

**FIVE NEW SPECIES IN THE SUBGENUS *PARASITATAX*
(ACARI: UNIONICOLIDAE: *UNIONICOLA*) FROM NORTH AMERICA AND ASIA,
WITH A RE-EVALUATION OF RELATED SPECIES**

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ABSTRACT—Five new species (*Unionicola (Parasitatax) dimocki*, *arcuatoides*, *bishopi*, *cooki* and *tumidoides*) are described for the first time. All species in *Parasitatax* are mussel parasites. The species of the subgenus are re-evaluated, and distribution and host records are reported for *U. ypsilophora* (Bonz), *U. arcuata* (Wolcott), *U. tumida* (Wolcott) and *U. thienemanni* Viets.

INTRODUCTION

The subgenus *Parasitatax* Viets 1949 was re-evaluated by Viets (1957) and later diagnosed by Cook (1974). These mites are parasites of fresh-water mussels (Unionacea) in North America, Europe and Asia (Vidrine and Bereza 1978 and Vidrine 1980). Studied species deposit eggs in the blade of the gills (demi-branches) of their hosts. The species in this taxon are re-evaluated, and new distribution and host records are presented. Five new species are described for the first time.

The author has examined preserved lots of mussels for mites from: The Academy of Natural Sciences of Philadelphia (ANSP); The Ohio State University Museum, Columbus (OSUM); The United States National Museum (Smithsonian Institution), Washington (USNM); The Museum of Zoology of the University of Michigan, Ann Arbor (MZUM); and The National Museum of Canada, Ottawa (NMC). The fresh-water mussels have recently been re-evaluated by Brandt (1974), Burch (1975), Clarke (1981a and b, 1985) and Davis and Fuller (1981).

Holotypes and representative paratypes are deposited in the Canadian National Collections and Biosystematics Research Institute, Agriculture Canada, Ottawa (CNC). Additional paratypes are retained in the author's collection.

Terminology for adult structures follows that used by Vidrine (1985a). Measurements are expressed in microns in the format, mean (range). All bars on figures equal 100 microns (0.1 mm).

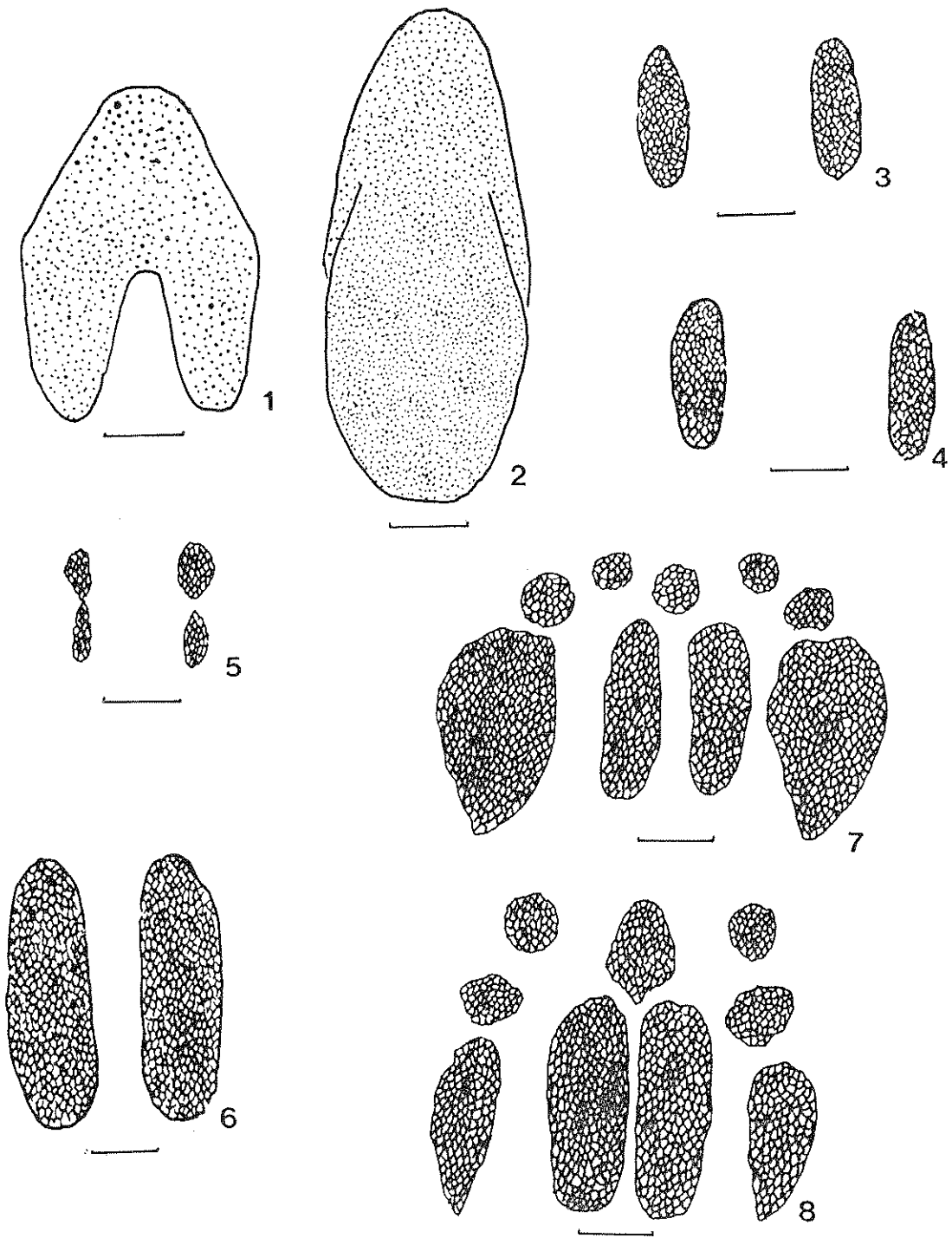
RESULTS

1. *Unionicola (Parasitatax) ypsilophora* (Bonz 1783) (Fig. 3)

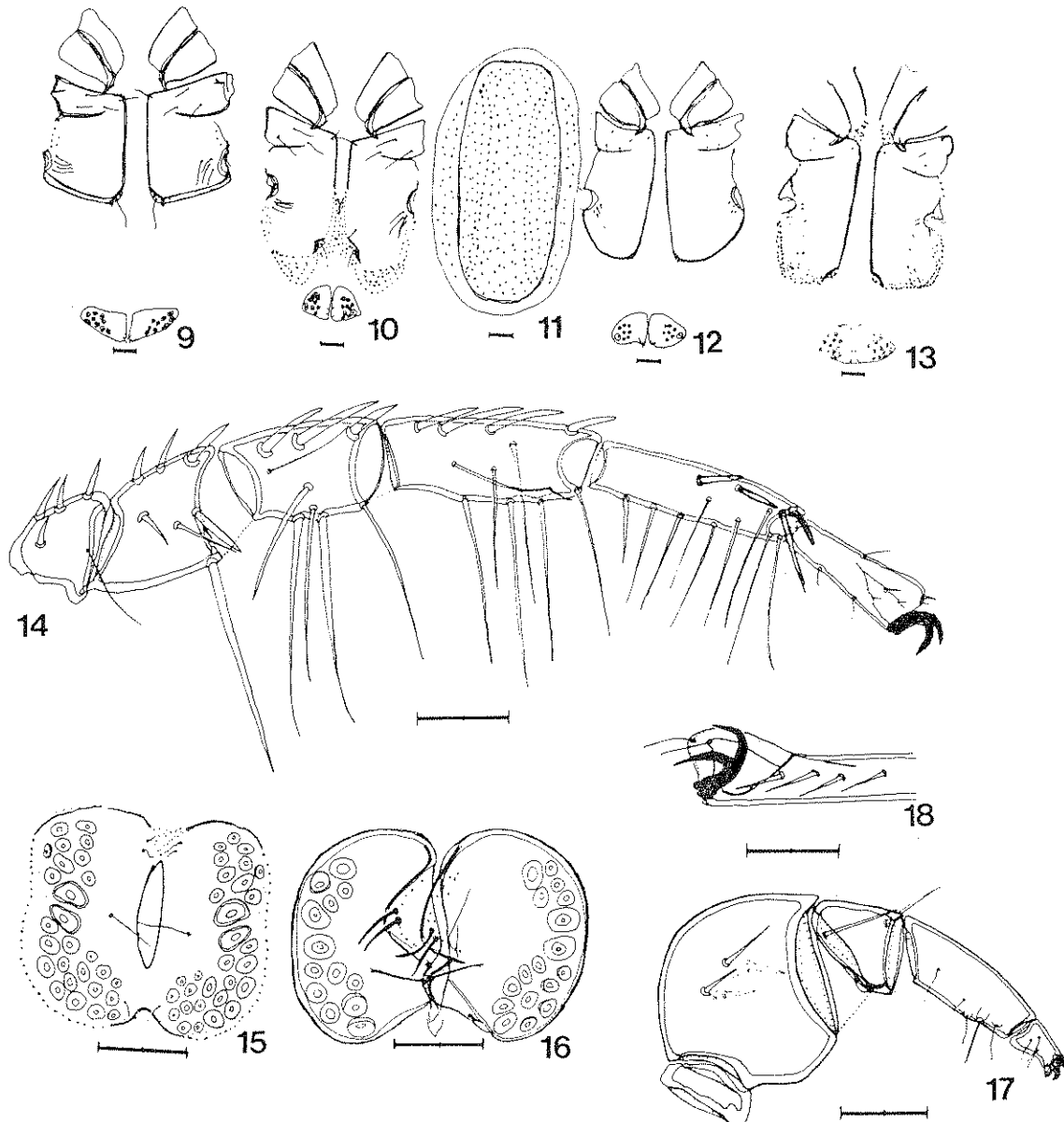
DIAGNOSIS — Character states of the subgenus; male dorsum with an elongate plate; female dorsum with 2, small, widely separated plates (fig. 3); male posterior coxal group with well sclerotized and distinct posterior borders and with only moderate secondary sclerotization fusing coxal plates to the abdomen and the genital field.

MALE (5 specimens): Length including capitulum 1150 (1000-1250); length of posterior coxal group 500 (480-540); dorsal lengths of pedipalp segments: Ti 185 (170-200); Ta 65 (60-70); dorsal lengths of leg segments: leg I: TFe 188 (170-200); Ge 255 (230-290); Ti 240 (210-270) Ta 178 (160-200); leg IV: TFe 263 (230-300); Ge 418 (360-480); Ti 553 (500-640); Ta 448 (410-500).

NOTES — Specimens were measured from: *Anodonta cataracta* Say (NMC 20531) from Sydney River southwest of junction of Highways 4 and 5, Cape Breton County, Nova Scotia, Canada, 4 May 1962 (A.M. Rick); *A. cataracta* (NMC 56559) from Lake George at southwest end, New Brunswick, Canada, 30 June 1962 (A.M. Rick); *A. implicata* Say from 100 acre pond, Rhode Island, 10 September 1978; *Obovaria olivaria* (Rafinesque) from Mississippi River ca. 8.0 km southeast of Guttenberg, Clayton County, Iowa (U.S. Army Corps of Engineers Mississippi River Project), 1977 (S.L.H. Fuller); and *A. grandis* Say



Figs. 1-8. *Unionicola uchidai* Imamura: 1. female dorsal plate (redrawn after Imamura 1953); *U. thienemanni* Viets: 2. female dorsal plate; *U. ypsilophora* (Bonz): 3. female dorsal plates; *U. formosa* (Dana and Whelpley): 4. female dorsal plates; 5. female dorsal plates; *U. dimocki* n. sp.: 6. female dorsal plates; 7. female dorsal plates; 8. female dorsal plates.



Figs. 9-18. *Unionicola formosa* (Dana and Whelpley): 9. female venter; 10. male venter; 11. male dorsum; *U. dimocki* n. sp.: 12. female venter; 13. male venter; 14. male first walking leg; 15. male genital field; 16. female genital field; 17. male pedipalp; and 18. male distal end of tarsus of fourth walking leg.

from Mississippi River at Lansing, Allamakee County, Iowa (U.S. Army Corps of Engineers Mississippi River Project), 1977 (S.L.H. Fuller). In each case only a single male was encountered in a single host.

REMARKS — Only the males can be distinguished from *U. formosa* (Dana and Whelpley) (Mitchell 1957). *U. ypsilophora* has been adequately figured in Mitchell and Pitchford (1953) and Hevers (1978). Although all previous North American records of *U. ypsilophora*, except Baker's (1982) record from New

York, are suspect, these males closely match European males in coxal plate structure and measurements of leg segments. Previous authors (Wolcott 1899, Marshall 1933 and Viets 1956) considered all North American specimens of this complex to be *U. ypsilophora*, and later Mitchell (1957) considered all North American specimens to be *U. formosa*. However, these two sibling species are variable and similar, and they may be conspecific. The females are presently indistinguishable, while the males are separated based upon the

structure of the posterior coxal group. My lots of this group from the northeastern portion of North America are small and insufficient to confirm the presence of intermediates in this region of range overlap for *U. ypsilophora* and *U. formosa*, and thus, I treat them as two species and extend the range of *U. ypsilophora* to northeastern North America. A third species in this group is described in this paper.

2. *Unionicola (Parasitatax) formosa*
(Dana and Whelpley 1836)
(Figs. 4, 5 and 9-11)

DIAGNOSIS — Character states of the subgenus; male dorsum with an elongate plate (fig. 11); female dorsum with 2, small, widely separated plates, sometimes divided into 3 or 4 smaller plates with varied degrees of fusion (figs. 4-5); female posterior coxal group usually not elongated nor extending much posterior of the junction with the fourth walking leg (fig. 9); male posterior coxal group with poorly sclerotized posterior border and with extensive fusion along midline and with abdomen and genital field by secondary sclerotization (fig. 10).

MALE (13 specimens): Length including capitulum 1190 (1000-1400); length of posterior coxal group 595 (580-600); dorsal lengths of pedipalp segments: Ti 191 (160-220); Ta 68 (60-75); dorsal lengths of leg segments: leg I: TFe 195 (180-240); Ge 270 (240-300); Ti 263 (230-300); Ta 168 (150-180); leg IV: TFe 271 (240-300); Ge 456 (400-510); Ti 631 (550-700); Ta 510 (450-570).

FEMALE (16 specimens): Length including capitulum 1467 (1200-1800); length of posterior coxal group 454 (350-580); dorsal plate 235 (220-250) long, 85 (70-100) wide; dorsal lengths of pedipalp segments: Ti 151 (110-190); Ta 63 (50-80); dorsal lengths of leg segments: leg I: TFe 166 (130-210); Ge 233 (170-300); Ti 227 (160-290); Ta 151 (130-170); leg IV: TFe 276 (230-330); Ge 449 (350-540); Ti 588 (470-700); Ta 479 (380-570).

NOTES — Upon re-examination of lots in my collection, *U. formosa* occurred in the following mussel lots (specific locality data in Vidrine 1980): *A. cataracta* (Delaware and Pennsylvania), *A. grandis* (Louisiana, Texas, Wisconsin, Iowa, Ohio, Missouri, Minnesota and Illinois), *A. imbecilis* Say (Louisiana, Arkansas, North Carolina, Pennsylvania, Texas, Mississippi, South Carolina, Alabama and Florida), *A. suborbiculata* Say (Louisiana and Texas), *A. hal-lenbecki* Lea (Alabama), *A. peggyae* Johnson (Florida), *A. couperiana* Lea (Florida), *Alasmidonta triangulata* Lea (North Carolina) and *Strophitus subvexus* (Conrad) (Louisiana). The latter two hosts con-

tained only single individuals and may constitute incidental occurrences. Additional lots of *U. formosa* that were obtained since 1980 include specimens from: *A. grandis* (NMC 45978) from Assiniboine River ca. 5.0 km northeast of Amsterdam, Saskatchewan, Canada, 28 July 1965 (H.D. Athern); *A. grandis* (NMC 31633) from a stream ca. 20 km east of Kapaskasing, Ontario, Canada, 25 July 1961 (A.H. Clarke); and *A. cataracta* (NMC 66901) from Calbrooks Pond, Bedeque, Prince County, Prince Edward Island, Canada, 18 September 1966 (M. Thomas).

REMARKS — *U. formosa* is figured in Wolcott (1899), Marshall (1933) and Mitchell (1957). Thon (1901) described *U. adensameri*, which apparently is *U. formosa*. *U. formosa* is apparently restricted to North America and prefers mussels of the genus *Anodonta*. Dimock (1985) summarizes his extensive work on the natural history of *U. formosa*.

3. *Unionicola (Parasitatax) dimocki* new species
(Figs. 6-8 and 12-18)

DIAGNOSIS — Character states of the subgenus; male dorsum with an elongate plate that is fused by secondary sclerotization to the body surfaces along the edge of the plate; female dorsum with 2-9 large plates that are not widely separated, and the 2, more central plates are somewhat elongate (figs. 6-8); female posterior coxal group elongate and extending well posterior of the junction with the fourth walking leg (fig. 12); male posterior coxal group either with or without distinct posterior borders and extensively fused with abdomen and genital field (fig. 13); pedipalp and leg morphology similar to *U. ypsilophora* and *U. formosa* (figs. 14, 17 and 18); genital fields posterior (figs. 15-16).

MALE (13 specimens): Length including capitulum 1220 (1000-1800); length of posterior coxal group 648 (540-700); dorsal lengths of pedipalp segments: Ti 215 (190-240); Ta 93 (70-110); dorsal lengths of leg segments: leg I: TFe 222 (190-250); Ge 292 (260-330); Ti 282 (240-320); Ta 187 (170-220); leg IV: TFe 288 (270-320); Ge 505 (440-580); Ti 713 (580-800); Ta 590 (470-640).

FEMALE (17 specimens): Length including capitulum 1300 (1100-1700); length of posterior coxal group 657 (590-740); central dorsal plate 388 (350-450) long, 119 (100-150) wide; dorsal lengths of pedipalp segments: Ti 201 (160-270); Ta 88 (70-110); dorsal lengths of leg segments: leg I: TFe 222 (190-270); Ge 296 (250-350); Ti 283 (240-330); Ta 189 (160-240); leg IV: TFe 310 (260-350); Ge 545 (470-640); Ti 762 (670-870); Ta 635 (580-710).

NOTES — Holotype (female) (CNC type number 19113) is from *Lasmigona costata* (Rafinesque) (NMC 43421) from Rideau River near Billings Bridge, Ottawa, Ontario, Canada, 5 July 1933 (A. LaRocque). Upon re-examination of my lots, *U. dimocki* occurred in the following mussels (specific locality data in Vidrine 1980): *Strophitus undulatus* (Say) (Oklahoma, Arkansas, Ohio, Pennsylvania and Missouri), *L. costata* (Arkansas and Tennessee), *S. subvexus* (Louisiana), *Arcidens (Arkansia) wheeleri* (Ortmann and Walker) (Oklahoma) and *Arcidens confragosus* (Say) (Kentucky). Additional lots obtained since 1980 include specimens from: *S. undulatus* from: 1.) (NMC 66070) from Well Road ca. 2.0 km northeast of Highway 6, Wellington County, Ontario, Canada, 4 August 1971 (B.T. Kidd); 2.) (NMC 66197) from Conestogo River, Drayton, Wellington County, Ontario, Canada, 15 July 1970 (B.T. Kidd); and 3.) (NMC 66077) from Willow Brook ca. 3.0 km east northeast of Grand Valley, Dufferin County, Ontario, Canada, 5 August 1971 (B.T. Kidd); *L. compressa* (Lea) from: 1.) (NMC 66081) from Willow Brook ca. 3.0 km east northeast of Grand Valley, Dufferin County, Ontario, Canada, 5 August 1971 (B.T. Kidd); 2.) (NMC 66195) from Conestogo River, Drayton, Wellington County, Ontario, Canada, 15 July 1970 (B.T. Kidd); and 3.) (NMC 66075) from Irvine Creek at Highway 6, ca. 4.0 km northwest of Fergus, Wellington County, Ontario, Canada, 4 August 1971 (B.T. Kidd); and *Anodontoides ferussacianus* (Lea) from: 1.) (NMC 66101) from a small creek ca. 2.5 km northwest of Leggett, Dufferin County, Ontario, Canada, 6 August 1971 (B.T. Kidd); 2.) (NMC 66095) from Grand River at Leggett, Dufferin County, Ontario, Canada, 6 May 1971 (B.T. Kidd); and 3.) (NMC 66045) from Smith Creek at Poole, ca. 5.0 km southeast of Milverton, Perth County, Ontario, Canada, 3 August 1971 (B.T. Kidd).

REMARKS — Cook (1974) apparently figured a female of this species and labelled it *Unionicola (Parasitatax)* sp. *U. dimocki* is apparently a sibling species with *U. formosa* and *U. ypsilophora*. The males of *U. dimocki* are quite variable, but generally, they are more heavily sclerotized than the other species. The females of *U. dimocki* are readily distinguishable with the extensive dorsal plate structure and the elongate posterior coxal group. Apparently, *U. dimocki* is restricted to North America and prefers hosts that belong to genera other than *Anodonta*, which is the usual host genus for *U. formosa* and *U. ypsilophora*. Ecologically, many of the *Anodonta* prefer lentic waters, whereas the other anodontine genera prefer lotic waters.

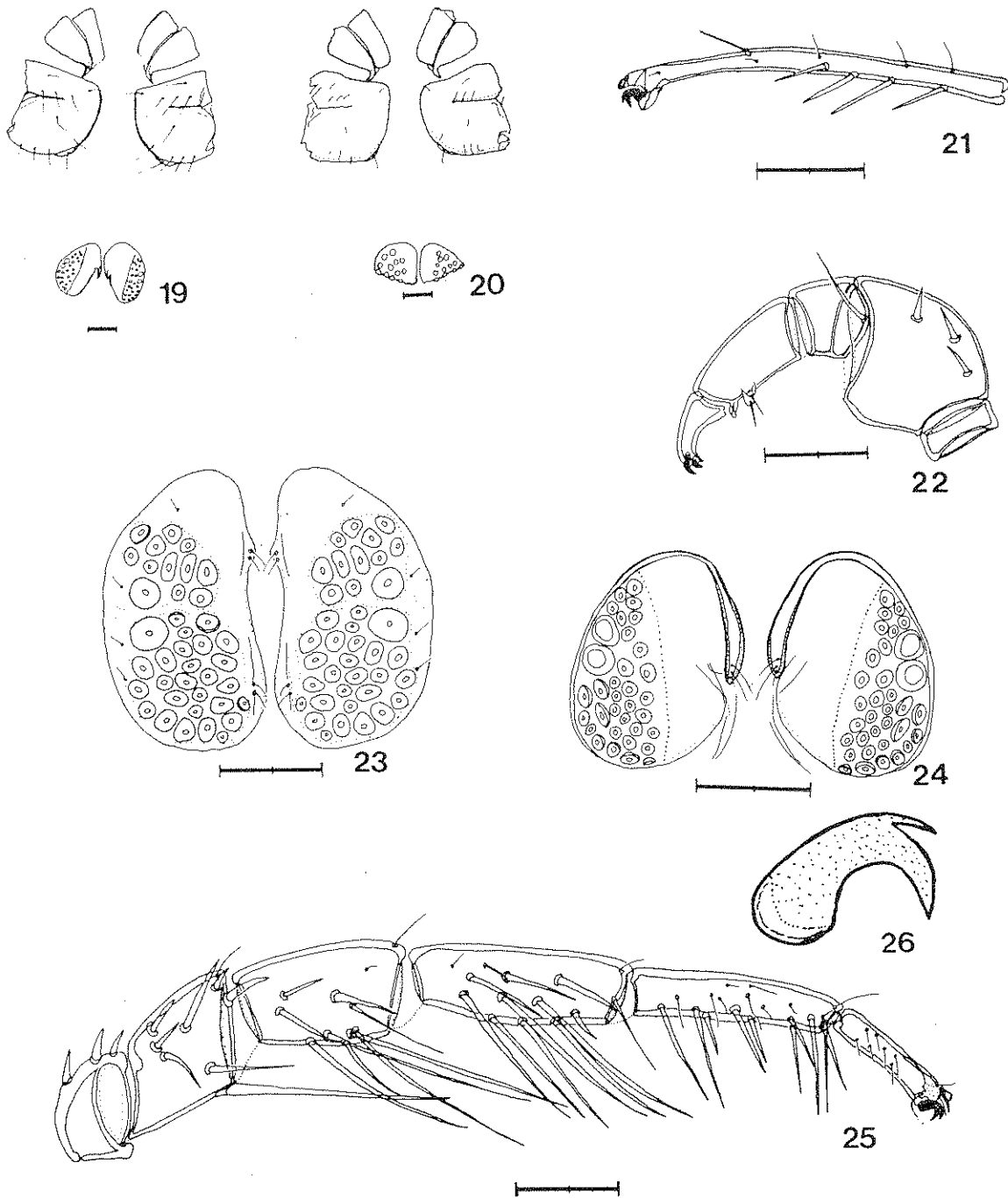
4. *Unionicola (Parasitatax) thienemanni* Viets 1957 (Fig. 2)

DIAGNOSIS — Character states of the subgenus; female dorsum with an elongate plate (fig. 2); female with an elongate posterior coxal group; male posterior coxal group lacking distinct inner and posterior borders and fused by secondary sclerotization to the abdomen and genital field.

MALE (3 specimens): Length including capitulum 1233 (1200-1300); length of posterior coxal group 558 (500-650); dorsal lengths of pedipalp segments: Ti 168 (155-180); Ta 72 (65-80); dorsal lengths of leg segments: leg I: TFe 192 (175-220); Ge 253 (220-300); Ti 238 (210-290); Ta 162 (150-175); leg IV: TFe 257 (235-300); Ge 462 (410-525); Ti 625 (550-725); Ta 497 (450-540).

FEMALE (5 specimens): Length including capitulum 1360 (1250-1450); length of posterior coxal group 625 (575-700); dorsal plate 752 (700-780) long, 352 (330-375) wide; dorsal lengths of pedipalp segments: Ti 155 (150-160); Ta 70 (65-75); dorsal lengths of leg segments: leg I: TFe 186 (150-225); Ge 265 (200-300); Ti 241 (175-280); Ta 169 (125-200); leg IV: TFe 290 (250-325); Ge 494 (415-575); Ti 648 (510-750); Ta 520 (410-600).

NOTES — Specimens measured are among the following lots from: *Ensidens ingallsianus* (Lea) from: 1.) (ANSP A3638) Maenam Mun, Ban Pring, Ampoe Tha Thum, Surin Province, Thailand, 14 April 1971 (B. Heard); 2.) (ANSP A3577 and A3624) Lam Nam Mun, Ampoe Phimai, Nakon Ratchasima Province, Thailand, 29 January and 11 July 1971 (B. Heard); 3.) (ANSP A3593) Lam Yang, Ampoe Yasothon, Ampoe Selaphum, border of Roi Et and Upon Ratchathani Provinces, Thailand, 19 May 1971 (B. Heard); 4.) (ANSP A3601) Maenam Mun, Ampoe Tha Thum, Surin Province, Thailand, 19 May 1971 (B. Heard); 5.) (ANSP A3642, A3628 and A3584) Lam Siao Yai, Ampoe Suwannaphum, Roi Et Province, Thailand, 31 January, 16 March and 8 July 1971 (B. Heard); 6.) (ANSP A3598) Lam Dom Noi, Ban Sapham Dom, Ampoe Phibun Mangsahan, Ubon Ratchathani Province, Thailand, 27 April 1971 (B. Heard); 7.) (ANSP A3599) Lam Phlapphla, Ampoe Tha Thum, border of Surin and Roi Et Provinces, Thailand, 31 January 1971; 8.) (ANSP 3602) Lam Chi, Ban Lam Chi, Surin, border of Buriram and Surin Provinces, Thailand, 17 March 1971 (B. Heard); 9.) (ANSP A3648) Huai Bong, Ban Bung Mafai, Ampoe Phu Wiang, Khon Kaen Province, Thailand, 9 December 1970 (B. Heard); 10. (ANSP A3649) Huai Nam Khong, Ban Non Ya Phlong, Ban Bung Mafai,



Figs. 19-26. *Unionicola arcuata* (Wolcott): 19. female venter; 20. male venter; 21. tarsus of fourth walking leg; 22. female pedipalp; 23. male genital field; 24. female genital field; 25. male first walking leg; 26. tarsal claw of fourth walking leg.

Khon Kaen Province, Thailand, 9 December 1970 (B. Heard); 11.) (USNM 786377) station 2457, South Khon Kaen, Ban Gaen Ton, Thailand, 25 July 1963 (R. Brandt); 12.) (USNM 786362) station 2443, Palace Garden, Bang Pa In, Thailand, 25 July 1963 (R. Brandt); and 13.) (USNM 786376) station 2444, Bang Sue, Bangkok, Klong Prapa, Thailand, 2 April 1964 (R. Brandt); *Hyriopsis myersiana* (Lea) from: 1.) (ANSP A3656) Maenam Khwae Yai, Ban Nong Bua, Kanchanaburi, Kanchanaburi Province, Thailand, 10 April 1971 (B. Heard); 2.) (ANSP A4430) Mun River, Phibun Mangsahan, Ubon Ratchathani Province, Thailand, 15 March 1972 (G. Davis); and 3.) (ANSP A4431) Ban Dan, Mekong River, Ubon Province, Thailand, 18 April 1973 (G. Davis); *H. bialatus* Simpson (ANSP A5085) from Khong Town, Ban Nuah near sports club, Khong Island, Laos, 23 March 1972 (G. Davis); and *Pseudodon vondembuschianus ellipticus* Conrad (ANSP A3768) from Maenam Mun, Ampoe Satuk, border of Buriram and Surin Provinces, Thailand, 16 March 1971 (B. Heard). The latter record is considered an incidental host record.

REMARKS — *U. thienemanni* is a sibling species with *U. uchidai* Imamura 1953, but *U. uchidai* has females with a horse-shoe shaped dorsal plate (fig. 1) and males with distinctly bordered, elongate posterior coxal groups. *U. thienemanni* was described from Borneo and later reported from Thailand (Vidrine 1985a). These specimens are nearly identical to the original description. Pedipalps, legs, tarsal claws and chaetotaxy of *U. thienemanni* and *U. uchidai* are very similar to *U. ypsilophora*, *U. formosa* and *U. dimocki*. These species form an artenkreis, with the North American species showing some host specificity.

5. *Unionicola (Parasitax) arcuata* (Wolcott 1898)
(Figs. 19-26)

DIAGNOSIS — Character states of the subgenus; dorsum apparently lacking a dorsal shield; coxal plates abbreviate and with distinct borders (figs. 19-20); pedipalp Ta with 2, distinct clawlets (fig. 22); genital fields with numerous acetabula (figs. 23-24); all legs with small, bifid tarsal claws with the dorsal prong shorter than the ventral prong (figs. 25-26); fourth walking leg with Ta distinctly arcuate (fig. 21).

MALE (22 specimens): Length including capitulum 1200 (1000-1400); length of posterior coxal group 333 (270-400); dorsal lengths of pedipalp segments: Ti 144 (120-180); Ta 75 (60-90); dorsal lengths of leg segments: leg I: TFe 177 (140-220); Ge 229 (160-300); Ti 214 (160-280); Ta 137 (110-170); leg IV: TFe 321 (240-430); Ge 424 (310-580); Ti 578 (440-780); Ta 379 (320-470).

FEMALE (19 specimens): Length including capitulum 1600 (1300-1900); length of posterior coxal group 320 (260-400); dorsal lengths of pedipalp segments: Ti 143 (120-170); Ta 73 (65-90); dorsal lengths of leg segments: leg I: TFe 180 (150-240); Ge 235 (180-310); Ti 226 (170-290); Ta 138 (110-170); leg IV: TFe 326 (260-420); Ge 429 (320-570); Ti 574 (450-780); Ta 391 (320-480).

NOTES — Specimens were measured from (specific locality in Vidrine 1980): *Anodontoides radiatus* (Conrad) (Alabama), *Alasmidonta calceola* (Lea) (Michigan), *Alasmidonta undulata* (Say) (Rhode Island), *S. subvexus* (= *S. radiatus* (Conrad)) (eastern Louisiana and Mississippi), *Alasmidonta (Prolasmidonta) heterodon* (Lea) (New Hampshire) and *Alasmidonta marginata* Say (Arkansas). Additional measured specimens that were obtained after 1980 are from: *A. calceola* from: 1.) (MZUM lot) River Raisin at Sharon Hollow, Washtenaw County, Michigan, 3 October 1959; 2.) (NMC 66061) Swan Creek ca. 3.0 km northwest of Bethany Church, Wellington County, Ontario, Canada, 4 August 1971 (B.T. Kidd); 3.) (NMC 66168) Cox Creek at Highway 86, East Zubers Corners, Waterloo County, Ontario, Canada, 6 June 1970 (B.T. Kidd); and 4.) (NMC 66076) Irvine Creek at Highway 6, ca. 3.0 km northwest of Fergus, Wellington County, Ontario, Canada, 4 August 1971 (B.T. Kidd); *A. ferussacianus* from: 1.) (MZUM lot) Sandstone Creek at Rte. MI 50 in Tompkins, Jackson County, Michigan, 21 July 1961; 2.) (NMC 66078) Willow Brook ca. 3.0 km east northeast of Grand Valley, Dufferin County, Ontario, Canada, 5 August 1971 (B.T. Kidd); 3.) (NMC 45883) branch of Black Lake outlet ca. 3.0 km east southeast of Breckenridge Station, Gatineau County, Quebec, Canada, 5 August 1967 (H.D. Athern); 4.) (NMC 66112) Grand River ca. 3.5 km southeast of Dundalk, Dufferin County, Ontario, Canada, 6 August 1971 (B.T. Kidd); and 5.) (NMC 30698) Pagwachuan River ca. 100 km west of Hearst, Ontario, Canada, 31 July 1965 (H.D. Athern); *S. undulatus* (NMC 66077) from Willow Brook ca. 3.0 km east northeast of Grand Valley, Dufferin County, Ontario, Canada, 5 August 1971 (B.T. Kidd); *Alasmidonta varicosa* (Lamarck) (NMC 46387) and *A. undulata* (NMC 46073) from Peticodiac River at Riverglade, New Brunswick, Canada, 22 June 1960 (A.H. Clarke); and *L. compressa* from: 1.) (NMC 66081) Willow Brook ca. 3.0 km east northeast of Grand Valley, Dufferin County, Ontario, Canada, 5 August 1971 (B.T. Kidd); 2.) (NMC 66195) Conestogo River, Drayton, Wellington County, Ontario, Canada, 15 July 1970 (B.T. Kidd); and 3.) (NMC 66089) Grand River ca. 2.5 km south of Keldon, Dufferin County, Ontario, Canada, 6 August 1971 (B.T.

Kidd). Usually a single infested host contained numerous specimens.

REMARKS — *U. arcuata* has been figured in Wolcott (1899) and Marshall (1933). Among my lots, these mites vary greatly in size, but relative leg segment ratios are consistent enough to prevent separation into subgroups. Apparently *U. arcuata* in North America forms a rassenkreis, since varied size morphs are found in specific taxa of hosts. A thorough re-evaluation of this group with larger lots from more habitats may provide more insight.

6. *Unionicola (Parasitatax) arcuatooides* new species

SYNONYMY — *Unionicola arcuata* (Wolcott) in Imamura (1953).

DIAGNOSIS — Character states of the subgenus; fourth walking leg Ta proportionately longer than Ti in comparison with *U. arcuata*.

MALE (after Imamura 1953): Length including capitulum 1216; dorsal lengths of pedipalp segments: Ti 140; Ta 72; dorsal lengths of leg segments: leg I: TFe 193; Ge 266; Ti 266; Ta 163; leg IV: TFe 370; Ge 474; Ti 666; Ta 511.

FEMALE (after Imamura 1953): Length including capitulum 1210; dorsal lengths of pedipalp segments: Ti 152; Ta 80; dorsal lengths of leg segments: leg I: TFe 192; Ge 311; Ti 311; Ta 178; leg IV: TFe 392; Ge 496; Ti 718; Ta 518.

REMARKS — *U. arcuatooides* is nearly identical to *U. arcuata* and is figured and described in detail in Imamura (1953). It is only known from mussels in Shiroyama, Kaizu-gun, Gifu Prefecture, Japan (Imamura 1953). Comparison of Imamura's description with *U. arcuata* from North America showed that the Ta of the fourth walking leg is proportionately longer than the Ti in *U. arcuatooides*. This difference is very obvious when the larger measurements in the range of *U. arcuata* are compared with *U. arcuatooides*. Apparently these are sibling species, although little is known of the biology of *U. arcuatooides*.

7. *Unionicola (Parasitatax) tumida* (Wolcott 1898) (Figs. 29-37)

DIAGNOSIS — Character states of the subgenus; dorsum apparently lacking a dorsal shield; posterior coxal group with distinct borders (fig. 29); female acetabular plates with an elongate, bird-bill-like spinous process (Fig. 36); male acetabular plates with more than 20 acetabula each (fig. 37); pedipalps thick (fig. 31); pedipalp Ta with 2, very small clawlets that are almost indistinct (fig. 34); all tarsal claws of walking legs bifid with the dorsal prong shorter than the

ventral prong (figs. 32 and 35); first walking leg with short setae (fig. 32); fourth walking leg Ta nearly straight (figs. 30 and 32); body light in color.

MALE (7 specimens): Length including capitulum 1150 (1000-1200); length of posterior coxal group 298 (250-340); dorsal lengths of pedipalp segments: Ti 102 (80-110); Ta 75 (68-80); dorsal lengths of leg segments: leg I: TFe 137 (115-150); Ge 167 (140-180); Ti 173 (150-180); Ta 125 (110-130); leg IV: TFe 221 (200-230); Ge 303 (260-320); Ti 393 (350-420); Ta 286 (250-310).

FEMALE (7 specimens): Length including capitulum 1800 (1600-1900); length of posterior coxal group 342 (300-400); dorsal lengths of pedipalp segments: Ti 116 (110-120); Ta 79 (75-80); dorsal lengths of leg segments: leg I: TFe 167 (140-180); Ge 217 (190-230); Ti 224 (200-240); Ta 143 (140-150); leg IV: TFe 324 (280-360); Ge 466 (390-500); Ti 544 (490-570); Ta 349 (320-370).

NOTES — Specimens measured are from (specific locality data in Vidrine 1980): *S. undulatus* (Arkansas, Pennsylvania and Ohio), *S. subvexus* (= *S. radiatus*) (eastern Louisiana) and *A. imbecilis* (Louisiana). Wolcott (1898 and 1899) described and figured this species. *U. tumida* usually occurs as a single male and one or two females in each infested host.

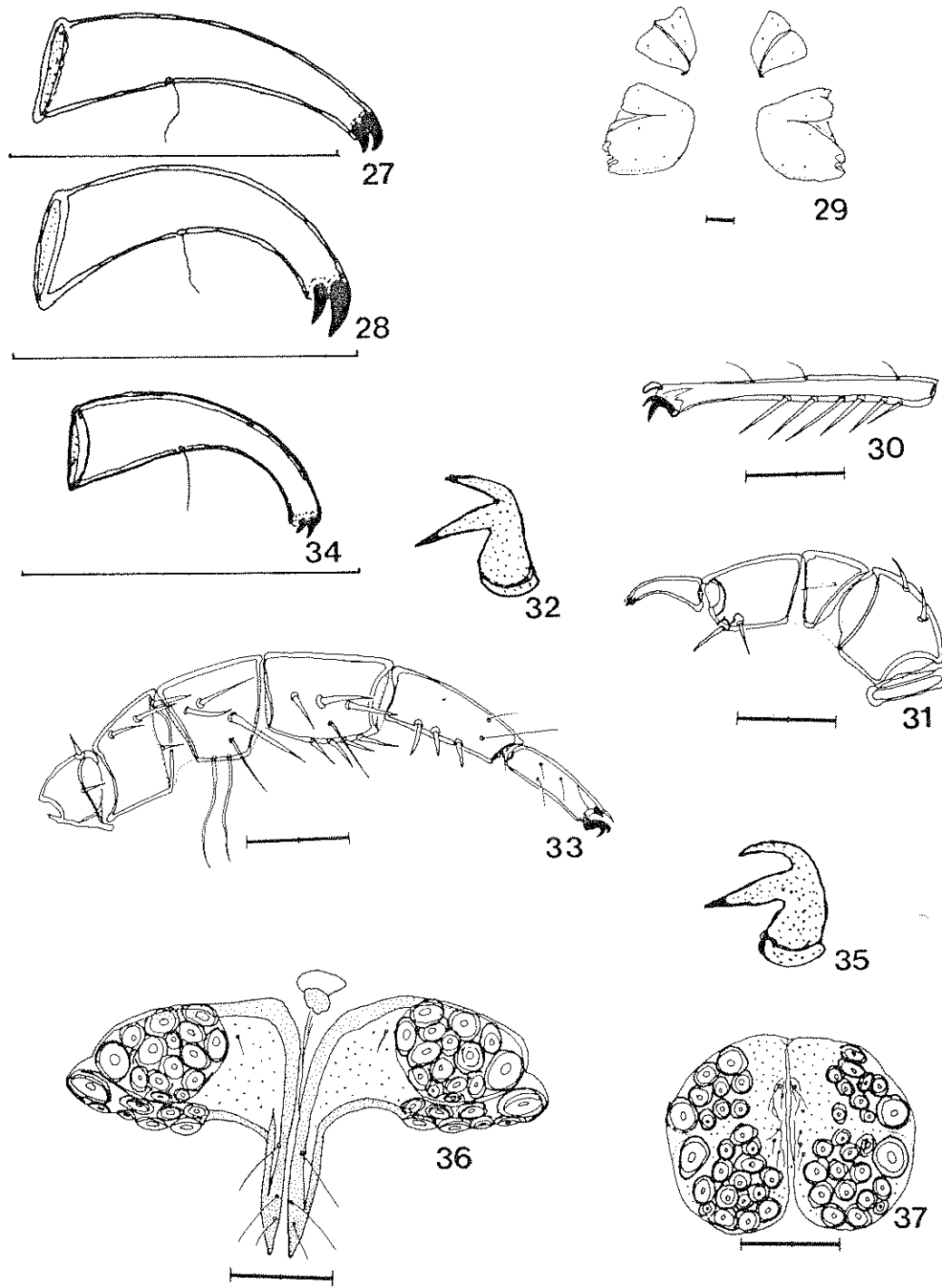
REMARKS — *U. tumida* may have previously been confused with other species. It is also closely related to two Asian species, *U. diversipes* Viets 1926 and *U. brandti* Vidrine 1985a. A re-evaluation of my lots of *U. tumida* showed that 4 species were mixed within the lots.

8. *Unionicola (Parasitatax) bishopi* new species (Fig. 28)

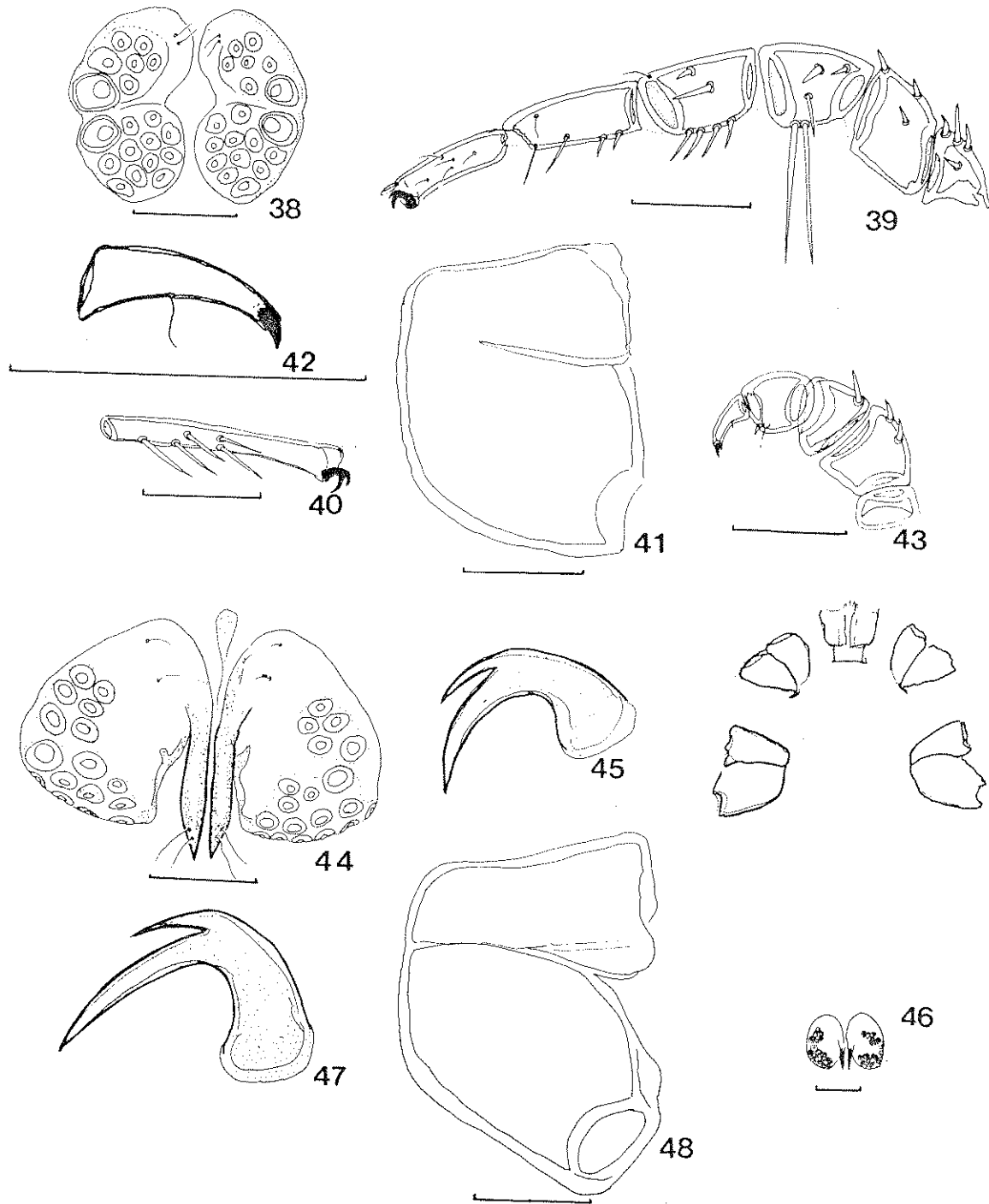
DIAGNOSIS — Character states of the subgenus; dorsum apparently lacking a dorsal shield; posterior coxal plates with distinct borders; female acetabular plates with an elongate, bird-bill-like spinous process; male acetabular plates with more than 20 acetabula each; pedipalps thick; pedipalp Ta with 2, moderately large and distinct clawlets (fig. 28); all tarsal claws of walking legs bifid with the dorsal prong shorter than the ventral prong; fourth walking leg Ta nearly straight; body light in color.

MALE (4 specimens): Length including capitulum 1250 (1000-1500); length of posterior coxal group 370 (340-400); dorsal lengths of pedipalp segments: Ti 136 (120-145); Ta 84 (80-90); dorsal lengths of leg segments: leg I: TFe 168 (160-170); Ge 200 (190-210); Ti 220 (210-230); Ta 169 (160-175); leg IV: TFe 275 (270-280); Ge 373 (360-380); Ti 500 (490-510); Ta 343 (340-350).

FEMALE (3 specimens): Length including capitu-



Figs. 27-37. *Unionicola cooki* n. sp.: 27. tarsus of pedipalp; *U. bishopi* n. sp.: 28. tarsus of pedipalp; *U. tumida* (Wolcott): 29. female coxal plates; 30. tarsus of fourth walking leg; 31. female pedipalp; 32. tarsal claw of fourth walking leg; 33. male first walking leg; 34. tarsus of pedipalp; 35. tarsal claw of first walking leg; 36. ventral view of female genital field; and 37. male genital field.



Figs. 38-48. *Unionicola tumidoides* n. sp.: 38. male genital field; 39. male first walking leg; 40. tarsus of fourth walking leg; 41. male posterior coxal group; 42. tarsus of pedipalp; 43. male pedipalp; 44. ventral view of female genital field; 45. tarsal claw of first walking leg; 46. female venter; 47. tarsal claw of fourth walking leg; and 48. female posterior coxal group.

lum 1833 (1500-2000); length of posterior coxal group 400; dorsal lengths of pedipalp segments: Ti 133 (120-150); Ta 87 (80-90); dorsal lengths of leg segments: leg I: TFe 186 (180-200); Ge 253 (250-260); Ti 260 (250-280); Ta 185 (170-210); leg IV: TFe 387 (370-410); Ge 540 (520-570); Ti 650 (620-690); Ta 417 (400-430).

NOTES — Holotype (male) (CNC type number 19114) is from *A. marginata* from Ouachita River at Rte. U.S. 270, Rocky Shoals Park, Montgomery County, Arkansas, 12 August 1978 (D.R. Clark, W. Bell and M.F. Vidrine). Additional specimens were obtained from the type host and locality on 15 August 1985 (Gail, Macky and M.F. Vidrine). Usually a single male and one or two females occur in each infested host.

REMARKS — *U. bishopi* is nearly identical to *U. tumida*, but *U. bishopi* is larger and has distinctive clawlets on the pedipalp Ta. It is only known from its type host and locality.

9. *Unionicola (Parasitatax) cooki* new species
(Fig. 27)

DIAGNOSIS — Character states of the subgenus; dorsum apparently lacking a dorsal shield; posterior coxal group with distinct borders; female acetabular plates with an elongate, bird-bill-like spinous process; male acetabular plates with more than 20 acetabula each; pedipalps thick; pedipalp Ta with 2, small but distinct clawlets (fig. 27); all tarsal claws of walking legs bifid with the dorsal prong shorter than the ventral prong; fourth walking leg Ta nearly straight; body light in color.

MALE (5 specimens): Length including capitulum 1800 (1750-2000); length of posterior coxal group 488 (400-540); dorsal lengths of pedipalp segments: Ti 143 (140-150); Ta 90; dorsal lengths of leg segments: leg I: TFe 215 (200-220); Ge 282 (250-320); Ti 296 (270-320); Ta 174 (150-190); leg IV: TFe 436 (410-460); Ge 582 (570-600); Ti 758 (710-780); Ta 466 (450-480).

FEMALE (5 specimens): Length including capitulum 2250 (2000-2600); length of posterior coxal group 512 (500-520); dorsal lengths of pedipalp segments: Ti 168 (160-170); Ta 92 (90-100); dorsal lengths of leg segments: leg I: TFe 226 (220-240); Ge 322 (320-330); Ti 338 (300-370); Ta 194 (180-210); leg IV: TFe 530 (510-540); Ge 748 (720-780); Ti 868 (830-940); Ta 538 (520-570).

NOTES — Holotype (male) (CNC type number 19115) is from *L. compressa* (NMC 66081) from Willow Brook ca. 3.0 km east northeast of Grand Valley, Dufferin County, Ontario, Canada, 5 August 1970 (B.T. Kidd). Additional paratypes are from *L. com-*

pressa from: 1.) (NMC 66195) Conestogo River, Drayton, Wellington County, Ontario, Canada, 15 July 1970 (B.T. Kidd); and 2.) (NMC 66069) Speed River ca. 2.3 km northeast of Highway 6, Wellington County, Ontario, Canada, 4 August 1971 (B.T. Kidd).

REMARKS — *U. cooki* is nearly identical to *U. tumida* and *U. bishopi*, but *U. cooki* is larger and has distinctive morphology of the pedipalp Ta. It is only known from Ontario from a single host species, where usually a single male and one or two females are found in each infested host.

10. *Unionicola (Parasitatax) tumidoides* new species
(Figs. 38-48)

SYNONYMY — *Unionicola tumida* (Wolcott) in Vidrine 1985a.

DIAGNOSIS — Character states of the subgenus; dorsum apparently lacking a dorsal shield; posterior coxal group with distinct borders (figs. 41 and 48); female acetabular plates with an elongate, bird-bill-like spinous process (figs. 44 and 46); male acetabular plates with less than 20 acetabula each (fig. 38); pedipalps thick (fig. 43); pedipalp Ta with a single clawlet (fig. 42); all tarsal claws of walking legs bifid with the dorsal prong shorter than the ventral prong (figs. 45 and 47); first walking leg with short setae (fig. 39); fourth walking leg Ta nearly straight (fig. 40).

MALE (holotype): Length including capitulum 1000; length of posterior coxal group 250; dorsal length of pedipalp segment: Ta 55; dorsal lengths of leg segments: leg I: TFe 100; Ge 115; Ti 125; Ta 100; leg IV: TFe 140; Ge 200; Ti 270; Ta 210.

FEMALE (allotype): Length including capitulum 1500; length of posterior coxal group 250; dorsal length of pedipalp segment: Ta 60; dorsal lengths of leg segments: leg I: TFe 125; Ge 160; Ti 155; Ta 100; leg IV: TFe 225; Ge 345; Ti 400; Ta 225.

NOTES — Holotype (male) (CNC type number 19116) is from *E. ingallsianus* (ANSP A3642) from Lam Seio Yai, Ampoe Suwannaphum, Roi Et Province, Thailand, 31 January 1971 (B. Heard). Allotype is from *E. ingallsianus* (ANSP A3601) from Maenam Mun, Ampoe Tha Thum, Surin Province, Thailand, 19 May 1971 (B. Heard). Only a single individual was found in each of two infested hosts.

REMARKS — The two specimens of *U. tumidoides* are much smaller than their North American relatives. They are easily diagnosed by their distinctive pedipalp Ta, which resembles that of the subgenus *Fulleratax* Vidrine 1984. *U. tumidoides*, *U. tumida*, *U. bishopi* and *U. cooki* apparently form an artenkreis. *U. tumidoides* is only known from Thailand and from a single host taxon.

DISCUSSION

The subgenus *Parasitatax* appears to be a holophyletic group that can be divided into four sibling species groups: (1) *U. ypsilophora*, *U. formosa*, *U. dimocki*, *U. uchidai* and *U. thienemanni*; (2) *U. arcuata* and *U. arcuatoides*; (3) *U. diversipes* and *U. brandti*; and (4) *U. tumida*, *U. bishopi*, *U. cooki* and *U. tumidoides*. Apparently the most closely related group is the Asian subgenus *Fulleratax* although *Parasitatax* shares some synapomorphies with *Polyatax* Viets and *Ampullariatax* Vidrine (Vidrine 1984 and 1985b).

Mites of the *Parasitatax* are parasites of freshwater mussels that belong to two major groups: (1) Anodontinae (of Davis and Fuller 1981) in North America, Europe and Asia; and (2) Asian mussels that have been placed in several subfamilies in Amblemididae (see Brandt 1974) but Davis and Fuller (1981) suggested that they may be members of the tribe Gonideini in Unionidae. Although the higher systematics of the mussels remain unclear, these mussels share a specific group of mite parasites which may indicate a close relationship and a common origin for the mussel groups.

Among the *Parasitatax*, *U. ypsilophora* has the greatest range (Europe, Asia and North America) while its sibling species are restricted to single continents. The *U. arcuata* and *U. tumida* groups contain species in both Asia and North America. The *U. diversipes* group is apparently restricted to southeast Asia. These distributions also reflect the host-specific nature of these mites since the absence of host groups may result in the absence of the mite groups. This is apparent in Europe where only two species of *Anodonta* occur which may account for the presence of only *U. ypsilophora*. Detailed studies of host-specificities and zoogeography of these mites may uncover new taxa and a more meaningful interpretation of the systematics of the mites and their hosts.

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LITERATURE CITED

- Baker, R.A. 1982. Unionicolid mites from central New York. *New York Entomol. Soc.* 90 (3): 176-180.
- Bonz, C. 1783. Observatio X. *Acarus ypsilophorus*. *Nova Acta Physico-Medica Akad. Leopold. Carolin. Natur. Curiosor. Norimbergae*, 7: 52-53.
- Brandt, R. 1974. The non-marine aquatic Mollusca of Thailand. *Arch. Moll.* 105 (1-4): 1-423.
- Burch, J.B. 1975. Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America. *Malacol. Publ.*, Hamburg, Michigan. 204 pages.
- Clarke, A.H. 1981a. The Freshwater Molluscs of Canada. *National Museum of Canada, Ottawa*. 204 pages.
- Clarke, A.H. 1981b. The Tribe Alasmidontini (Unionidae: Anodontinae), Part I: *Pegias*, *Alasmidonta*, and *Arcidens*. *Smithson. Contr. Zool.* No. 326, 101 pages.
- Clarke, A.H. 1985. The Tribe Alasmidontini (Unionidae: Anodontinae), Part II: *Lasmigona* and *Simpsonaias*. *Smithson. Contr. Zool.* No. 399, 75 pages.
- Cook, D.R. 1974. Water mite genera and subgenera. *Mem. Amer. Entomol. Inst. (Ann Arbor)*, No. 21, 860 pages.
- Dana, J. and J. Whelpley. 1836. On two American species of the genus *Hydrachna*. *Amer. J. Sci.* 30: 354-359.
- Davis, G.M. and S.L.H. Fuller. 1981. Genetic relationships among Recent Unionacea (Bivalvia) of North America. *Malacologia* 20 (2): 217-253.
- Dimock, R.V. Jr. 1985. Population dynamics of *Unionicola formosa* (Acari: Unionicolidae), a water mite with a harem. *Amer. Midl. Nat.* 114 (1): 168-179.
- Hevers, J. 1978. Morphologie und Systematik der in Deutschland auftretenden Schwamm- und Muschel-Milben-Arten der Gattung *Unionicola* (Acarina: Hydrachnellae: Unionicolidae). *Entomol. Gen.* 5 (1): 57-84.
- Imamura, T. 1953. Water-mites from Gifu Prefecture. *J. Fac. Sci., Hokkaido Univ., Ser. VI, Zool.*, 11: 411-471.
- Marshall, R. 1933. Preliminary list of the Hydracarina of Wisconsin. Part III. *Trans. Wisconsin Acad. Sci.* 28: 37-61.
- Mitchell, R.D. 1957. On the mites parasitizing *Anodonta* (Unionidae: Mollusca). *J. Parasit.* 43 (1): 101-104.
- Mitchell, R.D. and O. Pitchford. 1953. On the mites parasitizing *Anodonta* in England. *J. Conchol.* 23: 365-370.
- Thon, K. 1901. Ueber eine neue parasitische *Atax*-Art aus Texas. *Ann. Naturhist., Hofmus (Vienna)*. 16:

31-35.

- Vidrine, M.F. 1980. Systematics and coevolution of unionicolid water mites and their unionid mussel hosts in the eastern United States. Ph.D. dissertation, Univ. of Southwestern Louisiana, Lafayette. 661 pages. Univ. Microfilms Int. No. 8100290.
- Vidrine, M.F. 1984. *Fulleratax*, new subgenus (Acari: *Unionicolidae*: *Unionicolinae*: *Unionicola*), in southeast Asia. Internat. J. Acarol. 10 (4): 229-233.
- Vidrine, M.F. 1985a. Three new species of *Unionicola* (Acari: *Unionicolidae*: *Unionicolinae*) inhabiting fresh-water mussels (*Unionacea*) in southeast Asia. Internat. J. Acarol. 11 (2): 125-131.
- Vidrine, M.F. 1985b. Six new species in the subgenus *Polyatax* (Acari: *Unionicolidae*: *Unionicola*) from North America, with a re-evaluation of related taxa. Internat. J. Acarol. 11 (4): 273-287.
- Vidrine, M.F. and D.J. Bereza. 1978. Some considerations and implications of host-specificity studies of unionicolid mite parasites on the systematics of some groups of North American unionacean fresh-water mussels. Bull. Amer. Malacol. Union, Inc. 1977, pp. 85-86.
- Viets, K. 1926. Indische Wassermilben. Zool. Jb., Syst. 52: 371-394.
- Viets, K. 1949. Nomenkatorische und taxonomische Bemerkungen zur Kenntnis der Wassermilben (Hydrachnellae, Acari) I-X. Abh. Naturwiss. Ver. Bremen 23: 292-327.
- Viets, K. 1956. Die Milben des Susswassers und des Meeres. Zweitter und Dritter Teil. Gustav Fischer Verlag, Jena. 870 pages.
- Viets, K. 1957. Neue Wassermilben (Hydrachnellae, Acari) von Borneo, Indonesia. Abh. Naturwiss. Ver. Bremen 35 (1): 8-23.
- Wolcott, R. 1898. New American species of the genus *Atax* (Fab.) Bruz. Zool. Bull. 1: 279-285.
- Wolcott, R. 1899. On the North American species of the genus *Atax* (Fabr.) Bruz. Trans. Amer. Microsc. Soc. 20: 193-259.
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