeus; LB labral brush; MP maxillary palp; MX maxilla.



1



2



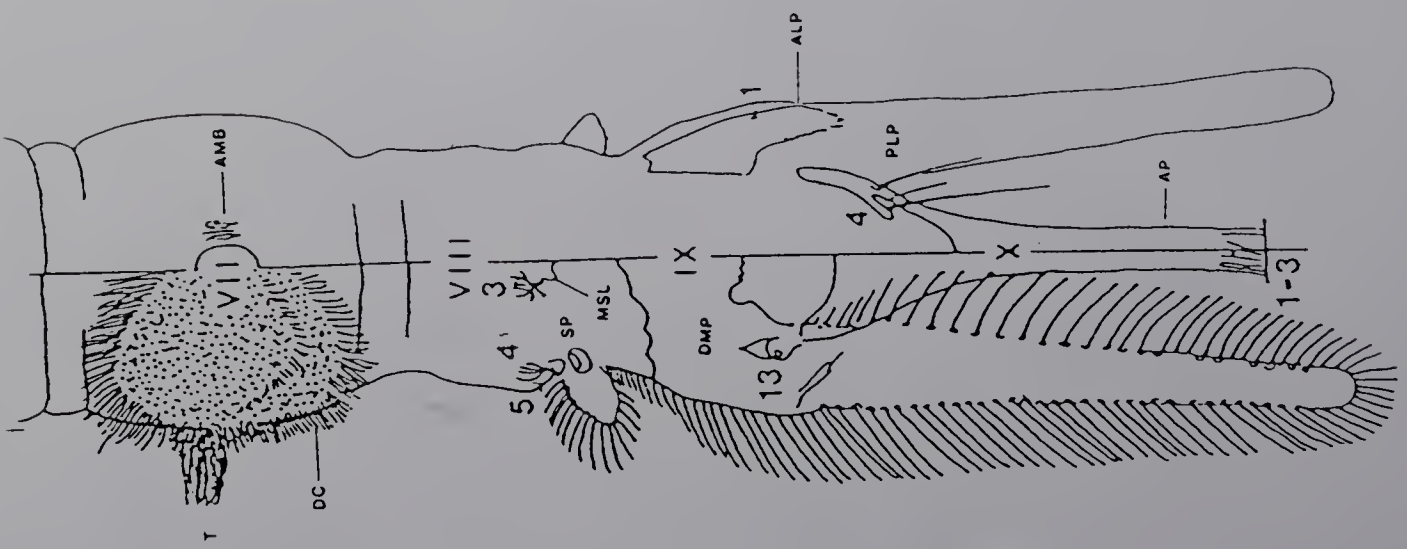
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Plate 2 Larval Terminalia

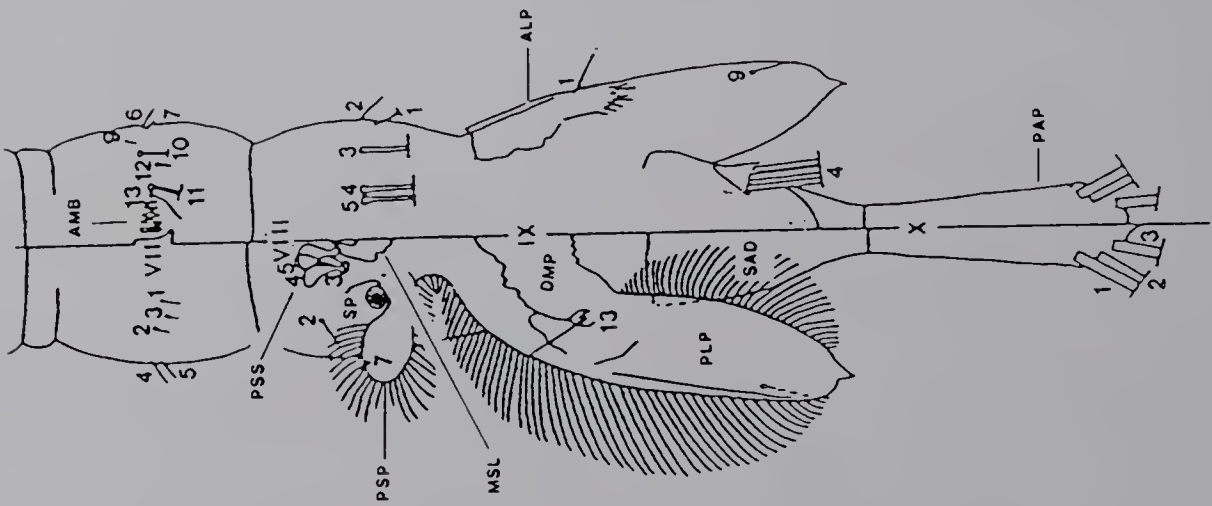
4. Meringodixa. Split drawing of abdominal segments VII-X.
5. Dixella. Split drawing of abdominal segments VII-X.
6. Dixa. Split drawing of abdominal segments VII-X.

Split drawings: Left is dorsal aspect, right is ventral aspect.

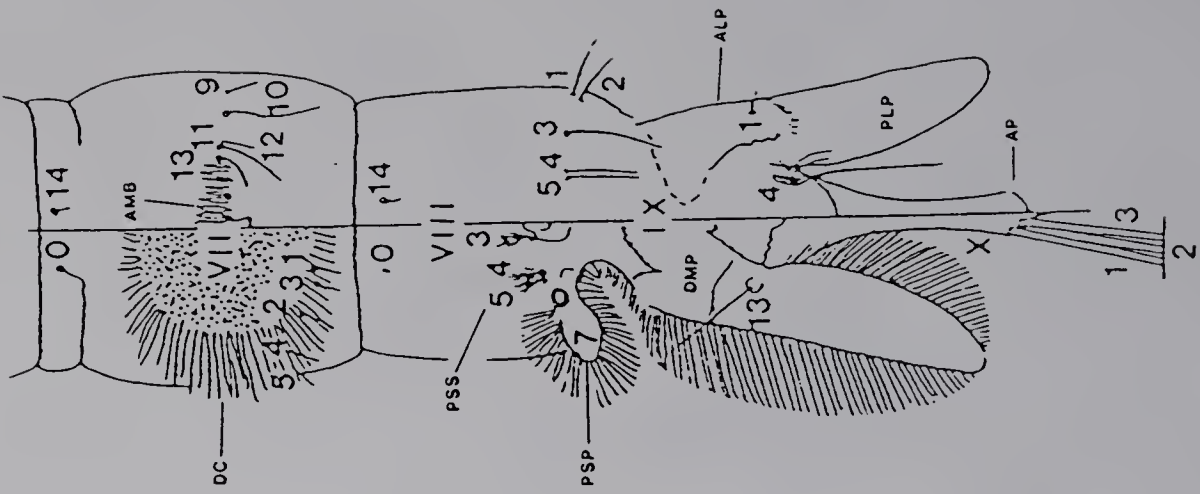
Legend - ALP anterolateral plate; AMB ambulacral comb; AP anal process; DC dorsal corona; DMP dorsal median plate; MSL metaspiracular lobe; PAP postanal process; PLP posterolateral process; PSP postspiracular process; PSS paraspiracular setae; SAD saddle; SP spiracle; T tuft.



4



5



6

Plate 3 Larval Thoraxes

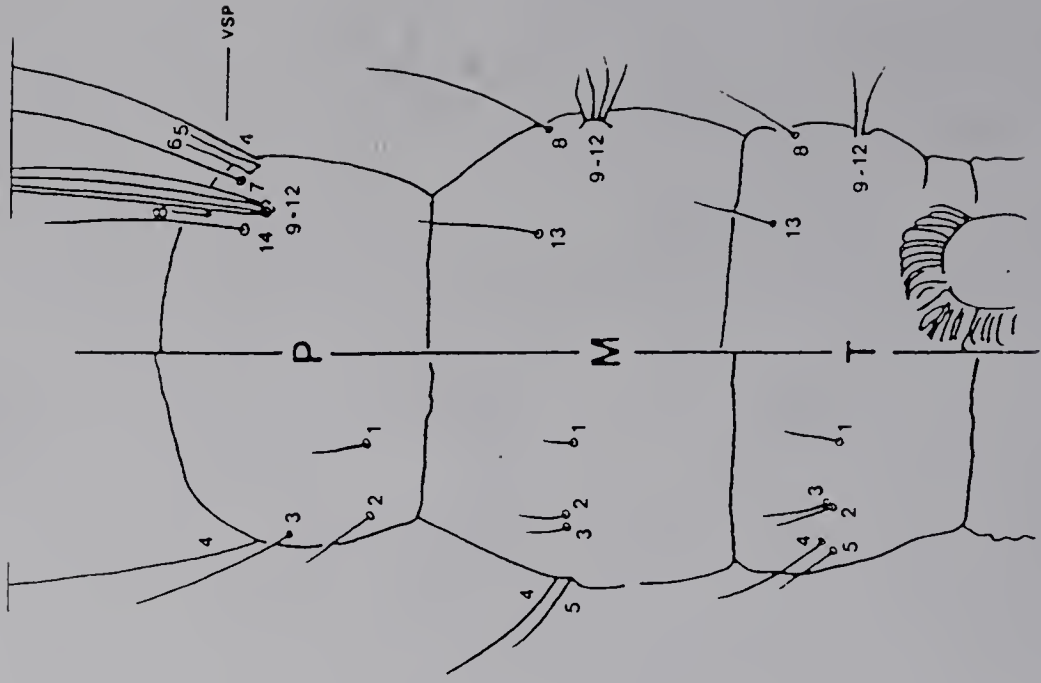
7. Meriogodixa. Split drawing of thoracic segments.

8. Dixella. Split drawing of thoracic segments.

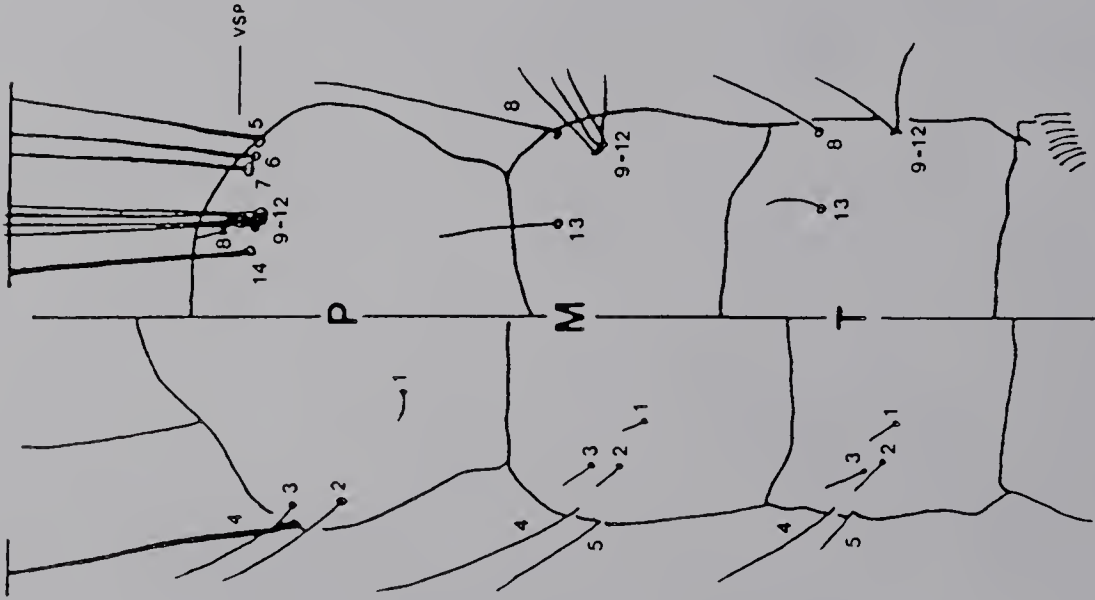
9. Dixa. Split drawing of thoracic segments.

Split drawings: Left is dorsal aspect, right is ventral aspect.

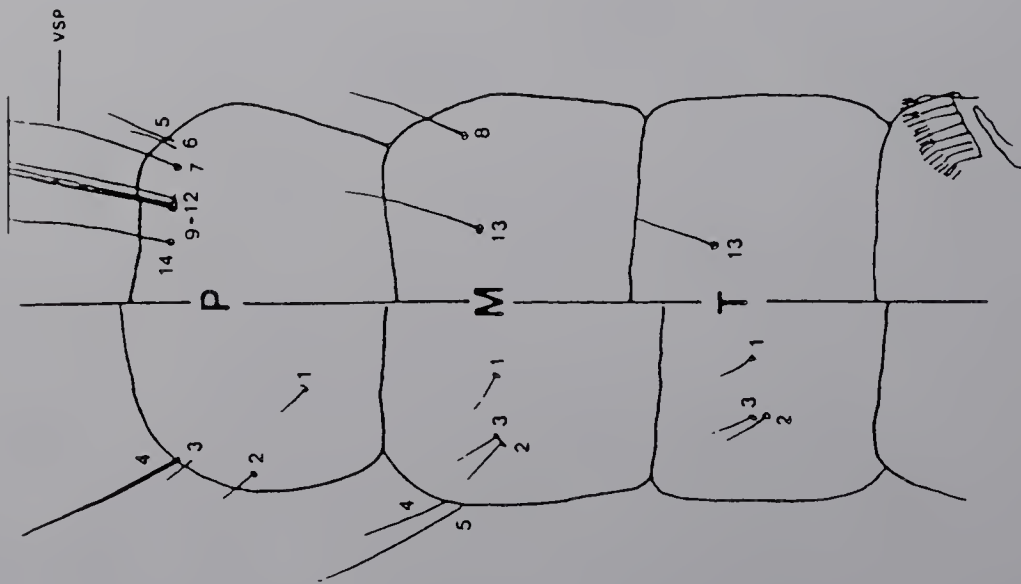
Legend - VSP ventral prothoracic setae.



9



8



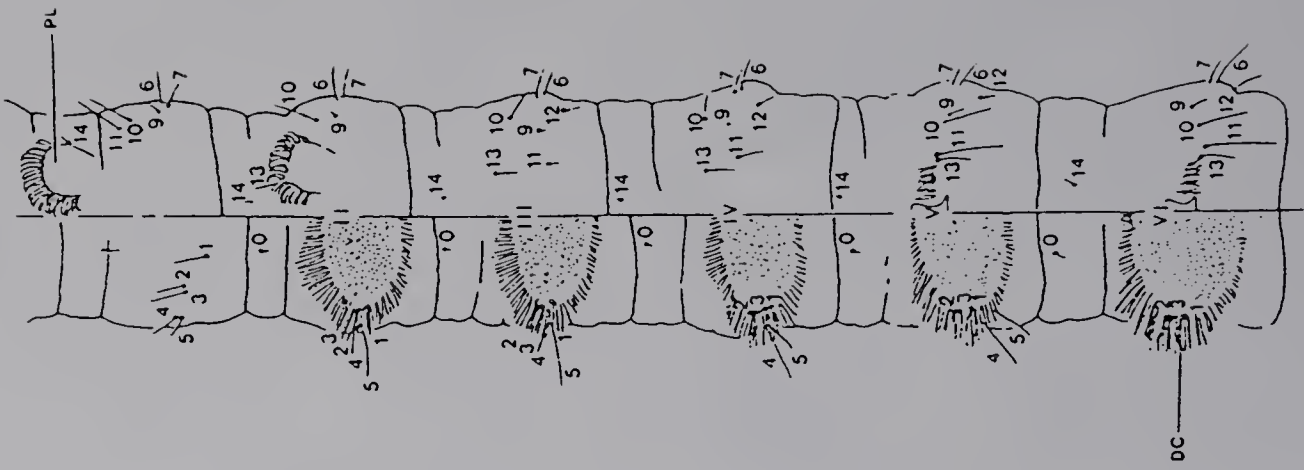
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Plate 4 Larval Abdomens

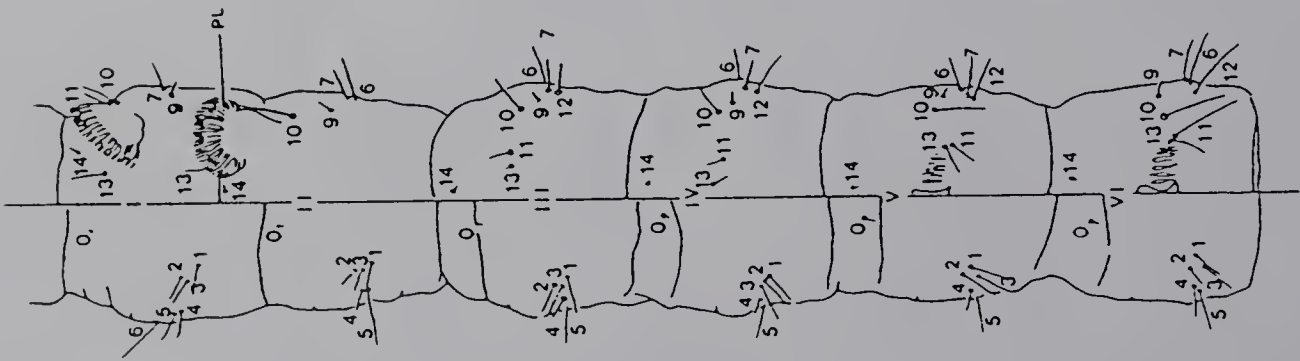
10. Meringodixa. Split drawing of abdominal segments I-VI.
11. Dixella. Split drawing of abdominal segments I-VI.
12. Dixa. Split drawing of abdominal segments I-VI.

Split drawings: Left is dorsal aspect, right is ventral aspect.

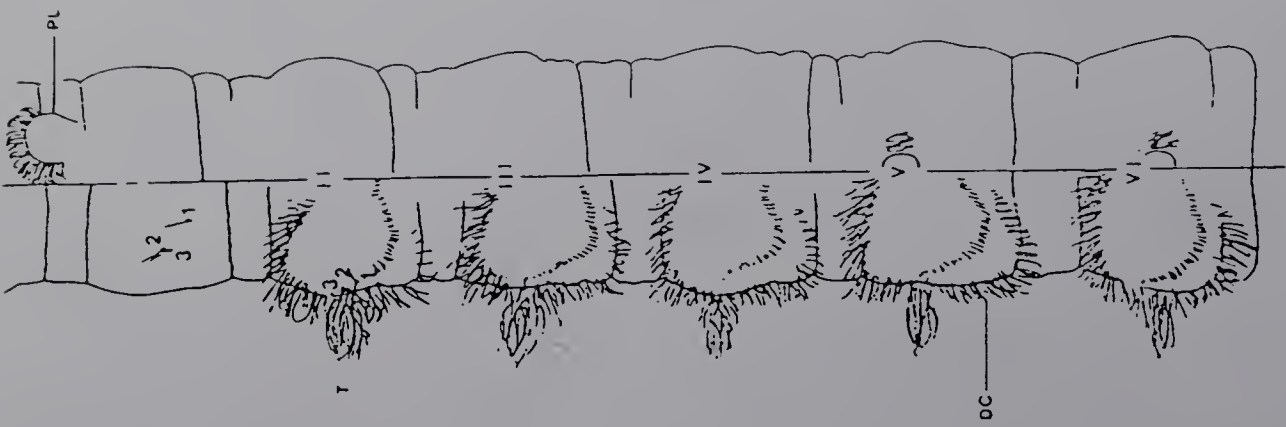
Legend - DC dorsal corona; PL proleg; T tuft.



12



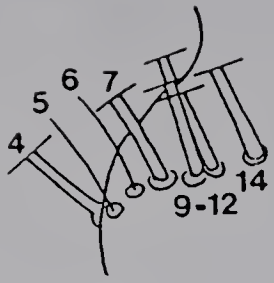
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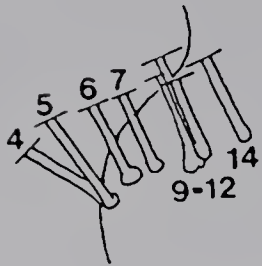
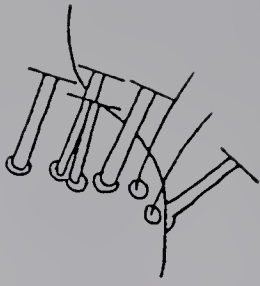
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Plate 5 Larval Ventral Prothoracic Setae and Dorsal Median Plates

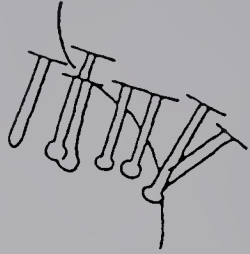
13. Ventral prothoracic setae (ventral aspect).  
1:1:1:1:4:1::1:4:1:1:1:1 pattern.
14. Ventral prothoracic setae (ventral aspect).  
1:1:4:1::1:4:1:1 pattern.
15. Dorsal median plate. Dixella aliciae, D. techana.
16. Dorsal median plate. Dixella californica, D. clavata,  
D. naevia, D. nova, D. serrata.
17. Dorsal median plate. Dixella cornuta, D. dorsalis, D. nova, D. serrata.
18. Dorsal median plate. Dixella deltoura, D. indiana.
19. Dorsal median plate. Dixella marginata.
20. Dorsal median plate. Dixa adleri, D. fluvica,  
D. lobata, D. xavia.
21. Dorsal median plate. D. pullogruma.



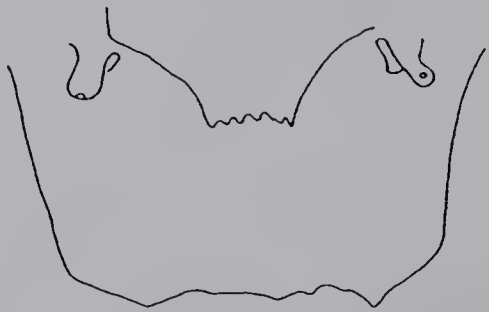
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14



18



15



19



16



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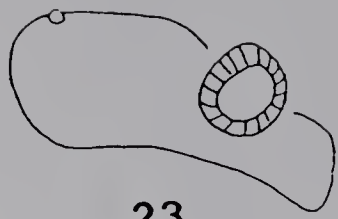
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Plate 6 Larval Postspiracular Processes, Paraspiracular  
Setae and Anterolateral Plates

23. Postspiracular process. Square type.
24. Postspiracular process. Lanceolate type.
25. Postspiracular process. Rounded type.
26. Paraspiracular seta. Branched throughout.
27. Paraspiracular seta. Unbranched below mid-point.
28. Paraspiracular seta. Fan-like.
29. Paraspiracular seta. Assymmetrically fan-like.
30. Paraspiracular setae 4 and 5. Dixa lobata.
31. Meringodixa. Anterolateral plate with pecten (lateral aspect).
32. Dixa. Anterolateral plate with pecten (lateral aspect).
33. Dixella. Anterolateral plate with pecten (lateral aspect).



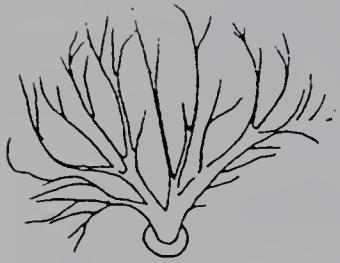
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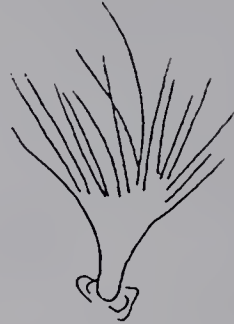
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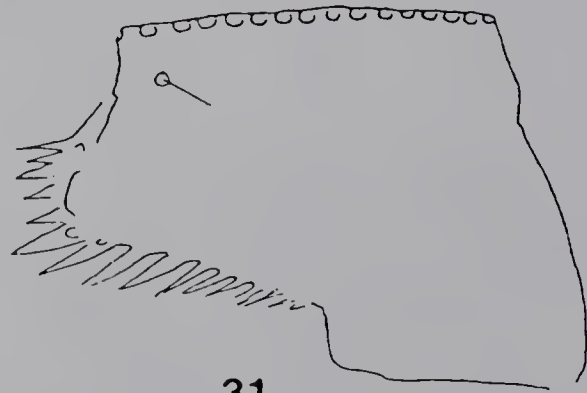
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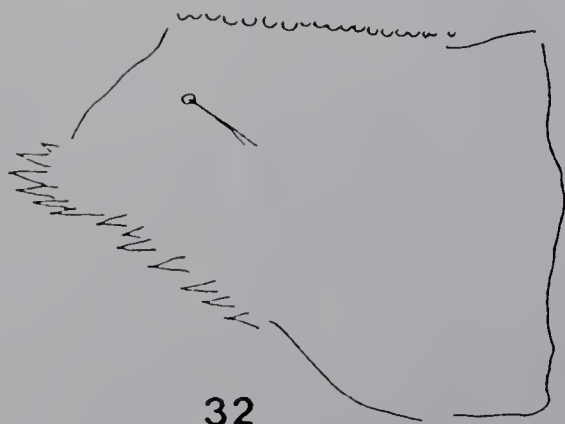
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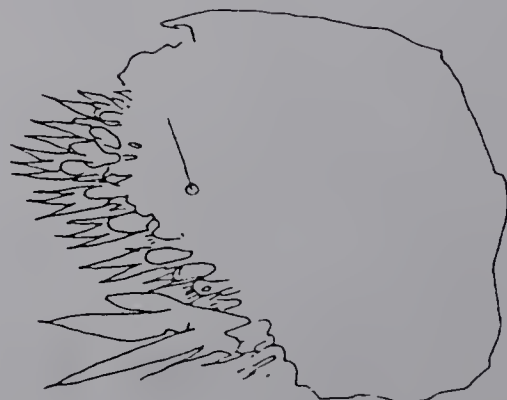
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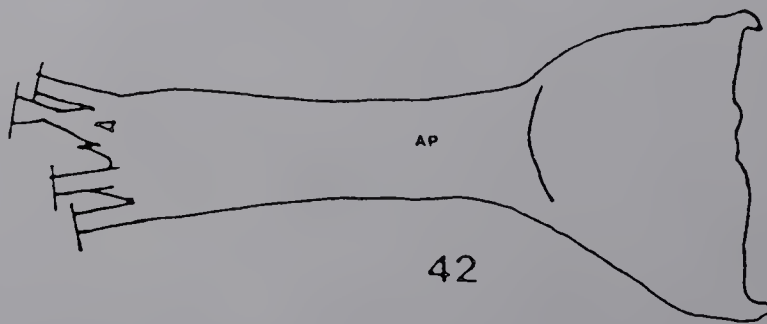
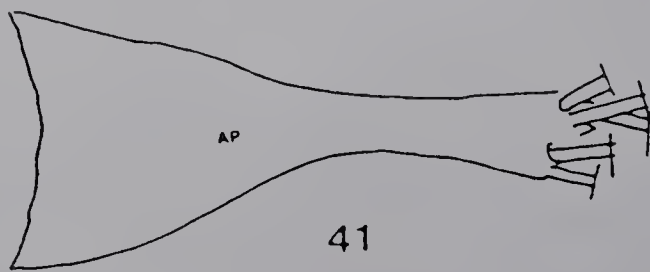
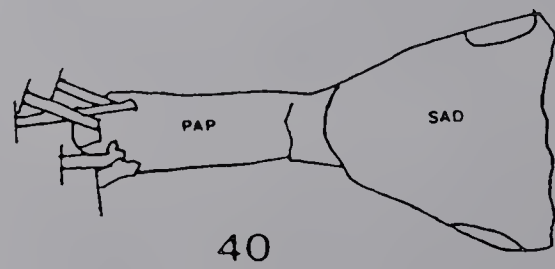
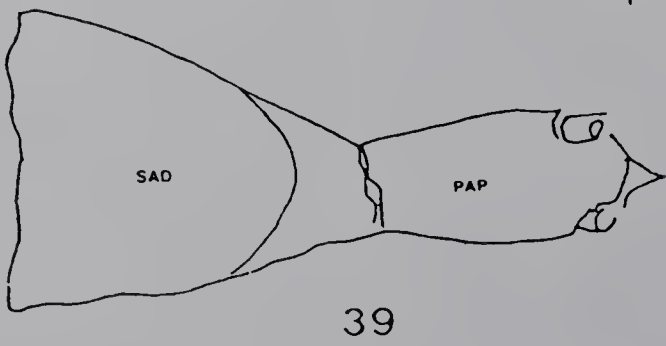
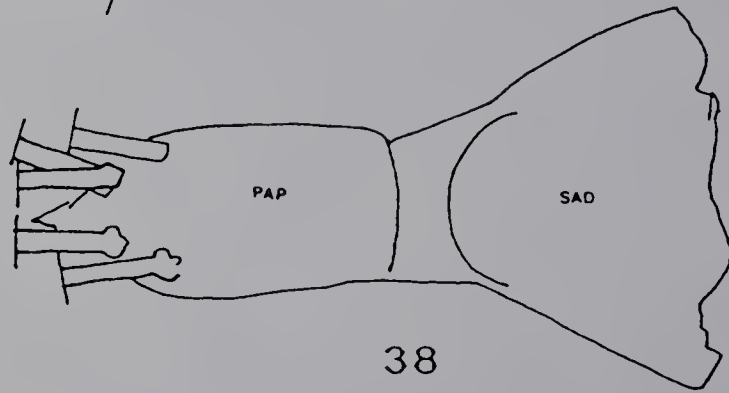
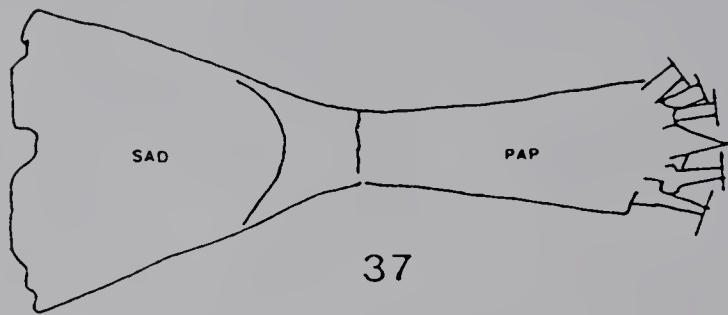
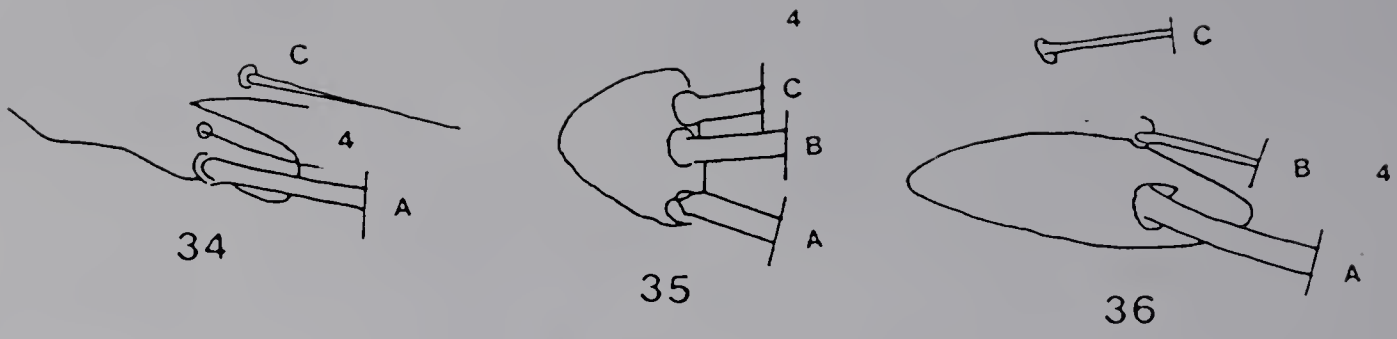


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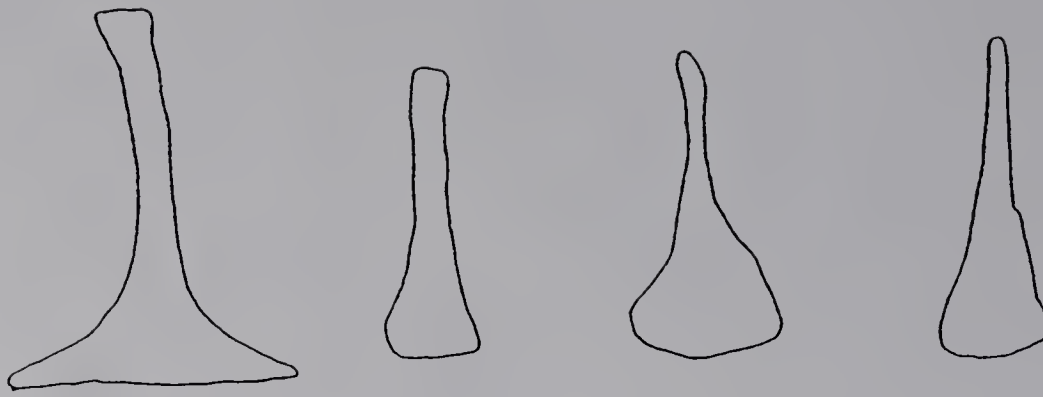
Plate 7 Larval Ventrolateral Plates and Anal Processes

34. Meringodixa. Ventrolateral plate (ventrolateral aspect).
35. Dixella. Ventrolateral plate (ventrolateral aspect).
36. Dixa. Ventrolateral plate (ventrolateral aspect).
37. Anal process (dorsal aspect). Dixella alexanderi, D. cornuta, D. dorsalis, D. naevia, D. nova, D. serrata.
38. Anal process (dorsal aspect). Dixella aliciae, D. californica.
39. Anal process (dorsal aspect). Dixella clavata, D. marginata.
40. Anal process (dorsal aspect). Dixella deltoura, D. indiana.
41. Anal process (dorsal aspect). Dixa adleri, D. fluvica, D. lobata, D. pullogruma.
42. Anal process (dorsal aspect). D. xavia.

Legend - AP anal process; PAP postanal process; SAD saddle.







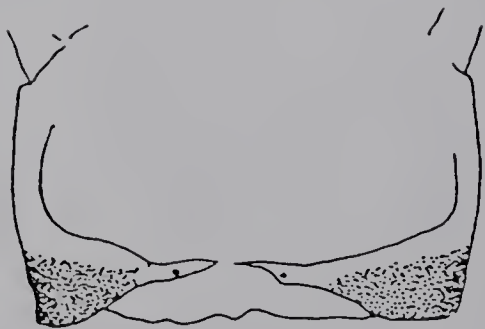
43



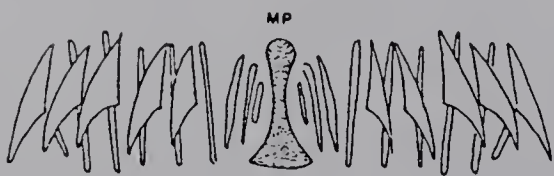
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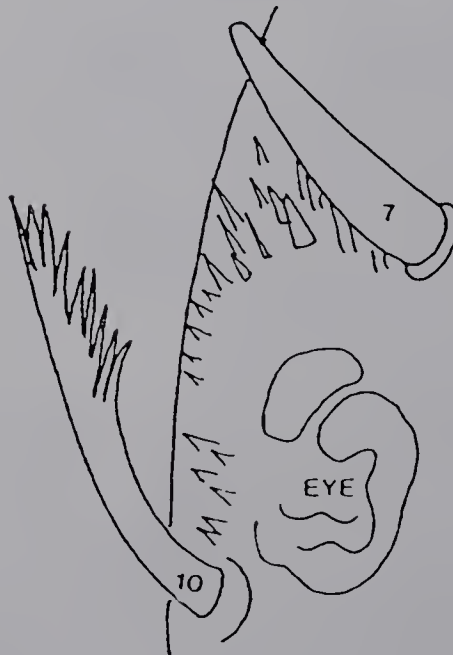
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