TAXONOMY OF THE AMERICAN HEBRIDAE

AND THE

NATURAL HISTORY OF SELECTED SPECIES

by

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ABSTRACT

The taxonomy of the American Hebridae and the natural histories of *Hebrus burmeisteri* L. & S., *Hebrus buenoi* D. & H., *Hebrus sobrinus* Uhler, *Merragata hebroides* White and *Merragata brunnea* Drake are presented in this paper. Fifteen species of *Hebrus* are redescribed. The following new species are described: *Hebrus hubbardi*, type locality, Palm Springs, California; *Hebrus beameri*, type locality, Meade County, Kansas; *Hebrus plaumanni*, type locality, Nova Teutonia, Brazil. Four species of *Merragata* are redescribed. *Merragata slossoni* Van Duzee is a synonym of *Merragata hebroides* White. The genus *Lipogomphus* Berg has been retained. Keys for the determination of the species of the Western Hemisphere, including drawings of the characters used in the keys, are given. Crosses were attempted between the species of *Hebrus* and *Merragata*.

INTRODUCTION

When the study here reported upon was begun, many species of the family Hebridae were incompletely described and there were no comprehensive keys to the species. Life histories and habits were incompletely known. Since there were some species in Hebrus and others in Merragata that were indistinguishable except on the basis of the antenna, there was the possibility these species might be dimorphic forms of single species. In this case there would not be two genera.

The writer first studied the family Hebridae in 1941 at the University of Michigan Biological Station under the direction of Doctor Herbert B. Hungerford.

This dissertation presents the results of a critical taxonomic study of the Hebridae of the Western Hemisphere, an ecological and life history survey of five species of the family, the results of attempted crosses and conclusions resulting from these several lines of study.

PART I - TAXONOMY

FAMILY HEBRIDAE (Am. & Serv.)

1843. Amyot and Serville, Hémip., pp. xl, 293, Hebrides.

1851. Fieber, Genera Hydroc., p. 9, Hebroidea.

1859. Dohrn, Cat. Hemip., p. 41, Hebridae.

1860. Flor, Rhyn. Livl., i, p. 371, Hebroidea.

1861. Fieber, Europ. Hemip., pp. 23, 32, 104, Hebridae.

1865. Douglas and Scott, Brit. Hemip., p. 25, Hebridae.

1873. Walker, Cat. Heter., viii, p. 159, Hebridae.

1875. Sahlberg, Notiser ur Sallskapets pro Fauna et Flora Fennica Förhandlingar, xiv, pp. 264-267, Hebridae.

1884. Berg, Hemip. Argent., p. 116, Hebridae.

1896. Puton, Cat. Hémip. Palae., p. 36, Hebridae.

1896. Lethierry and Severin, Cat. Génl. Hémip., iii, p. 51, Hebridae.

1898. Champion, Biol. Centr. Am., Heter., ii, p. 117, Hebridae.

1902. Horváth, Term. Füz., iii, p. 606, Hebridae.

1903. Distant, Fauna Br. Ind., Rhyn., ii, p. 167, Hebridae.

1908. Horváth, Ann. Mus. Natl. Hung., ix, p. 21, Hebridae.

1908. Oshanin, Verz. Palae. Hemip., i, p. 482, Hebridae.

1910. Reuter, Acta Soc. Sci. Fenn., xxxvii, p. 78, Hebridae.

1912. Oshanin, Kat. Palae. Hemip., p. 56, Hebridae.

1915. Parshley, Psyche, xxii, p. 93, Hebridae.

1916. Parshley, Ent. News, xxvii, p. 105, Hebridae.

1917. Van Duzee, Cat. Hemip. N. Mex., p. 272, Hebridae.

1918. Hungerford, Jour. New York Ent. Soc., xxvi, p. 13-14, Hebridae.

1920. Hungerford, Univ. Kansas Sci. Bull., xi, p. 88, Hebridae.

1921. Hussey, Psyche, xxxviii, p. 13, Hebridae.

1922. Hussey, Occ. Papers Univ. Michigan, No. 118, p. 36, Hebridae.

1923. Butler, Biol. Brit. Hemip., pp. 222-223, Hebridae.

1928. Jones, Ent. Record and Jour. Variation, Suppl. vol. 40, p. (23), Hebridae.

1931. De Sebra, Mem. Mus. Zool. Univ. Coimbra (1) No. 1, pp. 453-454, Hebridae.

1934. Poisson, Bull. Soc. France, lix, p. 87, Hebridae.

1938. Harris, Iowa State College Jour. Sci., xi, p. 175, Hebridae.

1938. Brimley, Insects of North Carolina, p. 74, Hebridae.

1939. Millspaugh, Field and Laboratory, vii, p. 72, Hebridae.

1940. Costa Lima, Insectos do Brazil, pp. 304-306, Hebridae.

1942. Harris, Pan-Pac. Ent., xviii, p. 124, Hebridae.

1942. Harris, Pan-Pac. Ent., xviii, p. 168, Hebridae.

1943. Drake and Harris, Notas del Museo de la Plata, viii, pp. 44-58, Hebridae.

1944. Poisson, Rev. France d'Ent., x, p. 92, Hebridae.

1948. Zimmerman, Insects of Hawaii, Heter. iii, pp. 224-225, Hebridae.

1949. China and Usinger, Ann. and Mag. Nat. Hist., ser. 12, ii, p. 349, Hebridae.

= Naeogeidae Kirkaldy.

1900. Kirkaldy, Entomologist, xxxviii, p. 241, Naeogeidae.

1902. Kirkaldy, Fauna Hawaii, iii, p. 168, Naeogeidae.

1906. Kirkaldy, Trans. Am. Ent. Soc., xxxii, p. 156, Naeogeidae.

1908. Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., x, p. 214, Naeogeidae.

1910. Torre-Bueno, in Smith, Cat. Ins. New Jersey, edn. 3, p. 152, Naeogeidae.

1912. Bergroth, Wien Ent. Zeit., xxxi, p. 164, Naeogeidae.

1912. Reuter, Of. Finska Vet. Akad. Forh., liv, Afd. A, No. 6, pp. 23, 49, 55, Naeogeidae.

1926. Blatchley, Heterop. E. N. Amer., pp. 605-608, Naeogeidae.

1926. Hale, Rec. S. Aust. Mus., iii, No. 2, pp. 195-217, Naeogeidae.

1934. Hungerford, Bull. Brooklyn Ent. Soc., xxix, pp. 70-71, Naeogeidae.

1948. Brown, Entom. Mo. Mag., lxxxiv, p. 125, Naeogeidae.

Family Characteristics

Small (length 1.50 mm. to 3.2 mm.); plump-bodied; subaquatic in habit; bucculae large, forming distinct longitudinal groove, which extends to base of head; two ocelli in macropterous adults; brachypterous forms with minute ocelli that are lacking in

apterous forms; rostrum four segmented; tarsi two segmented; membrane of wing without veins; head and thorax sulcate beneath.

The following key to the Families of Gerroidea is taken from China and Usinger (1949:349).

1. Scutellum of metanotum, and usually also of mesonotum, exposed forming transverse, rounded or subtriangular plates - 2

_. Scutella of mesonotum and metanotum not exposed, nor developed as separate plates - - - - - - - - - - - - 3

2. Bucculae very large, forming a distinct longitudinal groove, which extends to base of head - - - - - - Hebridae

_. Bucculae small, not forming a longitudinal groove beneath head - - - - - - - - - - - - - - - - - - -Mesoveliidae

3. Head very long and slender, at least three times as long as broad across the eyes; eyes distant from base of head - - - - - - - - - - - - - - - - - Hydrometridae

_. Head short and broad; eyes close to or at base of head- 4

4. Vertex with a distinct median longitudinal suture- Veliidae

_. Vertex without a median longitudinal suture - - - Gerridae

A List of, and Key to, the Genera of Hebridae of the World

Doctor Halbert M. Harris has kindly provided this list and key to the genera of Hebridae from an unpublished manuscript. It is reproduced here by his permission.

List of Genera

1. Hebrus Curtis, 1833.
   Naeogaeus Laporte, 1833.
2. Hyrcanus Distant, 1910.
3. Lipogomphus Berg, 1879.
4. Merragata White, 1877.
5. Timasiellus Lundblad, 1933.
6. Timasius Distant, 1909.

Key to Genera

1. Antennae clearly four-segmented, the distal segments rather stout and fusiform - - - - - - - - - - - - - - - - - 2

   Antennae five-segmented, the distal segments fine, their origin sometimes obscure- - - - - - - - - - - - - - - 4

2. Head and pronotum clothed with fine, metallic, scale like hairs - - - - - - - - - - - - - - - - - Lopogomphus Berg

   Not as above - 3

3. Head distinctly produced in front of eyes, the apex on each side (maxillary blades) produced with result that from above the tip is excised - - - Hyrcanus Distant

   Not as above - - - - - - - - - - - - - - - - Merragata White

4. Antenniferous tubercles strongly produced into distinct spines. Scutellum longitudinally keeled - - - - 5

   Not as above - - - - - - - - - - - - - - - - Hebrus Curtis

5. Head and pronotum with two median longitudinal ridges - Timasius Distant

   Head and pronotum not keeled - - - - - - Timasiellus Lundblad

There are three genera of Hebridae in the Western Hemisphere. Hebrus has twenty-three described species of which three here are named as new. Merragata has five described species and Lipogomphus has a single species.

Historical Review

The hebrids were originally placed by Brulle', in 1835, with the group which now forms the Gerridae. This classification was retained by Burmeister (1835:214), Blanchard (1840:97), Westwood (1840:119-120), Fieber (1861:32, 104), Baernsprung (1860:13), Walker (1873:159), J. Sahlberg (1875:62), Saunders (1875:142-143), Berg (1884:116-117), and Kirkaldy (1909:214-215). The Hebridae were classified as relatives of the Tingididae by Amyot and Serville (1843:293), Flor (1860:372), Douglas and Scott (1865:263), Puton (1875:56), and by Saunders (1892:142-143). Lethierry and Severin (1896:51), Distant (1904:167), Champion (1898:118-119) and Oshanin (1908:482-483) placed these insects between the aradids and gerrids (Hydrometridae). The Hebridae were classed with the lygaeids by Herrich-Schaffer (1842:38-39). Reuter (1910:61) presents a phylogenetic tree indicating a possible origin of the Hebridae from the Neidoidae group. Tingididae is the family nearest related to the Hebridae within the Neidoidae group. The Coreidae are in the group next above the Hebridae. Horvath (1911:21-22), Bergroth (1912:164) and Champion (1898:118-121) consider the Hebridae and Mesoveliidae to be closely related. China (1933:180) believes that

the families Gerridae, Veliidae, Hydrometridae, Hebridae and Mesoveliidae are of monophyletic origin, and suggests that they arose from primitive reduvioid forms by the way of the early Nabidae. He further indicates in his phylogenic tree that the Hebridae and Veliidae had a common origin.

Kirkaldy (1900:156) indicated that Naeogeus antedated Hebrus. He corrects Lethierry and Severin's Catalogue as follows: "Naeogeus Lap., 1832 /nec Naeogaeus/= Hebrus Curtis 1833."

Oshanin (1908:482) replaced the name Naeogeidae with Hebridae but did not indicate his reason for the change. Reuter (1910:78) refused to accept Kirkaldy's change and stated that Kirkaldy gave no valid reason for the change; that Laporte's Naeogeus has a four-segmented antenna while Curtis's Hebrus has a five-segmented antenna and that Naeogeus was terrestrial whereas Hebrus is semiaquatic. Horvath (1911:21-22) also disagreed with Kirkaldy for the reasons given by Reuter and further added that the membrane of the wing of Naeogeus is described as white which does not fit the species of Hebrus. Harris (1942: 124) doubted the date of Laporte's Essai. He writes as follows:

> "There has been some question as to the priority of the generic names, Hebrus Curtis and Naeogeus Laporte, also as to their synonymy and the name to be applied to the family. Kirkaldy (Entomologist, 1900, p. 241), assuming that Laporte's work antedated that of Curtis cited Hebrus in synonymy and on the basis of the oldest included genus proposed for the group the family name Naeogeidae. That the haplotype of Naeogeus (erythrocephalus Laporte) was congeneric with the haplotype of Hebrus (pusillus Fallen) had already been suggested by Spinola (Essai Hemip., p. 223, 1840) and Fieber (Europ. Hemip., p. 104, 1860). Horvath,

however, was inclined to doubt that Hebrus pusillus Fallen and Naeogeus erythrocephalus were congeneric and based the family name more logically on its type genus - the type genus having been established by Fieber's use of Hebroidea in 1851. (Note: Horvath failed to indicate the use of Hebrides by Amyot and Serville in 1843.) Now, if erythrocephalus and pusillus are congeneric, as modern hemipterists are agreed (actually most workers consider erythrocephalus Laporte as only a variety of the older pusillus Fallen), and if Laporte's paper antedates Curtis's as all recent bibliographies indicate, then the genus name Naeogeus will have to hold and the family name will be Naeogeidae.

"However, abundant evidence has been presented (China, Ann. Mag. Nat. Hist., (9) 19:114, 1927) to show that the paper by John Curtis, entitled "Characters of some undescribed Genera and Species indicated in the Guide to an Arrangement of Brittish Insects," in which the genus Hebrus was established, was in print prior to January 10, 1833.

"It now seems equally evident that Laporte's Essai, in which Naeogeus is established, did not appear in 1832 as cited by most present-day hemipterists, but instead actually was not in print in its entirety until after April, 1833 (see Harris, The Date of publication of Laporte's Essai, to follow in the next issue). By reason of this, Hebrus Curtis, 1833, takes precedence over Naeogeus Laporte, 1833, and the name of the family of this group of bugs will be Hebridae."

Harris (1942:161-162) concluded:

"The genera and species described by F. L. de Laporte, Compte de Castelnau, in his "Essai d'une Classification Systématique de l'Odre des Hémiptères" have been dated by most taxonomists and bibliographers from 1832. In an effort to solve some questions of synonymy and priority I have recently had occasion to investigate the date of publication of the Essai, and have concluded that it did not appear until 1833, although the preceding parts of volume II of Guérin's Magasin de Zoologie, in which Laporte's Essai appeared, actually were printed in 1832.

"The title page of the 'deuxieme année' of Magasin de Zoologie bears the date, 1832. The introductory paragraphs, however, are signed 'Guérin,

Paris, Mars 1833' and the opening sentences are - 'Aujourd 'hui nous faisons enfin paraître les 11 et 12 livraisons du Magasin de Zoologie. Ces deux livraisons, qui ont été retardées des circonstances independantes de notre volonte, formant le complement de l'année 1832.' This followed by a 'Table Methodique' of the species and genera 'decrits ou indiques dans l'année 1832.' An examination of the Table discloses that none of the genera or species treated in the Essai is listed, although a species described on the page immediately preceding the Essai is given. Laporte introduces the Supplement of the Essai with the statement 'Ce travail ayant paru successivement, feuille par feuille,...'

"Thus the Essai itself and in the volume of the journal in which it is published there is sufficient cause for doubting the 1832 date. Also it is made clear that the Essai appeared in parts. In his reference to the Heteroptera, Westwood (Introd. Mod. Classif. Insects, 11:451, 1840) cites Laporte's Essai as dating from 1833 as he previously had given it in an address read before the Entomological Society of London on January 21, 1835.

"An examination of the early volumes of the Annales de la Société Entomologique de France and the Entomological Magazine, both of which had their inception in 1832, sheds still more light on the matter. On page 111 of the Annales, Volume I, 1832, in the report of the 'Séance du février, 1832' is the statement, 'M. De Laporte lit un essi d'une nouvelle classification des Hémiptères.' In volume II of the Annales, p. xxxiii, livraison 11 of Guérin's Magasin is listed among the works having been published since January, 1833; and on p. xlii, livraison 12 and 13 are noted as having appeared after April 1, 1833. Still later in this second volume of the Annales there is a list of works published by members of the Société Entomologique de France during 1833, which list includes Laporte's Essai.

"In volume I of the Entomological Magazine, p. 305, there is a review of Guérin's Magasin de Zoologie in which the reviewer specifically mentioned Laporte's Essai. This is in the third number of the volume, issued in April, 1833. In the fifth number of the same volume, issued in October, 1833,

> one finds Guérin's Magasin de Zoologie again reviewed in the 'Notice of Entomological Works' and it is specifically noticed that 'De Laporte's excellent Essay on the Hemiptera is concluded.'
>
> "In the copy of volume II of Guérin's Magasin before me there is no indication of the livraisons. One surmises that Laporte's Essai was issued as livraisons eleven and twelve and perhaps the Supplement as thirteen (note: Guérin's introduction does not mention the thirteenth). In any case it seems clearly evident that no parts of the Essai were issued in 1832, and that a portion of it, but not all, appeared before April, 1833."

Information gained from the above references indicate that it is advisable to retain the generic name Hebrus Curtis and the family name Hebridae A. & S.

Rostral and Antennal Segmentation

Curtis (1833:198) describes the antenna as five segmented. He does not mention the small segment between the second and third segments nor the annulations at the base of the fifth. Westwood (1843:652) states:

> "This genus is very near to Microvelia in its habits, its size and its general appearance; Lygaeus pusillus Fallen is the type which has been considered by this author, as appertaining strictly to a different genus. Mr. Curtis as a matter of fact likewise described it in Entomologists Magazine (vol. 1, p. 198) under the name Hebrus pusillus (fig. nos. 6, a, b) omitting however, some important characters in his description. He describes the antenna (fig. 6, d) as being divided into five sgements, but he does not describe the two small rudimentary segments which exist between the second, third and fourth segments. He describes simply the beak (fig. 6, c) as being as long as the thorax, antenuated and pointed; that organ is composed of four segments; the two segments at the base very small, the third is very long, and the fourth of medium length. The labium reaches the end of the segment of the base, which is the widest. ...."

Douglas and Scott (1865:25) give the following description:

> "Antenna: first and second joints stout; third and fifth very minute, like a petiole of the preceding joints, ... Rostrum: 4-jointed, long, first and second very short, rostral channel with deep raised sides."

Saunders (1892:142-143) objects to the report of Douglas and Scott, revising their determination of antennal segmentation as follows:

> "Antenna five-jointed; the sixth joint mentioned by Messrs. Douglas and Scott appears to me to be only the extreme, narrow, base of the third; rostrum four-jointed, received into a canal under the head and thorax...."

If the antennae of Hebrus burmeisteri L. & S., Hebrus buendi D. & H., Hebrus sobrinus Uhler and Hebrus concinnus Uhler are cleared with potassium hydroxide the minute segments at the base of the third and fourth segments described by Westwood become evident. These segments are difficult to see in most uncleared antennae.

Anatomical Notes and Techniques

A medial longitudinal sulcus is present on the vertex and frons of some species. When checking the specimens for the presence or absence of this sulcus the insect must be placed so that the vertex will be viewed on a horizontal level. If the hebrids are placed so that the head is viewed from a dorsal position, this sulcus may be overlooked in some species. Other species may seem to have this furrow when it is actually lacking.

The tip of the scutellum is bifid in some species and truncate in others. The scutellum should be brushed lightly with a fine camel's hair brush if there is any detritus on the scutellum to enable one to see the tip clearly. The scutellum may be cleaned with 70 per cent alcohol if the specimens are muddy or covered with glue.

The inner vein of the hemelytron may be produced, angulate or rounded (plate v, figs. 5, 6, and 7). Setae may be matted over this area. These setae can be loosened by brushing with 70 per cent alcohol.

Parameres are difficult to see. It is advisable to remove and mount them in glycerin gel. The genital chamber may be softened by a relaxing fluid having the following formula:

Alcohol (95%)----------	1060 cc.
Water (distilled)----------	980 cc.
Benzol----------	140 cc.
Ethyl acetate----------	380 cc.

If the entire insect is moistened, the glue may dissolve and the insect drop off of the point. Therefore a hair fastened to a wooden holder should be used to moisten the chamber. The insect can be placed on a mounting block for dissection. Approximately five minutes is required for the structure to soften. A light pressure on the eighth venter will cause the genital chamber to protrude. It can be broken away from the abdomen with a dissecting needle.

After the genital chamber is removed, it must be cleared

by boiling in 10 percent potassium hydroxide and then rinsed in water. The length of time required for clearing the parameres varies according to the specimen. Teneral specimens will not provide good characters because of the shrinkage of the parameres. Therefore, teneral specimens should not be used in determinations if the parameres are the critical criteria to be used.

Boiling in caustic potash not only clears the genital structures, but it softens them as well. After boiling, the enclosed structures can be evaginated. This process requires a fine dissecting needle. Such a tool can be prepared by inserting a "minute nadel" in an orange stick. The little needle is inserted through the broken end of the genital chamber into the anal tube. A slight pressure will force the anal tube outward and down. As the anal tube is pushed out, the parameres will be evaginated.

The genital chamber should then be embedded in glycerin gel to facilitate the examination of the parameres. The gel should be warmed slowly until it is soft enough to permit the genital chamber to be submerged. If too much heat is applied the gel will become filled with bubbles of gas and must be discarded. The genital chamber must be submerged before it dries or air will get in the parameres. This air must be removed from the parameres before they can be used in identification of the specimen. When the genital chamber has been rotated to the desired position the gel should be permitted to cool. If the parameres are not congruent the gel can be softened by reheating and the genital chamber rotated again.

The drawings of the parameres were made by the use of a camera lucida. They are all drawn to the same scale.

Key to the Genera and Species of the Family Hebridae of the Western Hemisphere

1. Antenna with four segments---------- 2
   Antenna with five segments---------- (*Hebrus* Curtis) 6

2. (1) Males with a spur at the distal end of the posterior tibia---- (*Lipogomphus* Berg) - *Lipogomphus lacunifera*
   Males without a spur at the distal end of the posterior tibia---------- (*Merragata* White) 3

3. (2) Apical segment of the antenna elongate---------- 4
   Apical segment of the antenna fusiform---------- 5

4. (3) Large white spot on each side of membrane beyond tip of vein---------- *Merragata sessoris*
   White spot indistinct or lacking----- *Merragata brevis*

5. (3) Apex of the scutellum rounded; membrane of wing white- *Merragata brunnea*
   Apex of the scutellum truncate or slightly concave; membrane with four white spots on dark background----- *Merragata hebroides*

6. (1) Male with a small tubercle on the inside of the posterior femur near the base-------- *Hebrus usingeri*
   Males without the above character---------- 7

7. (6) Male with a tubercle on the inside of the intermediate femur near the base---------- *Hebrus sulcatus*
   Males without the above---------- 8

8. (7) Medial longitudinal sulcus of pronotum extending into collar---------- 9
   Medial longitudinal sulcus of the pronotum ending before reaching collar---------- 11

9. (8) Sulcus of vertex deep---------- *Hebrus pudoris*
   Sulcus not present; two anastomosing lines may be present---------- 10

10. (9) Scutellum distinctly bifid---------- *Hebrus major*
    Scutellum truncate---------- *Hebrus hungerfordi*

11. (8) Inner vein of hemelytron rounded or angulate at the distal end---------- 12
Angle of the inner vein of the hemelytron produced at the distal end---------- 16

12. (11) Medial longitudinal sulcus of the pronotum wide and shallow ending anteriorly in two well defined pits---------- 13
Medial longitudinal sulcus of the pronotum narrow; nearly as wide as deep anteriorly------- 14

13. (12) Scutellum distinctly bifid; notch rectangular and nearly as deep as wide------Hebrus gloriosus
Scutellum not distinctly bifid; notch only a shallow depression at most----- Hebrus consolidus

14. (12) Medial longitudinal sulcus of vertex deep-------
Hebrus buenoi
Medial longitudinal sulcus of vertex absent or only slightly depressed---------- 15

15. (14) Apex of scutellum distinctly bifid; notch nearly as deep as wide----------Hebrus bilineatus
Apex of scutellum often not distinctly bifid; notch shallow when present--- Hebrus burmeisteri

16. (11) Medial longitudinal sulcus of vertex deep------- 17
Medial longitudinal sulcus of vertex absent----- 19

17. (16) Medial longitudinal sulcus of pronotum shallow and ending anteriorly in two well defined pits--
Hebrus priscus
Medial longitudinal sulcus of pronotum deeper than wide at anterior end; pits when present indistinct---------- 18

18. (17) Length of paramere not more than three times its width---------- Hebrus buenoi
Length of paramere more than three times its width---------- Hebrus comatus

19. (16) Medial longitudinal sulcus of pronotum shallow; with sides nearly parallel throughout its entire length---------- Hebrus laeviventris
Medial longitudinal sulcus of pronotum deeper than wide anteriorly; sides not parallel-------- 20

20. (16) Paramere* hook only slightly longer than wide--- 21
Hook of paramere much longer than wide---------- 23

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*Parameres are described from the lateral position.

21. (20) Hook of paramere nearly as wide as broadest part of base---------- Hebrus nubilus
Hook of paramere much narrower than broadest part of base---------- 22

22. (21) Hook of paramere shorter than wide-Hebrus concinnus
Hook of paramere as long as wide---- Hebrus beameri

23. (20) Cleft at base of hook directed toward base of paramere---------- Hebrus sobrinus
Cleft at base of hook not directed toward base of paramere---------- 24

24. (23) Hook of paramere not more than $1\frac{1}{2}$ times as long as wide measured from anterior side----------
Hebrus hubbardi
Hook of paramere more than $1\frac{1}{2}$ times as long as wide when measured from anterior side----------
Hebrus plaumanni

I have not seen the following species and have not included them in the key: Merragata leucosticta Champion; Hebrus parvulus Stål; Hebrus ecuadoris D. & H.; Hebrus paulus D. & H.

Genus Hebrus Curtis 1833

Haplotype pusillus (Fall.)

1833. Curtis, Ent. Mag., i:198.

1834. Westwood, Ann. Soc. Ent. Fr., ser. 1, iii:652.

1835. Burmeister, Handb. d. Ent., ii:214.

1835. Brulle, Hist. des Ins., ix:296.

1840. Blanchard, Hist. Nat. des Ins., Hemip., p. 97.

1840. Westwood, Int. Mod. Classif. Ins., ii Synop., p. 119.

1843. Amyot and Serville, Hemip., p. 293.

1850. Spinola, Tavala Sinot., p. 44.

1860. Flor, Rhyn. Livl., i:372.

1861. Fieber, Europ. Hemip., pp. 32, 104.

1865. Douglas and Scott, Brit. Hemip., p. 263.

1873. Walker, Cat. Heter., viii:159.

1896. Puton, Cat. Hemip. Palae., p. 36.

1896. Lithierry and Severin, Cat. Génl. Hémip., iii:51.

1898. Champion, Biol. Centr.-Amer., Heter., ii:117.

1903. Distant, Fauna Brit. Ind., Rhyn., ii:167.

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1912. Bergroth, Wien. Ent. Zeit., xxxi:164.

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1916. Parshley, Ent. News, xxvi:105.

1916. Torre-Bueno, Ann. Ent. Soc. Am., ix:353-365.

1917. Van Duzee, Cat. Hemip. Amer. N. Mex., p. 272.

1918. Bergroth, Philippine Jour. Sci., xiii:121.

1918. Hungerford, Jour. New York Ent. Soc., xxvi:13.

1920. Hungerford, Univ. Kansas Sci. Bull., xi:88.

1921. Hussey, Psyche, xxxviii:13.

1922. Hussey, Occ. Papers Univ. Michigan, No. 118, p. 36.

1923. Butler, Biol. Brit. Hemip., pp. 222-223.

1925. Hungerford and Beamer, Ent. News, xxxvi:262-266.

1925. Poisson, Proc. Verb. Soc. Linn. Normandie, (7) viii:66-69.

1929. Horvath, Ann. Hist. Natl. Mus. Hung., xxvi:317.

1931. De Sebra, Mem. Mus. Zool. Univ. Coimbra, (1) No. 1, pp. 453-454.

1934. Poisson, Bull. Soc. France, lix:87.

1938. Harris, Iowa State College Jour. Sci., xi:175.

1939. Brimley, Insects of North Carolina, p. 74.

1939. Millspaugh, Field and Laboratory, vii:72.

1940. Costa Lima, Insectos do Brasil, pp. 304-306.

1943. Drake and Harris, Notas del Museo de la Plata, viii:44-58.

1944. Poisson, Rev. Francaise d'Ent., x:92.

= Naeogeus Kirkaldy.

1900. Kirkaldy, Entom., xxxiii:241.

1902. Kirkaldy, Fauna Hawaii, iii:168.

1906. Kirkaldy, Trans. Am. Ent. Soc., xxxii:156.

1908. Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., x:214.

1910. Torre-Bueno, in Smith, Cat. Ins. New Jersey, edn. 3, p. 152.

1948. Brown, Entom. Mo. Mag., lxxxiv:125.

Hebrus bilineatus Champion

1898. Hebrus bilineatus Champion, Biol. Centr.-Amer. Rhynch., ii:119.

1926. Naeogeus bilineatus Blatchley, Heterop. E. N. Amer., p. 608.

1943. Hebrus bilineatus Drake and Harris, Notas de la Plata, viii:52.

Size. Length, 2 mm. to 2.8 mm.; width, 0.82 mm. to 0.88 mm.

Color. Rufo-fuscous; median portion of vertex and depressed lateral parts of anterior lobe of pronotum blackish; hemelytron with long narrow white streak on outer part of clavus and another narrow white streak between nervures of corium, corium blackish at apex, membrane smoky-brown with four indistinct whitish marks;

connexival margins and under margins of pronotum fulvous; under surface of body black; legs testaceous; antenna with segments one and two testaceous, distal ones fuscous.

Structural characteristics. Vertex of head medial longitudinal sulcus; antenna 5-segmented; pronotum moderately constricted at sides, medial longitudinal sulcus of anterior lobe deep, becoming obsolete posteriorly, depressed subtriangular lateral portions of anterior lobe demarcated by a line of punctures; scutellum deeply bifid at apex; inner vein of hemelytron angulate at distal end.

Location of type. Vienna museum. Wien. Champion (1898: 119) states: "One example taken at Chapultepec, Mexico."

Data on distribution. Known from Florida and Mexico. Blatchley (1926:609) lists the following localities: "Miami, R. P. Park, Bassenger, Sarasota, Ft. Myers, and Dunedin, Fla., Nov. 23 - April 16." I have examined one female from Blatchley's collection, a second female labeled Lamont, Fla., 3-8-1947, L. D. Beamer, and three females labeled Lake Placid, Fla., 7-13-1947, L. D. Beamer.

Hebrus buenoi Drake and Harris

(Plate vii, fig. 6; plate viii, fig. 13; plate x, fig. 26)

1943. Hebrus buenoi Drake and Harris, Notas del Museo de la Plata, viii:52.

Size. Length, 2.10 mm.; width, 0.80 mm.

Color. Rufo-fuscous; median portion of vertex and lateral portions of pronotum blackish; collar testaceous, median posterior

portion of disc vinaceous-russet; scutellum blackish; hemelytron with an elongate whitish spot at apex of clavus, anterior half of veins testaceous, posterior half blackish, membrane smoky-brown with subapical whitish spot, sometimes spot not well defined or not even distinct; rostrum yellow-brown; legs testaceous.

Structural characteristics. Vertex of head with deep medial longitudinal sulcus; pronotum moderately constricted at sides, medial longitudinal sulcus deep; scutellum deeply bifid at apex; hemelytron with inner vein angulate or produced at distal end.

Location of types. Holotype male, allotype female and paratypes, White Plains, N. Y., J. R. de la Torre-Bueno (in private collection of Drake and Harris). Paratypes: Ft. Collins Colorado, C. H. Barber (U. S. N. M.). Ames, Iowa, H. M. Harris; Wiggins, Mississippi, H. M. Harris; Beaver Dam, Wisconsin, H. M. Harris (in private collection of H. M. Harris). Ithaca, N. Y., 6-22-1917, H. B. Hungerford; Douglas Co., Kansas, R. H. Beamer; Texas, D. D. Millsbaugh (in the Francis Huntington Snow Entomological Collections, University of Kansas).

Data on distribution. The published records are: Massachusetts, New York, Michigan, Wisconsin, Mississippi, Iowa, Kansas, Colorado, Texas. I have studied the following specimens: Massachusetts: Farmington, V-17-1924, C. A. Frost, 2 females; North Haven, 2-VII-24, C. A. Frost, 1 male.

New York: Ithaca, 6-22-1917, H. B. Hungerford, 1 male and 4 females (paratypes); White Plains, 15-VII-07, J.R.T.B., 4 females and 6 males; White Plains, 7-VII-17, J.R.T.B., 3 females; White Plains, 27-VI-23, J.R.T.B., 5 females; Ringwood, Ithaca, J.R.T.B., 2 females.

Virginia: Deer Creek, 12-6-1905, H. S. Barber (U.S.N.M.) 1 male.

Michigan: East Lansing, 1 male; Cheboygan Co., 6-11-1947, T. W. Porter, 9 males and 8 females; Black Lake, Cheboygan Co., 7-24-1939, Isabella Baird, 1 male and 3 females (Univ. Mich. Biol. Sta. Col.); Cheboygan Co., VIII-9-1947, Milton Sanderson, 3 females; Cheboygan Co., 1947, Wayne Porter, 8 males and 5 females.

Illinois: Orland Park, 7-13-1936, R. H. Beamer, 1 male.

Iowa: Ledges State Park, 7-4-1945, Tom Polhemus, 8 males and 12 females; Ames, 7-3-1945, Tom Polhemus, 6 males and 2 females; Huxley, 7-11-1945, Tom Polhemus, 1 male and 2 females.

Kansas: Burton, 7-16-1945, R. H. Beamer, 1 female; Meade Co., R. H. Beamer, 1 male and 1 female; Muscotah, 5-30-1946, R. H. Beamer, 1 female; Douglas Co., 6-11-1947, T. W. Porter, 23 males and 18 females.

Texas: 3-19-1939, D. D. Millsbaugh, 1 female (paratype).

Colorado: C. H. Barber (U.S.N.M.), 1 male.

Hebrus burmeisteri Lethierry and Severin

(Plate vii, fig. 7; plate ix, fig. 16; plate x, fig. 25)

1835. Hebrus pusillus Burmeister, Hand. Ent. ii:214 (nec. Fallen).

1896. Hebrus burmeisteri L. & S., Cat. Gen'l Hemip., iii:51

1916. Hebrus burmeisteri, Parshley, H. M. Ent. News, xxvii:105.

1917. Hebrus burmeisteri Van Duzee, Cat. Hemip. Amer. N. of Mex., p. 273.

1920. Hebrus burmeisteri Hungerford, Univ. Kansas Sci. Bull., xi:86-87.

1921. Hebrus burmeisteri Parshley, Can. Ent., liii:239.

1925. Hebrus burmeisteri Hungerford and Beamer, Ent. News, xxxvi:265.

1926. Naeogeus burmeisteri Blatchley, Heter. N. E. Amer., p. 609.

1943. Hebrus burmeisteri Drake and Harris, Notas del Museo de la Plata, viii:50.

Size. Length, 2.20 mm. to 2.30 mm.; width, 0.99 mm. to 1.00 mm.

Color. Light chocolate brown; vertex and frons light chocolate brown; sides of pronotum dark chocolate brown, lighter on disc; hemelytron with clavus white at base cut off squarely by brown behind; white spots of membrane may or may not be clearly defined; rostrum light chocolate brown; legs testaceous.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with medial longitudinal sulcus shallow, humeri depressed within; scutellum only slightly invaginated at apex; hemelytron with inner vein rounded at distal end.

Location of types. In Berlin Zoological Museum. Type locality, Pennsylvania.

Data on distribution. New Hampshire south to Virginia west to Kansas. The published records are: New England, New Hampshire, Massachusetts, New York, Pennsylvania, New Jersey, Washington, D. C., Virginia, South Carolina, Michigan, Kentucky, Indiana, Wisconsin, Illinois, Iowa, Missouri and Kansas. I have studied specimens from the following:

Massachusetts: Edgewatertown, Martha's Vyd., 28-VI-12, C. W. Johnson, (U.S.N.M.), 1 female; Ashland, 11-V-1924, C. A. Frost, 1 female; Natick, 27-IV-24, C. A. Frost, 3 females (J.R. de la Torre-Bueno Col.).

New York: White Plains, 12-X-23, J. R. de la Torre-Bueno, 1 male; Ithaca, 6-22-1917, H. B. Hungerford, 1 male and 3 females.

Pennsylvania: Darlington, IV-26-1906, M. Wirtner, 2 females.

New Jersey: Westfield, 3-VIII-1904, J. R. de la Torre-Bueno, 4 males and 10 females; Westfield, 19-IV-1904, J. R. de la Torre-Bueno, 3 males and 5 females.

Maryland: Piney Point, 8-26-1946, R. H. Beamer, 27 males and 28 females.

Virginia: Norfolk, 8-II-34, P. McKinstry, 10 females; Woodbridge, 8-28-1946, L. D. Beamer, 2 males and 2 females; Dismal Swamp, 8-13-34, P. McKinstry, 3 females; Charlottesville, II-16-1934, M. L. Bobb, 3 males and 1 female; Woodbridge,

8-28-1946, L. D. Beamer, 3 males and 4 females (brachypterous form); Woodbridge, 8-28-1946, R. H. Beamer, 1 male and 2 females (brachypterous form).

Michigan. Nichol's Bog, Cheboygan Co., 7-23-1939, Isabella Baird, 14 males and 18 females; Vincent Lake, Cheboygan Co., VIII-8-1948, T. W. Porter, 10 males and 16 females, Nichol's Bog, Cheboygan Co., VIII-12-1948, T. W. Porter, 8 males and 12 females.

Kansas: Douglas Co., Oct. 8, 1923, H. B. Hungerford, 5 males and 4 females; Douglas Co., 10-9-1923, R. H. Beamer 17 males and 31 females; Muscotah, V-26-1948, T. W. Porter, 1 male and 3 females.

Hebrus comatus Drake and Harris

(Plate ix, fig. 18)

1943. Hebrus comatus Drake and Harris, Notas del Museo de la Plata, viii:53.

Size. Length, 2.56 mm.; width, 1.00 mm.

Color. Brownish-black; head black, brownish around eyes; pronotum uniformly black; hemelytron with basal part of clavus gray, basal half of veins tan, distal half black, membrane smoky-chestnut with subapical white spot and another at apex of vein; rostrum testaceous; legs testaceous, darker near joints.

Structural characteristics. Vertex of head with deep medial longitudinal sulcus; pronotum with deep medial longitudinal sulcus; scutellum bifid at apex; hemelytron with inner vein produced at distal end.

Location of types. In California Academy of Science. Holotype male, allotype female, paratype male. Taken at Mesilla Dam, New Mexico, by J. O. Martin.

Data on distribution. I have examined specimens as follows: New Mexico: Mesilla, 4-26-1948, R. H. Beamer, 1 male, 4 females; Mesilla, 4-26-1948, L. D. Beamer, 2 males, 2 females; Las Cruces, 4-30-1948, R. H. Beamer, 4 males, 5 females; Las Cruces, 4-30-1948, L. D. Beamer, 3 males, 3 females.* Texas: Cisco, 6-19-1947, R. H. Beamer, 1 female.

Hebrus concinnus Uhler

1894. Hebrus concinnus Uhler, Proc. Zool. Soc. Lond., p. 221.

1895. Hebrus concinnus Gillette and Baker, Hemip. Colo., p. 61.

1898. Hebrus concinnus Champion, Biol. Centr.-Amer., Heter., ii:121.

1908. Naeogeus concinnus Torre-Bueno, Jl. N. Y. Ent. Soc., xvi:234.

1910. Naeogeus concinnus Torre-Bueno, in Smith, Cat. Ins. New Jersey, edn. 3, p. 152.

1912. Naeogeus concinnus Torre-Bueno, Can. Ent., xliv:212.

1914. Naeogeus concinnus Barber, Bul. Am. Mus. Nat. Hist., xxxiii:502.

1917. Hebrus concinnus Van Duzee, Cat. Hemip. N. Mex., p. 273.

1918. Hebrus concinnus (= burmeisteri) Hungerford, Jl. N. Y. Ent. Soc., xxvi:13-19.

1920. Hebrus concinnus Hungerford, Univ. of Kansas Sci. Bull., xi:87.

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*Dr. R. H. and Mrs. Beamer made a special stop at Mesilla Dam, New Mexico, to collect additional specimens of this species. The above specimens were collected by them. These specimens were compared with the Drake and Harris types.

1921. Hebrus concinnus Parshley, Can. Eng., liii:239.

1925. Hebrus concinnus Hungerford and Beamer, Ent. News, xxxvi:262.

1926. Naeogeus concinnus Blatchley, Heterop. E. N. Amer., p. 607.

1943. Hebrus concinnus Drake and Harris, Notas del Museo de la Plata, viii:49.

Size. Length, 2.5 mm. to 2.75 mm.; width, 1.00 mm.

Color. Head dark brown to black, tinged with rufous at apex; pronotum rufous lighter on lateral margins; scutellum dull fuscous; hemelytron with clavus white at base, smoky-brown distally, corium with long pale streak, membrane pale fuscous with whitish spot at apex of vein, sometimes with three faint whitish spots on membrane; under side of head, bucculae and rostrum testaceous; legs testaceous, darker at joints.

Structural characteristics. Vertex of head without a medial longitudinal sulcus; pronotum with medial longitudinal sulcus deep at anterior end becoming shallow caudally to obsolete on posterior lobe; scutellum incised at apex; hemelytron with inner vein produced at distal end.

Location of types. In the British Museum. Uhler collected his types on the Mount Gay estate (Leeward side) Grenada W. I. and Balthazar (Windward side) Grenada, W. I.

Data on distribution. Originally described from Insular America. The published records are as follows: Grenada, Peru, Panama, Costa Rica, Guatemala, Mexico, Maryland, Virginia, North Carolina, South Carolina, Florida, Louisiana, Mississippi, Oklahoma, Colorado, Texas, Washington and California. I have seen specimens from the following localities:

Grenada: Mount Gay estate (Leeward side), H. H. Smith (U.S.N.M.), 1 female; Balthazar (Windward side), H. H. Smith (U.S.N.M.), 1 female.

U.S.A.: New York: Yaphank, Long Island, 26-IX-12, Collector's label missing, 5 males and 8 females (J. R. de la Torre-Bueno Col.).

Virginia: Charlottesville, II-16-1947, M. L. Bobb, 6 males and 8 females.

Louisiana: Hammond, 6-22-1948, R. H. Beamer, 13 males and 11 females.

New Mexico: Las Cruces, 4-30-1948, R. H. Beamer, 2 males and 5 females; Las Cruces, 4-30-1948, L. D. Beamer, 5 males and 7 females.

Hebrus consolidus Uhler

(Plate viii, fig. 14)

1898. Hebrus consolidus Uhler, Proc. Zool. Soc. Lond., p. 222.

1914. Hebrus consolidus Barber, Am. Mus. Nat. Hist. Bul., xxxiii:502.

1917. Hebrus consolidus Van Duzee, Cat. Hemip. N. Mex., p. 273.

1920. Hebrus consolidus Hungerford, Univ. Kansas Sci. Bul., xi:86.

1925. Hebrus consolidus Hungerford and Beamer, Ent. News, xxxvi:262.

1926. Naeogeus consolidus Blatchley, Heterop. E. N. Amer., p. 608.

1943. Hebrus consolidus Drake and Harris, Notas del Museo de la Plata, viii:48.

Size. Length, 1.75 mm. to 2.00 mm.; width, 0.75 mm. to 1.00 mm.

Color. Pale reddish-brown to reddish-brown; head tinged with rufous, silvery patch in front of eye and along upper margin of eye; pronotum rufous; scutellum blackish; hemelytron with long bluish-white, sharply defined, wedge-shaped mark on posterior part of clavus, narrow white streak between veins, membrane chestnut-brown with three conspicuous whitish marks, marks are irregular in outline; rostrum yellowish-testaceous; bucculae testaceous; legs testaceous darker at joints.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with shallow medial longitudinal sulcus on anterior lobe, sulcus obsolete on posterior lobe, two well defined pits at cephalic end of sulcus; scutellum truncate or slightly incurved at apex; helelytron with inner vein rounded at distal end.

Location of types. In the British Museum. They were taken on the Mount Gay estate, August 26 and September 6; also on the Telescope estate and at Balthazar, March 5, Grenada, W. I.

Data on distribution. The published records are: Grenada, Jamaica, Panama, Costa Rica, Guatemala, Florida, Louisiana, Mississippi and Kansas. I have seen specimens from the following localities:

Grenada: Mount Gay estate (Leeward side), H. H. Smith (U.S.N.M.), 1 male and 2 females.

Jamaica: Kingston, II-2-1937, Chapin and Blackweller (U.S. N.M.), 1 male and two females.

Costa Rica: San Jose, 6-7-1931, Heinrich Schmidt, 1 female.

Honduras: Phila Banana Cargo, 4-29-1934, (no collector's label), (U.S.N.M.), 1 female.

Mexico: Buente de Ixtla Morelos J. Parra, 7-30-1930, Dr. Dampf, 1 female.

U.S.A.: Puerto Rico: Guanica Lagoon, Needham and Diaz, 1 male; Florida: L. Worth, P. R. Uhler (U.S.N.M.), 1 female; South Bay, 3-13-1947, R. H. Beamer, 29 males and 33 females; South Bay, 3-13-1947, L. D. Beamer, 10 males and 19 females; Yankeetown, 7-31-1930, J. Nottingham, 1 female; Bradford, 7-31-1930, Paul W. Oman, 1 male; Lake Placid, 7-13-1948, L. D. Beamer, 29 males and 23 females; Lake Placid, 7-13-1948, R. H. Beamer, 7 males and 10 females; Labelle, 7-19-1948, R. H. Beamer, 7 males and 6 females; Palatka, 3-10-1948, R. H. Beamer, 1 male and 2 females.

Louisiana: Covington, 6-23-1948, R. H. Beamer, 3 females; Creole, 6-18-1948, R. H. Beamer, 2 males and 4 females; Mandeville, 6-24-1948, R. H. Beamer, 4 males and 2 females; Hammond, 6-22-1948, R. H. Beamer, 9 males and 4 females; Hammond, 6-22-1948, E. L. Todd, 1 male and 3 females.

Hebrus ecuadoris Drake and Harris

1943. Hebrus ecuadoris Drake and Harris, Notas del Museo de la Plata, viii:55.

I have not seen this species. The following description is from an unpublished manuscript of H. M. Harris:

> "Large, dark brown, the collar paler, head with a median impressed line. Eyes moderately large, dark, coarsely faceted. Antennae long, testaceous; proportions, 17: 10: 17: 13: 15. Rostral channel deep, extending on abdomen. Pronotum moderately constricted on the sides; the broad shallow median groove deepened anteriorly, terminating at inner-lobe constriction, there with a double pit, obsolete behind; pits on anterior lobe not very large; humeri fairly prominent. Scutellum broad, excised behind, with a median ridge, the lateral margins raised. Hemelytron dark smoky-brown, the nervures broad and hairy. Clavus and corium brownish, the former pale at base. Membrane dark smoky-brown, white spots indistinct.
>
> "Length, 2.56 mm.; width (across humeri), 1.00 mm.
>
> "Holotype male, Cachabe, Ecuador; in the collection of the author (Drake). The large size and long antenna separate this form at once from its congeners."

Hebrus gloriosus Drake and Harris

1943. Hebrus gloriosus Drake and Harris, Notas del Museo de la Plata, viii:47.

Size. Length, 2.40 mm.; width, 0.90 mm.

Color. Head golden brown, dark spot behind ocellus; pronotum golden-brown, anterior portion and collar yellowish-white; scutellum brown, lateral edges lighter; hemelytron with clavus white basally, membrane fuscous-brown, with pale subbasal spot and another subapical; rostrum yellowish-brown; legs testaceous.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with medial longitudinal sulcus broad and shallow, with two pits at anterior end of sulcus; scutellum bifid at apex; hemelytron with inner vein rounded at distal

end; entire body clothed with long golden setae.

Location of types. In the private collection of Drake and Harris. Holotype female; paratypes two females. Chapada, Brazil. Taken by the authors.

Data on distribution. Known only from Chapada. I have seen Harris's female paratype and two female specimens from the American Museum of Natural History labeled Chapada. The American Museum of Natural History specimens lack a collector's label and the date of collection.

Hebrus hirsutus Champion

1898. Hebrus hirsutus Champion, Biol. Centr.-Amer., Rhynch., ii:119.

1912. Hebrus hirsutus Torre-Bueno, Can. Ent., xliv:31-32.

1943. Hebrus hirsutus Drake and Harris, Notas del museo de la Plata, viii:46.

I have not seen this species, of which Champion gives the following description:

> "Female. Reddish-brown, the depressed portions of the pronotum, the pleura, and under surface with a greyish pruinosity; the eleytra with a wedge-shaped mark on the clavus and a narrow white streak between the two fuscous nervures of the corium; the membrane smoky-brown, with three indistinct whitish spots toward the base and a longitudinal, medially constricted obscure luteous stripe down the middle; the legs, antenna, and rostrum testaceous; the body, legs, and antenna clothed with long, bristly hairs, the hairs on the head, pronotum and scutellum blackish, the eleytra also with a scattered short fine pubescence. Head with a very fine median groove between the eyes; antenna slender, joint two a little shorter than one (the other joints broken off). Pronotum strongly constricted at the sides, the anterior lobe depressed

and with a few rather coarse punctures, the posterior lobe longitudinally sulcate down the middle anteriorly, and with a transverse groove before the base. Scutellum with a distinct carina.

"Length, 2.00 mm.

"Habitat. Mexico, La Noria in Sinaloa (Hoge).

"One example. Easily distinguished by the long bristly hairs on the body, legs, and antenna. The antenna are assumed to be 5-jointed."

Torre-Bueno (1912:31-32) indicates that he thinks hirsutus may be placed in the wrong genus, stating:

"In fact....it would not surprise me at all to find it eventually transferred to Merragata, especially since in the unique type the antenna were broken, but were assumed to be five jointed, a somewhat risky proceeding in view of the fact that the generic difference lies in this character...."

Location of type. In the Vienna Museum.

Hebrus hungerfordi Drake and Harris

(Plate viii, fig. 12)

1943. Hebrus hungerfordi Drake and Harris, Notas del Museo de la Plata, viii:58.

Size. Length, 2.45 mm.; width, 0.90 mm.

Color. Black-fuscous; vertex of head black, in front of and above eyes black-fuscous; pronotum black-fuscous lighter on disk; scutellum black; rostrum and legs fuscous.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with medial longitudinal sulcus deep and narrow, extending forward into collar; scutellum bifid;

hemelytron with inner vein angulate at distal end; parameres of male long, slender, cylindrical, extending beyond apex of terminal segment of abdomen.

Location of types. In the Francis Huntington Snow Entomological Collections at the University of Kansas. Holotype male; allotype female. Paratype male in the private collection of Carl J. Drake. Naranjapata, Ecuador, elevation 1850 ft., December 14, 1933, F. X. Williams.

Data on distribution. Known only from Naranjapata, Ecuador.

Hebrus laeviventris Champion

1898. Hebrus laeviventris Champion, Biol. Cent.-Amer., Rhynch., ii:120.

1943. Hebrus laeviventris Drake and Harris, Notas del Museo de la Plata, viii:46.

Size. Length, 1.96 mm. to 2.12 mm.; width 0.79 mm. to 0.87 mm.

Color. Vertex of head golden-brown, with dark spot above ocellus; pronotum fulvescent, anterior part flavous; scutellum fulvescent, lateral edges blackish; hemelytron with silvery-white mark at base of clavus, long pallid streak between veins, membrane smoky-brown with one or two obscure brownish-yellow oval medial spots, these may be connected; rostrum and legs flavous.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with medial longitudinal sulcus shallow, with a medial ridge and with two pits at anterior end;

scutellum truncate or slightly incurved at apex; hemelytron with inner vein produced at distal end.

Location of types. In the Vienna Museum. Champion states in his original description that he took nine specimens at Tole, Panama.

Data on distribution. The published record is Panama. I have seen the following:

Brazil: Chapada. No other information. (In private collection of H. M. Harris.) 1 female.

Peru: Peru S. A., vic. Pampa Hermosa, May 1-5, 1935, F. Woytkowski, 4 females. In the Francis Huntington Snow Entomological Collections.

Hebrus major Champion

(Plate viii, fig. 11)

1898. Hebrus major Champion, Biol. Centr.-Amer., Rhynch., ii;118.

1943. Hebrus major Drake and Harris, Notas del Museo de la Plata, viii:53.

Size. Length, 2.6 mm. to 3.0 mm.; width, 1.5 mm. to 2.0 mm.

Color. Head black, silvery around compound eyes; pronotum reddish-brown, darker on sides, collar fuscous; scutellum dark brown; hemelytron with broad, wedge-shaped, evanescent, white patch at base of clavus, veins black apically lighter basally, membrane smoky-brown with transverse pallid streak near apex of corium; rostrum and legs testaceous.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with medial longitudinal sulcus deep and narrow on anterior lobe obsolete on posterior lobe, anterior end of sulcus extending into collar; scutellum bifid at apex; hemelytron with inner vein produced at distal end; paramere of male strongly hooked at distal end.

Location of types. In the Vienna Museum. Collected at Orizaba, Mexico.

Data on distribution. The published records are: Costa Rica, Mexico, Arizona. I have seen specimens from the following localities:

Costa Rica: San Jose, 6-7, 1931, Heinrich Schmidt, 6 females.

Mexico: Real de Arriba, Temescaltepec, VI-31-1933, R. L. Usinger (in the private collection of R. L. Usinger), 3 males and 5 females; Lower California, P. R. Uhler (U.S. N.M.), 1 female; Xochimilco, June 21, 1934, H. Hinton, 1 female.

U.S.A.: Arizona; Chirichihua Mts., H. G. Hubbard (U.S.N.M.).

Hebrus nubilus Drake and Harris

(Plate ix, fig. 21)

1943. Hebrus nubilus Drake and Harris, Notas del Museo de la Plata, viii:56.

Size: Length, 2.00 mm. to 2.35 mm.; width, 0.82 mm. to 0.90 mm.

Color: Entire head black; pronotum fuscous, humeral angles

black, collar light fuscous; base of scutellum black, apex light fuscous; rostrum testaceous, dark at apex; legs testaceous.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with medial longitudinal sulcus deep and narrow, barely extending onto posterior lobe, evanescent on posterior lobe; scutellum truncate; hemelytron with inner vein produced at distal end; parameres of male curved upward at distal end.

Location of types. In the California Academy of Science. Holotype male, allotype female. Paratypes in the U. S. N. M. and in the private collections of Carl J. Drake and H. M. Harris. Collected at Real de Arriba, Temescaltepec, Mexico, May 22, 1933, by H. E. Hinton and R. L. Usinger.

Data on distribution. Known only from Mexico.

Hebrus parvulus Stål

1858. Hebrus parvulus Stål, Svenska Vetenskaps-Akademiens Handlingar, ii:60.

1898. Hebrus parvulus Champion, Biol. Centr.-Amer., Rhynch., ii:119.

1943. Hebrus parvulus Drake and Harris, Notas del Museo de la Plata, viii:46.

I have not seen Hebrus parvulus Stål. The following description is given by Stål:

> "Oblongus, fusco-testaceus, pedibus pallidioribus; hemelytris nigro-fuscis, vitta sub-obliqua prope scutellum maculisque 3 membranae albidis; thorace longitudine duplo fere latiore.
>
> "Long. 2, lat. 3/4 millim.--(Mus. Holm.).

> "H. pusillo valde similis et affinis, vitta hemelytrorum apice intus ramulum nullum emittente thoraceque (ut mihi videtur) nonnihil breviore, anterius subangustiore diversus."

which I have translated as follows: Oblong, fusco-testaceous, with tarsi rather pale; hemelytron nigro-fuscous, with a somewhat oblique band near the scutellum and with three whitish spots on the membrane, with the thorax almost twice as long as wide.

Length 2, width 3/4 mm.--(Mus. Holm.).

H. pusillus very similar and close with subapical spot of hemelytron unbranched and with thorax (as it seems to me) somewhat shorter, anteriorly somewhat narrower and diverse.

Champion (1894:118) writes in his description of Hebrus consolidus Uhler:

> "H. parvulus Stål from Rio Janerio (the type of which is before me) is a very closely allied form; but it has a rather more elongate basal joint to the antenna, the two lobes of the pronotum more distinctly separated, the wedge-shaped mark on the clavus shorter, the white streak between the nervures of the corium indistinct, and the whitish marks on the membrane less inconspicuous."

Drake and Harris (1943:46) lists Hebrus parvulus Stål but they do not give any description of it.

Location of types. In the Stockholm Museum. One specimen collected by F. Sahlb. Type locality, Brazil.

Data on distribution. The published records are: Brazil and Panamá.

Hebrus paulus Drake and Harris

1943. Hebrus paulus Drake and Harris, Notas del Museo de la Plata, viii:47.

I have not seen Hebrus paulus Drake and Harris. It was described from a single female. The following description is taken from Doctor Harris's manuscript:

> "Very much smaller but quite similar to H. laeviventris Champ. in form and color. Head dark reddish-brown, velvety in appearance, the median impressed line fine, divided in front and thus including a narrow, longitudinal ridge; ocelli prominent, brownish-black; eyes large, coarsely faceted; rostrum very long, testaceous, brownish distally, extending considerably on the venter. Legs testaceous, inconspicuously hairy, the apex of femora and base of tibiae narrowly embrowned. Antennae moderately long, testaceous, the two distal segments whitish, proportions - I, 8: II, 6; III, 10; IV, 7; V, 10.
>
> "Pronotum strongly constricted at the sides, with anterior and posterior lobes distinctly marked off with large, deep punctures; anterior lobe pale testaceous; posterior lobe dark reddish-brown, with median furrow very broad and shallow, a deep broad furrow on each side marking off humeral angles. Scutellum pitted, without median ridge, broad and widely bifid at apex. Hemelytra brown, a little more than basal half of clavus white; the nervures of corium large, prominent, becoming darker distally, obliquely truncate behind; membrane smoky-brown, concolorous. Abdomen yellowish-brown, inconspicuously hairy, the venter indistinctly divided into segments.
>
> "Length, 1.74 mm.; width, 0.63 mm.
>
> "Holotype winged female, Chapada, Brazil.
>
> "The tiny size, proportional lengths of antennal segments and color are the distinguishing characteristics."

Location of types. In the private collection of Carl J. Drake.

Data on distribution. The published record is Chapada, Brazil.

Hebrus priscus Drake and Harris

1943. Hebrus priscus Drake and Harris, Notas del Museo de la Plata, viii:57

Size. Length, 1.75 mm. to 1.93 mm.; width, 0.70 mm. to 0.99 mm.

Color. Head dark brown with dark spot above ocellus; pronotum dark brown, humeral angles blackish; scutellum dark brown, lateral edges blackish; hemelytron brown, basal portions of clavus and corium lighter, membrane without sharply defined spots; rostrum and legs testaceous.

Structural characteristics. Vertex of head with medial longitudinal sulcus; pronotum with medial longitudinal sulcus wide and shallow, sulcus with two well defined pits at anterior end and longitudinal row of punctures on each side, humeral angle furrowed within; scutellum shallowly bifid; hemelytron with inner vein produced at distal end; parameres curved upward at distal end and with distal end incurved.

Location of types. Holotype male and allotype female in the private collection of Drake and Harris. Paratype female in the private collection of H. M. Harris. Type locality Cuyaba, Brazil. Collection date not given.

Data on distribution. Published record is Brazil. I have seen specimens from the following localities:

Brazil: Corumba, Matta Grosso, collector's name and date specimen taken are lacking (in the J. R. de la Torre-Bueno Collection, University of Kansas), 3 males and 9 females. Chapada (in the private collection of H. M. Harris), 1 female.

Canal Zone: Bahia, Feb. 7-11, E. A. Schwarz (U.S.N.M.), 1 female.

Hebrus pudoris Drake and Harris

(Plate viii, fig. 15)

1943. Hebrus pudoris Drake and Harris, Notas del Museo de la Plata, viii:56.

Size. Length, 1.84 mm. to 2.25 mm.; width, 0.83 mm. to 0.92 mm.

Color. Head with median part of vertex fuscous to black, testaceous around compound eyes, base of vertex rufo-fuscous; pronotum with median area of disc fuscous, lateral edge dark anteriorly, posterior inner part of humeri fulvous, collar fulvous; scutellum fuscous, lighter apically; hemelytron with veins fuscous, clavus with distal and apical fulvous spots separated by smoky-fuscous, membrane fuscous with faint transverse pale streak at distal angle of corium, also with subapical oval spot; rostrum testaceous darker at distal end; legs testaceous.

Structural characteristics. Vertex of head with medial longitudinal sulcus; pronotum with medial longitudinal sulcus broad and deep anteriorly, evanescent on posterior lobe, anterior lobe with pit on either side of sulcus, posterior lobe with

numerous scattered pits; scutellum incurved to bifid at apex; hemelytron with inner vein produced at distal end.

Location of types. In the California Academy of Science. Holotype male; allotype female, Real de Arriba, Temescaltepec, Mexico, May 28, 1933, H. E. Hinton and R. L. Usinger. Paratypes in the private collections of H. M. Harris and Carl J. Drake.

Data on distribution. The published record is Mexico. I have seen the following specimens:

Costa Rica: San José, 6&7, 1931, Heinrich Schmidt, 1 male and 9 females.

México: Real de Arriba, Temescaltepec, May 28, 1933, H. E. Hinton and R. L. Usinger (California Academy of Science), 4 males and 5 females.

Hebrus sobrinus Uhler

(Plate x, fig. 22)

1877. Hebrus sobrinus Uhler, Bull. U. S. Geo. and Geog. Surv., iii:452-453.

1877. Hebrus sobrinus Uhler, Wheeler's Rept. Chief Eng. for 1887, p. 1330.

1894. Hebrus sobrinus Uhler, Proc. Calif. Acad. Sci., ser. 2, iv:228.

1895. Hebrus sobrinus Gillette and Baker, Hemip. Colo., p. 61.

1917. Hebrus sobrinus Van Duzee, Cat. Hemip. Amer. N. Mex., p. 273.

1920. Hebrus sobrinus Hungerford, Univ. Kansas Sci. Bul., xvii:87.

1925. Hebrus sobrinus Hungerford and Beamer, Ent. News, xxxvi:265.

1943. Hebrus sobrinus Drake and Harris, Notas del Museo de la Plata, viii:49.

Size. Length, 1.75 mm. to 2.00 mm.; width, 0.75 mm. to 0.80 mm.

Color. Head black with silvery pile across base, also around eyes and extending forward across tylus; pronotum fuscous, darker on lateral border of anterior lobe, collar testaceous; scutellum fuscous, lighter toward apex; hemelytron with clavus smoky-white at base, smoky-brown at posterior end, veins testaceous, darker at apex, corium smoky-brown, membrane smoky-brown, with narrow transverse pallid streak at apex of corium; rostrum and legs testaceous.

Structural characteristics. Vertex of head without medial longitudinal sulcus; pronotum with deep medial longitudinal sulcus, evanescent on posterior lobe, anterior and posterior lobes demarcated by row of coarse punctures, humeri impressed within, row of small punctures posterior to collar; scutellum with apex slightly incurved; hemelytron with inner vein produced; paramere of male three lobed, median lobe curved sharply upward.

Location of types. In the British Museum. Type locality, Denver, Colorado.

Data on distribution. The published records are: Texas, Colorado, New Mexico, Utah, Arizona and Colorado. I have seen specimens from the following localities:

Perú: Vic. Río Negre 790 m., River R. Negro, Oct. 28, 1935, F. Woytkowski, 1 female.

México: Tejupilco District of Temescaltepec, June-July, 1933, H. E. Hinton, 9 males.

U.S.A.: Georgia; Silver Lake, Fulton Co., Aug. 10, 1913, collector's label missing (U.S.N.M.), 1 male; Vogel State Park, X-1-1944, R. L. Usinger (Usinger collection), 3 males and 4 females.

Mississippi: Lucedale, 7-2-1930, H. Dietrich, 1 female.

Kansas: Rock Creek, Douglas Co., H. B. Hungerford (no date), 1 male; Riley Co., Aug. 27, (?), J. B. Norton, 1 female; Meade Co., 9-13-1944, R. H. Beamer, 1 female; Green's Lake, Lawrence, V-2-1948, T. W. Porter, 11 males and 14 females; Leavenworth, 7-24-1933, L. S. Henderson, 1 female.

Texas: C. V. Riley (U.S.N.M.). No other information on pin. 2 females.

Colorado: C. F. Baker (U.S.N.M.), 1 female. No other information on pin.

New Mexico: San Ildefonso. (U.S.N.M.). Female. No other information on pin.

Arizona: Ft. Yuma, 1-4, H. G. Hubbard (U.S.N.M.), 3 males and 1 female; Hot Springs, 26-6, Barber and Schwarz (U.S.N.M.), 1 female; Chiric. Mts., 2-7, H. G. Hubbard, 1 female.

California: Los Angeles Co., Coquillett (U.S.N.M.), 1 male and 3 females.

Hebrus sulcatus Champion

1898. Hebrus sulcatus Champion, Biol. Centr.-Amer., Rhynch., ii:120-121.

1943. Hebrus sulcatus Drank and Harris, Notas del Museo de la Plata, viii:47.

I have not seen Hebrus sulcatus Champion. The original description is as follows:

"Rather elongate, black, the pronotum with the disc rufous or fulvous and the anterior margin testaceous or flavo-testaceous; the head reddish-brown on each side between the eyes, in one specimen entirely of that color; the antennae, rostrum, legs, coxae and trochanters, and the apex of venter, flavous or flavo-testaceous, the knees, tibia, and outer joints of the antennae sometimes a little darker; the elytra smoky-brown, with the clavus and the narrow space between the two longitudinal nervures of the corium pale brown, the membrane with a narrow pallid transverse streak near the apex of the corium; the body, legs, and antennae clothed with short fine pubescence, the venter densely clothed with short pallid hairs, the entire under surface with a greyish pruinosity. Head with a very fine median groove; antennae about three-fourths the length of the body, 5-jointed, 3-5 very slender, 1 elongate, more than one-half longer than 2, 3 about as long as 1, 4 and 5 equal in length, together fully one-half longer than three. Pronotum strongly constricted at the sides, and with a fine transverse groove before the base; the posterior lobe deeply sulcate down the middle; the surface with scattered punctures. Scutellum with a fine median carina. Meso- and metasternal carinae prominent, the carinae continued on to the first ventral segment. Male: Intermediate femora armed with a short tooth near the base; second and third ventral segments flattened in the middle.

"Length 2 to 2½ millim. (Male and female.)

"Hab. Panama, Bugaba and Caldera in Chiriqui (Champion).

"Three males and two females. This species may be known by the deeply longitudinal sulcate disc of the pronotum, in connection with the long basal joint of the antennae, the rather elongate body, etc. The apical two joints of the antennae are together much longer than the third. The rostral groove is limited on each side by a prominent ridge, which is continued on to the first ventral segment."

Location of types. In the Vienna Museum. Type habitat, Panama.

Data on distribution: The published record is Panamá, Bugaba and Caldera in Chiriqui.

Hebrus usingeri Drake and Harris

1943. Hebrus usingeri Drake and Harris, Notas del Museo de la Plata, viii:54-55.

I have not seen Hebrus usingeri Drake and Harris. The following description was taken from H. M. Harris's manuscript:

> "Large, rather robust, dark fuscous-brown, the hemelytra with the base of clavus and three streaks on membrane white. Head blackish with a fine median groove. Eyes large, dark, coarsely faceted. Antennae dark brown, rather long, the last three segments slender; proportions 12:10:15:8:13. Buccualae long, yellowish-brown. Rostrum yellowish-brown, reaching base of venter. Legs yellowish-brown, the tibia darker. Pronotum rather finely pitted, the sides rather strongly constricted between the lobes, the median groove distinct, deepest at the inner-lobe constriction, becoming indistinct before the base; the anterior lobe with coarse pits on each side and a row of punctures limiting the collar, the hind lobe finely pitted on the disc, with a prominent somewhat crescent-shaped impression within the humeri.
>
> "Scutellum pitted, with distinct median carina, the apex truncate, bifid, the margins raised. Hemelytra slightly pilose along the sides, the white mark at base of clavus scarcely extending to tip of scutellum; membrane with a short spot on median line before the apex and an oblique streak on each side beyond apex of cuneus white.
>
> "Length, 2.35 mm.; width, 0.90 mm. (through humeri).
>
> "Holotype male and allotype female, Temescaltepec, Mexico, June 25, 1933, H. E. Hinton and R. L. Usinger, in California Academy of Science. Paratype male and two females taken with types. This very pretty species is named in honor of D. R. L. Usinger who is actively engaged in the study of Hemiptera. The male is unique in that there is a small tubercle on the hind femur within near the

base much as the one figured for the intermediate femur in H. sulcatus Champion. The pronotum and hemelytra are clothed with golden pubescence in both sexes. The species is nearest H. major Champion."

Hebrus beameri new species

(Plate ix, fig. 20; plate x, fig. 27)

Size. Length, 1.22 mm. to 2.05 mm.; width, 0.63 mm. to 0.71 mm.

Color. Head fuscous to testaceous, antenna with first and second segments testaceous, distal segments darker; pronotum fuscous to testaceous, collar lighter, lateral edge of anterior lobe dusky, humeri flavous to light testaceous; scutellum fuscous to testaceous, hemelytron smoky-brown, veins fuscous at either end, with middle portion testaceous, clavus smoky-brown, darker posteriorly, corium smoky-brown, membrane smoky-brown, with faint pallid transverse spot, irregular in outline.

Structural characteristics. Vertex of head without medial longitudinal sulcus, two anastomosing rows of tiny pits in this area, slightly tumid above ocelli; pronotum with medial longitudinal sulcus variable but usually deep on anterior lobe, evanescent on posterior lobe, the two lobes demarcated by an irregular row of coarse punctures, posterior lobe with scattered punctures, collar bounded posteriorly by row of small punctures, humeri impressed inward, depression containing a series of punctures, which continue near the posterior border of pronotum; hemelytron with inner vein produced at distal end, membrane

short, not reaching caudal border of abdomen; scutellum with medial longitudinal carina, carina evanescent posteriorly, lateral edges slightly raised, apex rounded.

Location of types. In the Francis Huntington Snow Entomological Collections, University of Kansas. Holotype male; allotype female and paratypes, 5 males and 7 females. Meade Co., Kansas, 9-13-1944 and May 2, 1948, R. H. Beamer, 5 males and 6 females, and L. D. Beamer, 1 male and 2 females.

Data on distribution. Known only from Meade Co., Kansas.

Hebrus hubbardi new species

(Plate x, figs. 23, 28)

Size. Length, 1.65 mm. to 1.95 mm.; width, 0.65 mm. to 0.95 mm.

Color. Head fuscous to light fuscous, antenna testaceous, two basal segments lighter; pronotum fusco-testaceous, collar fulvous to fusco-testaceous, anterior lobe darker; scutellum testaceous; hemelytron smoky-brown, veins black at ends, median portion fuscous, clavus smoky-brown, corium smoky-brown, membrane smoky-grey, without distinct spots; rostrum testaceous; legs testaceous; entire body with numerous testaceous setae.

Structural characteristics. Vertex of head without medial longitudinal sulcus but with two anastomosing rows of punctures; pronotum with medial longitudinal sulcus deep on anterior lobe, evanescent on posterior lobe, anterior and posterior lobes demarcated by an irregular row of coarse punctures, collar may or may not have a few fine punctures on posterior lateral edge;

medial longitudinal carina of scutellum becomes evanescent toward posterior end, apex of scutellum rounded, posterior border may be slightly incurved; hemelytron with inner vein produced at distal end, membrane extending to or nearly to caudal end of abdomen; paramere of male curved sharply upward at distal end.

Location of types. Holotype male and allotype female in the U. S. N. M. Paratypes, 2 males and 1 female, in the Francis Huntington Snow Entomological Collections, University of Kansas. Type locality Palm Springs, California, dated 10-3, by H. G. Hubbard.

Data on distribution. Known only from Palm Springs, California.

Hebrus plaumanni new species

(Plate x, figs. 24, 29)

Size. Length, 1.85 mm. to 2.50 mm.; width, 0.67 mm. to 0.82 mm.

Color. Head fuscous, antenna fuscous, basal two segments lighter; pronotum fuscous, anterior lobe darker, outer portion of humeri dusky, base of anterior border of posterior lobe darker; scutellum fuscous, apex lighter; hemelytron fuscous, veins fuscous, darker at either end, corium smoky-brown, clavus with white wedge-shaped spot at base, posterior two-thirds smoky-brown, membrane smoky-grey sometimes with subapical narrow oval white spot and a narrow white transverse mark at distal end of corium; bucculae fulvous, anterior tip fuscous;

rostrum fulvous, first and second segments fuscous; legs fulvous, joints darker.

Structural characteristics. Head without medial longitudinal sulcus, with or without anastomosing row of punctures; pronotum with medial longitudinal sulcus deep on anterior lobe, evanescent on posterior lobe, lobes demarcated by an irregular row of coarse punctures, humeri depressed inward with a series of punctures in depression; scutellum with medial longitudinal carina evanescent posteriorly, apex of scutellum incurved to bifid; hemelytron with inner vein produced at distal end, membrane extending nearly to tip of abdomen; paramere curved sharply upward at distal end, ventral surface of base tumid.

Location of types. Holotype male and allotype female in the private collection of R. L. Usinger. Paratypes, 2 males and 1 female, in the Francis Huntington Snow Entomological Collections, University of Kansas. Type locality Nova Teutonia, Brazil, collected XII-22-1935 by Fritz Plaumann.

Data on distribution. Known only from Nova Teutonia, Brazil.

Merragata White 1877

1877. Merragata White, Ann. Mag. Nat. Hist., ser. 4, xx:113.

1896. Merragata Lethierry and Servin, Cat. Hemip., p. 52.

1898. Merragata Champion, Biol. Centr.-Amer., Rhynch., ii:121.

1899. Merragata Kirkaldy, Entom., xxxii-112.

1912. Merragata Torre-Bueno, Can. Ent., xliv:31.

1917. Merragata Drake, Ohio Jour. Sci., xvii:101.

1920. Merragata Hungerford, Univ. Kansas Sci. Bull., xi:88.

1921. Merragata Parshley, Can. Ent., liii:239.

1921. Merragata Van Duzee, Proc. Calif. Acad. Sci., ser. 4, xi:113-114.

1921. Merragata Hussey, Psyche, xxxviii:13.

1922. Merragata Hussey, Occ. Papers Univ. Michigan, No. 118 p. 36.

1925. Merragata Hungerford and Beamer, Ent. News, xxxvi:266.

1926. Merragata Blatchley, Heterop. E. N. Amer., p. 610.

1933. Merragata Lundblad, Sonder-Abdruck aus dem Archiv für Hydrobiologie, Suppl. Bd. xii:263.

1934. Merragata Lundblad, Proc. Ent. Soc. Hawaii, viii:378.

1937. Merragata Harris, Iowa State College Jour. Sci., xi:175.

1943. Merragata Drake and Harris, Notas del Museo de la Plata, viii:42.

1944. Merragata Poisson, Revue Francaise d'Entomologie, x:91.

1944. Merragata Williams, Proc. Hawaiian Ent. Soc., xii:184.

1948. Merragata Zimmerman, Insects of Hawaii, Heterop. iii, p. 225.

The genus Merragata White is not so widely distributed as the genus Hebrus Curtis. It has been taken only in the Western Hemisphere, while Hebrus Curtis is world-wide in distribution. White (1877:113-114) described Merragata from the Hawaiian Islands, stating that the antennae were short and five segmented. The first segment is curved, reaching the apex of the head; second segment clavate, equal in length to first segment; third segment small; fourth clavate and as long as second segment

but more slender; fifth segment is long and fusiform.

Kirkaldy (1899:112) disagreed with White's description. He considered the third segment of the antenna as being only a node.

Hungerford (1920:83) considers the minute segment at the base of the third segment as not being counted as a true segment but as part of the third.

Blatchley (1926:607) in his key separating the two genera states that Merragata White has a four segmented antenna and Hebrus Curtis has a five segmented antenna.

When the antennae of Merragata White are properly cleared, the presence of five segments is unmistakable. This tiny segment between two and three is difficult to see in uncleared forms. It is advisable to ignore this segment in the key to the genera.

The pilosity of the body is highly developed. Merragata White is more aquatic in habit than Hebrus Curtis. The shorter antenna and minute pilosity of the body are apparently adaptations for this mode of life.

Dimorphism is present in Merragata hebroides White and Merragata brunnea Drake. Macropterous and brachypterous forms occur in both species, the latter form having only short wing pads that vary somewhat in length in the same species. The brachypterous individuals are not difficult to separate into the two species.

Merragata brevis Champion

(Plate viii, fig. 9)

1898. Merragata brevis Champion, Biol. Centr.-Amer., Rhynch., ii:122-123.

1943. Merragata brevis Drake and Harris, Notas del Museo de la Plata, viii:43.

Size. Length, 1.50 mm. to 2.05 mm.; width, 0.75 mm. to 0.82 mm.

Color. Variable. Head with vertex fuscous to black, lighter around compound eyes; pronotum fuscous on anterior lobe to black on posterior lobe, some specimens have pronotum concolorous, light fuscous to testaceous; scutellum black to fuscous; hemelytron with veins black at either end, fuscous in the middle, clavus smoky-white to white at base, smoky-brown posteriorly, corium smoky-brown, membrane smoky-brown with subapical and subbasal oval smoky-white spots and with transverse oval spot at apex of corium; rostrum and legs testaceous.

Structural characteristics. Vertex of head with medial longitudinal sulcus, clypeus tumid; pronotum with wide, shallow, medial longitudinal sulcus, sulcus with two longitudinal rows of pits, anterior and posterior lobes demarcated by row of punctures, humeri depressed inward with pits in depression, pits continue across distal border of posterior lobe, scattered pits on entire surface of posterior lobe, collar bounded posteriorly by a row of small pits; scutellum with apex slightly incurved; hemelytron with inner vein rounded at distal end.

Location of types. In the British Museum, taken at Guatemala City, Guatemala by Champion.

Data on distribution. The published records are: Panama, Tole, Panama City, Bohio; Costa Rica, San Jose; Guatemala, San Geronimo, Guatemala City, Rio Naranjo, Los Amates; Mexico, Tejupilco Dt., Temescaltepec; Real de Arriba, Temescaltepec; Texas and California. I have seen specimens from the following localities:

Honduras: Tela, Puerto Arturo farm, April 4, 1923, T. H. Hubbell, 1 female.

Mexico: Tejupilco District of Temescaltepec, June-July, 1933, H. E. Hinton and R. L. Usinger; Real de Arriba, Temescaltepec, H. E. Hinton and R. L. Usinger (both groups in the private collection of R. L. Usinger); Tejupilco District of Temescaltepec, alt. 1340 meters, June-July 1933, H. E. Hinton, 1 female.

U.S.A.: Florida; Labelle, 7-19-1948, R. H. Beamer, 1 male.

Louisiana: 15 mi. E. Creole, 6-22-1948, R. H. Beamer, 6 males and 3 females; Bursa, 6-21-1948, R. H. Beamer, 11 males and 7 females; 6-21-1948, L. D. Beamer, 2 males and 2 females; Venice, 6-22-1948, R. H. Beamer, 1 male and 3 females.

Arizona: Indian Hot Springs, VIII-6-1941, R. H. Beamer, 2 females.

Merragata brunnea Drake

(Plate vii, fig. 4)

1917. Merragata brunnea Drake, Ohio Jour. Sci., xvii:105.

1920. Merragata brunnea Hungerford, Univ. Kansas Sci. Bul., xi:83-84.

1921. Merragata brunnea Hussey, R. F., Psyche, xxviii:13.

1925. Merragata brunnea Hungerford and Beamer, Ent. News, xxxvi:266.

1926. Merragata brunnea Blatchley, Heterop. N. E. Amer., p. 611.

1943. Merragata brunnea Drake and Harris, Notas del Museo de la Plata, viii:42.

This species is dimorphic occurring in both the macropterous and brachypterous forms. The brachypterous form differs by lacking ocelli or having them much reduced, with shorter scutellum, with humeri reduced, and with short anterior wings, posterior wings lacking. Otherwise similar to macropterous form.

Size. Macropterous form: Length, 1.60 mm. to 1.83 mm.; width, 0.65 mm. to 0.73 mm.

Brachypterous form: Length, 1.45 mm. to 1.62 mm.; width, 0.45 mm. to 0.60 mm.

Color. Eyes red. Entire body usually concolorous varying from black to flavous. Venter of black form may be testaceous. Antennae, rostrum and legs black, testaceous or flavous. These parts are usually lighter than the body color. Hemelytra with membrane white, veins fuscous at either end, median portion testaceous.

Structural characteristics. Vertex and frons of head with anastomosing line which may be in form of sulcus or an anastomosing row of pits. (This character varied in specimens reared in laboratory.) Ocelli reduced or lacking in brachypterous forms; pronotum with broad medial longitudinal sulcus, evanescent on posterior lobe, anterior and posterior lobes demarcated by a row of coarse punctures, collar with row of small punctures along posterior border, humeri prominent in macropterous form, with inner margins depressed, brachypterous forms have reduced humeri; scutellum rounded apically, broadly so in brachypterous form, with indistinct medial longitudinal carina; hemelytra with inner vein rounded apically.

Location of types. In the private collection of Carl J. Drake. Paratypes in Van Duzee collection of California Academy of Science, in Ohio State University collection, and Cornell University collection. Type locality Ohio.

Data on distribution. The published records are: New York, Florida, Ohio, [Hebron (Locking Co.), Sugar Grove and Rockbridge (Hocking Co.), Delaware (Delaware Co.), Columbus (Franklin Co.), and Ira (Summit Co.)] Mississippi, Illinois, Minnesota and Nebraska. I have seen specimens from the following localities:

New York: Cattail Marsh, North Rose, 5-9-1911, A. C. Weed (U.S.N.M.), 2 males and 1 female; Cold Springs Harbor, L. E., 28 July 1920, J. R. de la Torre-Bueno, 31 males and 27 females; White Plains, 16-VIII-1924, J. R. de la Torre-Bueno, 6 male and 2 females.

Maryland: Cabin John, VIII-5-1944, R. I. Sailer, 2 females.

Virginia: Norfolk, 8-11-1934, R. H. Beamer, 2 females.

Georgia : Okefenokee, 7-30-1934, R. H. Beamer, 6 males and 6 females.

Florida: Gainesville, 7-14-1918, Carl J. Drake, 1 male; Wildwood, 8-2-1930, R. H. Beamer, 3 females.

Michigan: Mud Lake, Sylvan Twp., Washtenaw Co., V-30-1919, R. F. Hussey (in J. R. de la Torre-Bueno Coll.), 1 female.

Ohio: Rockbridge, 7-7-1916, Carl J. Drake (paratype in Cornell Coll.) 1 male; Rockbridge, 7-7-1916, Carl J. Drake, 1 male; Prentice, 7-17-16, Carl J. Drake, 1 male.

Minnesota: St. Paul, Phalen Lake, July 18, 1921, H. B. Hungerford, 1 male.

Kansas: Doniphan Co., 7-20-1924, R. H. Beamer, 3 males and 5 females; Doniphan Co., 7-21-1924, E. P. Breakey, 1 male; Lakeview, Douglas Co., iv-13-1948, T. W. Porter, 1 male and 4 females; Scott Co. State Park, 8-14-1948, R. L. McGregor, 7 males and 12 females.

Merragata hebroides White

1877. Merragata hebroides White, Ann. Mag. Nat. Hist., ser. 4, xx:113.

1896. Merragata hebroides Lethierry and Severin, Cat. Hemip., p. 52.

1898. Merragata hebroides Champion, Biol. Centr.-Amer., Rhynch., ii:112.

1899. Merragata hebroides Kirkaldy, Entom., xxxii:112.

1912. Merragata hebroides Torre-Bueno, Can. Ent., xliv:31.

1917. Merragata hebroides Drake, Ohio Jour. Sci., xvii:101.

1917. Merragata foveata Drake, Ohio Jour. Sci., xvii:101.

1920. Merragata hebroides Hungerford, Univ. Kansas Sci. Bul., xi:83.

1921. Merragata foveata Parshley, Can. Ent., liii:239.

1921. Merragata slossoni Van Duzee, Proc. Calif. Acad. Sci., ser. 4, xi:133-134.

1921. Merragata foveata Hussey, Psyche, xxvii:13.

1925. Merragata hebroides Hungerford and Beamer, Ent. News, xxxvi:265-266.

1926. Merragata hebroides Blatchley, Heterop. E. N. Amer., p. 612.

1926. Merragata slossoni Blatchley, Heterop. E. N. Amer., p. 611.

1934. Merragata hebroides Lundblad, Proc. Ent. Soc. Hawaii, viii:378.

1937. Merragata foveata Harris, Iowa State College Jour. Sci., xi:175.

1943. Merragata hebroides Drake and Harris, Notas del Museo de la Plata, viii:43.

1944. Merragata hebroides Williams, Proc. Hawaiian Ent. Soc., xii:188.

1948. Merragata hebroides Zimmerman, Insects of Hawaii, Heterop., ii:225.

Merragata foveata Drake was placed in synonymy by Blatchley (1926:610-611). Drake and Harris (1943:43) confirm Blatchley's belief that the two species are identical.

I have examined the type of M. slossoni Van Duzee and discovered it to be a female instead of a male. The genital armature was covered with glue. Upon removal of this material the

the sex became apparent. The characters which Van Duzee, in his original description, ascribed to the species were found but they are not unique. There is considerable variation within the species and the characters on which Van Duzee relied for distinguishing M. hebroides from M. slossoni are variations which occur in M. hebroides White.

Size. Macropterous form: Length, 1.70 mm. to 1.85 mm.; width, 0.74 mm. to 0.85 mm.

Brachypterous form: Length, 1.65 mm. to 1.73 mm.; width, 0.70 mm. to 0.79 mm.

Color. Exceedingly variable. Vertex of head fuscous, frons and clypeus dusky, antenna testaceous with distal segment infuscate; pronotum with two posteriorly confluent rufo-flavous spots on posterior lobe, anterior lobe, humeri and distal border of posterior lobe fuscous, collar flavous; scutellum dusky-fuscous; hemelytron with veins fuscous at either end, flavous medially, clavus white at base, smoky-white distally, corium smoky-white, membrane smoky-brown with a whitish oval subapical spot and a transverse irregular whitish spot at distal end of corium. Some specimens show faint oval subapical whitish spot; legs testaceous, darker at joints; rostrum testaceous, darker apically.

The color of the species varies in specimens from one locality. Study of individuals in the laboratory reveals that older adults are darker than younger adults.

Structural characteristics. Vertex and frons of head with a line which may or may not form an anastomosing structure. This line may be in form of a sulcus with raised median portion if it forms an anastomosis or it may be a row of fine punctures without indication of groove. When row of punctures is present the raised median portion is obsolete. Pronotum with medial longitudinal sulcus evanescent on posterior lobe, collar with row of punctures along posterior border, two lobes demarcated by irregular row of coarse punctures, humeri of brachypterous form reduced, humeri of macropterous form prominent, impressed inwardly, impression with punctures, posterior lobe with numerous scattered punctures, large in some specimens, minute in others; scutellum with medial longitudinal carina, posterior margin incurved; brachypterous forms have scutellum broadly rounded on posterior border; hemelytron with inner vein produced at distal end; paramere of male spatulate.

Location of types. In the Perth Museum. This species was taken by F. B. White in the Hawaiian Islands.

Data on distribution. The published records are: Argentina, Paraguay, Ecuador, Colombia, Cuba, Panama, Costa Rica, Mexico, U.S.A.; including Massachusetts, New York, New Jersey, Virginia, West Virginia, Florida, Pennsylvania, Michigan, Ohio, Kentucky, Illinois, Mississippi, Minnesota, Iowa, Missouri, Louisiana, Kansas, Texas, Colorado, New Mexico, Arizona, California and Territory of Hawaii. I have seen specimens from the following localities:

Cuba: Catalina, Havana Province, II-27-1933, P. J. Bermudez, 3 females.

Perú: Oct. 19-26, 1940, F. Woytowski, 21 males and 4 females.

México: Tejupilco Dist. of Temasceltepec, June-July 1933, H. E. Hinton, 3 females; Mazatlan, 1934, H. E. Hinton (R. L. Usinger collection).

Panamá: III-17-1945, Cpl. G. S. Ryan, 18 males and 22 females.

U.S.A.: Virginia; Norfolk, 7-30-1932, L. D. Anderson, 7 males and 8 females; Norfolk, 10-18-1928, Geo. E. Gould, 7 males and 1 female.

New York: Yaphank, L. I., July 2, 1913, J. R. de la Torre-Bueno (J. R. de la Torre-Bueno Collection), 1 female.

Florida: L. Matecumba Key, 3-14-1947, R. H. Beamer, 18 males and 13 females; L. Matecumba Key, 3-14-1947, L. D. Beamer, 8 males and 16 females; Okefenokee Swamp, VIII-8-1945, R. L. Usinger (R. L. Usinger collection); Bradford, 7-16-1934, P. McKinstry, 50 males and 34 females; Bradford, 7-16-1934, R. H. Beamer, 32 males and 20 females.

Michigan: Cheboygan Co., VIII-6-1930, H. B. Hungerford, 1 male and 3 females; Cheboygan Co., 7-8-1931, James Brennan, 1 male and 3 females; Nigger Creek, Mullet Lake, 7-3-1925, H. B. Hungerford, 9 males and 8 females.

Indiana: Howard Co., 10-23-1932, Geo. E. Gould (U.S.N.M.), 1 male and 3 females.

Illinois: Lake Forest, 10-2-1901, J. G. N. (J. R. de la Torre-Bueno Collection), 1 female.

Minnesota: St. Paul, Phalen Lake, 7-18-1921, H. B. Hungerford, 6 males and 8 females.

Iowa: Little Goose Lake, Hamilton Co., X-12-1949, T. W. Porter, 34 males and 41 females.

Kansas: Cheyenne Co., 7-1-1926, R. H. Beamer, 2 females; Douglas Co., 10-8-1923, H. B. Hungerford, 1 female; Hole-in-the-Rock, Douglas Co., 9-29-1922, H. B. Hungerford, 2 males; Coldwater, 6-19-1927, R. H. Beamer, 1 male; Lake View, V-13-1948, T. W. Porter, 27 males and 42 females.

Texas: Cisco, 6-19-1947, L. D. Beamer, 1 female; Marathon, 6-25-1947, R. H. Beamer, 2 males and 8 females; Rockport, 1-1-1946, L. D. Beamer, 1 female; Dallas Co., 2-16-1939, D. D. Millsbaugh, 5 males and 3 females.

Colorado: Golden, VII-23-09, W. J. Gerhard, 2 males and 2 females; East Park, Mary's Lake, Aug. 22, 1919, H. B. Hungerford, 1 male and 1 female;

New Mexico: Belan, 7-20-1936, J. D. Beamer, 9 males and 13 females.

Arizona: Hot Springs, 25-6, Barber and Schwarz (U.S.N.M.), 1 male and 2 females; Amado, 7-10-1947, L. D. Beamer, 4 males and 4 females; Maircopa Co., 8-7-1917, R. H. Beamer, 6 males and 6 females.

California: Laguna Beach, 26 Aug. 1922, collector label missing (Cornell Collection), 2 males and 9 females; Laguna Beach, 7-25-1933, R. H. Beamer, 25 males and 9 females; Salinas, VI-19-1931, R. L. Usinger (Usinger collection), 3 males and 1 female; Santa Barbara, P. R. Uhler (U.S.N.M.),

1 male and 1 female; San Diego, P. R. Uhler (U.S.N.M.) 1 female; Palmdale, VII-22-1940, L. C. Kuitert, 4 males and 5 females; Whittier, IV-17-1944, Ethel E. Ewy, 14 males and 12 females; Big Pine, 7-27-1947, L. D. Beamer, 13 males and 5 females; Santa Anna, 7-25-1933, R. H. Beamer, 16 males and 18 females; Lone Pine, VII-28-1940, L. C. Kuitert, 101 males and 71 females; Saltdale, 7-26-1947, L. D. Beamer, 6 males and 13 females.

Canada: Oliver, B. C., 8-6-1931, L. D. Anderson, 3 males and 1 female.

Territory of Hawaii: Waipio Reservoir, Aug. 7, 1933, F. X. Williams, 2 females; Waikiki, no other data (J. R. de la Torre-Bueno Collection), 4 males and 3 females; Kaneohe, Oahu, VII-4-1935, R. L. Usinger (R. L. Usinger collection), 2 males and 1 female.

Merragata leucosticta Champion

1898. Merragata leucosticta Champion, Biol. Centr.-Amer., Rhynch., ii:121.

1943. Merragata leucosticta Drake and Harris, Notas del Museo de la Plata, viii:43.

I have not seen Merragata leucosticta Champion. The following description is by Champion (1898:121):

> "Short, rufo-fulvous, slightly mottled with fuscous, the venter black, except at apex; the hemelytron smoky-brown with a silvery-white wedge-shaped mark at the base of the clavus, the base of the corium and the narrow space between the nervures pale

brown, the membrane with several indistinct pallid spots; the antennae obscure testaceous; the rostrum, legs coxae and trochanters flavo-testaceous; the body, legs and antennae clothed with rather long, fine hairs. Head with a distinct median groove; antennae four jointed, 3 and 4 very slender, 1 and 2 subequal, 3 much longer than 2, 4 much longer than 3. Pronotum deeply constricted at the sides, the disc without median groove, the surface with scattered punctures. Scutellum with indications of a median ridge, subtruncate behind.

"Length. 1 3/4 millim. (female).

"HAB. GUATEMALA, San Geronimo (Champion).

"Three examples. Shorter than Hebrus consolidus Uhler, the pronotum much more strongly constricted at the sides, the silvery-white wedge-shaped mark on the clavus shorter, the corium without a white streak, the membrane with indistinct paler spots, the pubescence longer, the antennae 4-jointed."

Location of type. In the Vienna Museum.

Data on distribution. The published record is Guatemala, San Geronimo.

Merragata sessoris Drake and Harris

1943. Merragata sessoris Drake and Harris, Notas del Museo de la Plata, viii:44.

Size. Length, 2.00 mm. to 2.25 mm.; width, 0.85 mm. to 0.95 mm.

Color. According to the original description the head is black. I have before me a female paratype of the described series which does not fit this description. I also have a male and female from the type locality which agree with the paratype in color. I am basing my color description on these three specimens.

Colors other than that given for the head are as described in the original description. Head with dorsal area fuscous, with black spot above ocellus; pronotum fuscous, humeri and anterior portion of anterior lobe flavous, collar flavous; scutellum fuscous; hemelytron with inner vein fuscous at basal end, short median area flavous, distal two-thirds fuscous, clavus with wedge-shaped white area at base, smoky-brown distally, membrane fuscous to smoky-brown, with circular white spot at apex of corium, with indistinct subapical oval spot smoky-brown, another near base of membrane; rostrum fulvous; legs flavous, joints darker.

Structural characteristics. Vertex of head with medial longitudinal sulcus; pronotum with wide, shallow, medial longitudinal sulcus, anterior end with two well defined pits, sulcus evanescent on posterior lobe, anterior and posterior lobes demarcated by row of coarse pits, scattered punctures on posterior lobe, collar with row of punctures on posterior border, humeri prominent, impressed within, with a row of pits in impression which continue near posterior border of lobe; scutellum with apex broad, slightly incurved medially, with medial longitudinal carina, lateral borders slightly emarginate; hemelytron with inner vein angulate or slightly produced at distal end.

Location of types. Holotype male, allotype female and paratypes one male and one female in the private collections of Drake and Harris. Type locality Chapada, Brazil.

Data on distribution. Known only from Chapada, Brazil. I have seen one female paratype from H. M. Harris's collection and a male and female labeled Chapada, from the American Museum of Natural History.

Lipogomphus Berg 1879

Haplotype lacunifera Berg

1879. Lipogomphus Berg, Hemip. Art., p. 287 (Family lygaeidae).

1884. Lipogomphus Berg, Hemip. Arg., Suppl., p. 116 (Family Hebridae).

1898. Merragata Champion, Biol. Centr.-Amer., Rhynch., ii:121.

1908. Merragata Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., x:215.

1912. Merragata Torre-Bueno, Can Ent., xliv:31.

1921. Merragata Pennington, List Hemip. Heterop. Repub. Arg., ii:31.

1943. Lipogomphus Drake and Harris, Notas del Museo de la Plata, viii:64.

This genus was characterized by Berg (1877:287) as being notably different from the other described genera. The original description is in Latin with additional comments in Spanish. The Latin translation is as follows: Body rather oblong. Head quite swollen, drawn out, below long and wide, almost beaked; with small, broadly drawn-out antenna-bearing tubercles; with elevated little cheeks extended as far as the throat; compound eyes and ocelli; the beak rising somewhat above the rear coxae, with the second segment much longer than the third segment; with the third segment shorter than the last segment. Graceful

antennae, hairy, with the basal segment scarcely rising above the apex of the head, with the second segment equal in length to the third segment, longer than the terminal segment, molten and a bit thick in appearance. The pronotum elevated behind, broadly slanting in front, pressed in transversely, formed with an elevated margin in front, with the margin behind crenulated, with the lateral angles a bit prominent, rotund underneath. The scutellum somewhat triangular, with the apex clearly excised and with broad apical lobules. The hemelytron incomplete, deprived of clavus and veins, provided with hairs near the veins and border; with the corium hyaline or equipped with a long and narrow gap, with the apex slightly twisted before the middle and with the interior margin slightly twisted immediately behind the angle; with a large membrane extending through the entire inner margin of hemelytron and occupying the place of the clavus. The mesonotum and metanotum broadly furrowed. Claws medium in size, the intermediate and rear legs quite far apart, with femora neither thick nor spiny.

Berg then adds the following in Spanish: This genus is distinguished from the previous ones by a large number of features. The chief of these are: the form and structure of the head and its different organs, of the pronotum, scutellum, legs and above all the hemelytra, which lack the clavus and have a very large membrane which also occupies all the inner margin and the place

of the clavus; the corium is quite small and has in its central part a transparent membrane which represents a king of lacuna quite long and narrow.

I have before me a specimen that was compared with the type by H. M. Harris. Careful examination of this specimen shows characters which agree with those given by Berg. I cannot agree with Berg's statement that a clavus is not present. This area is demarcated by a different color and by a microscopic depression. Several characters have been overlooked by other workers in this family. For example, the head and pronotum are clothed in short, broad, iridescent setae. When viewed with reflected light, they present a metallic sheen. There is a spine on the outer surface of the distal end of the posterior femur of the male. Tylus and clypeus are shorter in proportion to the length of the head in Lipogomphus Berg than in Merragata White. The vagina exterior is more elongate in Lipogomphus Berg than in Merragata White.

Lipogomphus Berg is retained here as a genus separate from Merragata White.

Lipogomphus lacunifera Berg 1879

1879. Lipogomphus lacunifera Berg, Hemip. Arg., p. 287.

1884. Lipogomphus lacunifera Berg, Hemip. Arg., Suppl., p. 116.

1896. Lipogomphus lacunifera Lethierry and Severin, Cat. Hemip., p. 52.

1898. Merragata lacunifera Champion, Biol. Centr.-Amer., Rhynch., ii:121.

1908. Merragata lacunifera Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., x:215.

1912. Merragata lacunifera Torre-Bueno, Can Ent., xliv:31.

1921. Merragata lacunifera Pennington, List Hemip. Heterop. Repub. Arg., iii:35.

1943. Lipogomphus lacunifera Drake and Harris, Notas del Museo de la Plata, viii:45.

Size. Length, 1.75 mm. to 1.91 mm.; width, 0.66 mm. to 0.81 mm.

Color. Vertex and sides of frons fuscous, anterior median part of frons and clypeus sometimes fulvous, base of head and around eyes testaceous; pronotum fuscous to black, some specimens with considerable maroon, collar fulvous; scutellum fuscous to black, distal portion lighter; hemelytron with veins testaceous anteriorly, fulvous medially and fuscous at base, clavus white at base, smoky-brown at posterior end, membrane smoky-brown, four faint yellowish-white oval spots may be present on membrane; rostrum fulvous, dusky at apex; legs testaceous, tips of tarsi and joints of legs fuscous.

Structural characteristics. Vertex of head without medial longitudinal sulcus, two rows of punctures that anastomose on the vertex and frons are present; antenna four segmented; pronotum with medial longitudinal sulcus, with a longitudinal row of punctures along lateral border of sulcus, anterior and posterior lobes demarcated by irregular row of punctures, both lobes with short, flat setae, collar with row of punctures along posterior border, humeri prominent, impressed inward, with punctures in depression, punctures continue near posterior border of

lobe; scutellum bifid at apex, with medial longitudinal carina; hemelytron with inner vein angulate at distal end; rostrum four segmented; posterior leg of male with spine at distal end of tibia; parameres of male curved upward at distal end.

Location of types. In the La Plata Museum of Argentina. Type locality Buenos Aires.

Data on distribution. The published records are: Uruguay, Argentina and Bolivia. I have seen specimens from the following:

Uruguay: Sweeping from Montevideo to Salto, 3-6; 14-1940, H. L. Park (U.S.N.M.), 6 males and 13 females; Montevideo, 1907, no other data (J. R. de la Torre-Bueno collection), 4 females; sweeping from Montevideo to Salto, 3-6; 14-1940, H. L. Park, 2 males and 2 females.

Argentina: Lujan, B. Aries, Dec. 18, 1938, C. J. Drake (Cornell Collection), 1 male; Lujan, B. A., Dec. 18, C. J. Drake (U.S.N.M.), 1 male.

Bolivia: Prov. del Sara, no other information (U.S.N.M.), 3 females.

PART II - THE NATURAL HISTORY OF SELECTED SPECIES

A Review of the Literature

Although the genus Hebrus Curtis was described in 1883, no reference to the natural history of the family Hebridae was made until 1894 when Uhler included a short description of the habitat of the species in his original descriptions of Hebrus concinnus and Hebrus consolidus. Much of what is known concerning the natural history of the family Hebridae is given in the following abstracts, translations and direct quotations.

Uhler (1894a:221-222) found Hebrus concinnus Uhler among the roots of grass and on the muddy soil near pools of water. Brachypterous individuals were observed on the surface of quiet water. Specimens of Hebrus consolidus Uhler were collected in a similar habitat.

Kirkaldy (1899:112) states: "Hebridae are found in Lemna, Sphagnum, etc...."

Torre-Bueno (1908:234) writes: "H. concinnus Uhler taken at White Plains, June 1, 15, 22, and 30. This species was quite common on the muddy bottom of a dried-up temporary pool, creeping leisurely about...."

In Brauer (1909:37) we find: Hebrus Curtis - Inshore for the most part, gregarious, on and in bodies of water with abundant vegetation, on plants such as Lemna, Potamogeton, Nymphaeae, Hydrocharis and other aquatic plants; with a preference for

moors of Sphagnum. Also found in peat diggings or on damp shore-sand and between stones, and often in flood debris. The food of Hebrus Curtis is the water-loving Poduridae (Collembola). The spiracles open through a thick silky border of hair which forms a protecting closure against the water. As yet no work has been done concerning habits, distribution and season of oviposition, appearance and length of development of the nymphs, and number of yearly generations. The eggs are unknown. Fully developed Hebrus ruficeps Thoms. have been found throughout the year. Nymphs overwinter in Sphagnum.

Kuhlgatz's (1911:180-181) account was translated as follows: Females were captured in January being removed from an ice block 6 cm. thick. They were chiseled out of the sheet of ice over Sphagnum. They were revived at room temperature. In November they were overwintering in Sphagnum under a 16 cm. thick layer of snow. Males and females are taken all the year around. Hebrus ruficeps Thoms survives as nymphs in winter. In the severest cold the nymphs freeze in the ice or under the snow and endure great dampness as shown by finding them submerged in Sphagnum.

Torre-Bueno (1912:212) found: "Hebrus concinnus Uhler quite abundant on the damp edges of a cranberry bog...."

Drake (1917:101) records Merragata hebroides White and Merragata brunnea Drake as being:

> ....dwellers in still and stagnant waters. Their favorite haunts are secluded coves of lakes, ponds and swampy pools, where the

water is shallow, and where there is an abundant growth of aquatic plants. I have rarely seen them on the damp ground near the water's edge. The Merragatas are aquatic pedestrians, capable of standing, walking, and running upon the surface of the water, their entire body being covered with a velvety pile which effectively sheds the water and prevents them from becoming wet. They can move forward or backward; but the usual mode of progression is a steady forward movement, all three pairs of legs being used in locomotion. I have often found them on Lemna, Nymphaea, and various other floating water plants. When submerged in the water, the insects are surrounded by a film of air which enables them to stay beneath the surface film for a considerable period of time. In an aquarium I have often watched them standing or walking for a period of a half hour or a little longer on pieces of cork or plants that were beneath the water. Occasionally, they will walk down the sides of the glass aquarium beneath the surface of the water, and when the water is shallow, they will walk across the bottom and come up on the opposite side."

Hungerford (1920:87-88) gives the following information under the biology of Hebrus concinnus Uhler, which really applies to Hebrus burmeisteri L. & S.:

"Habitat. This little species was found among the moss and grass clumps and upon the moist earth of the shores of an upland meadow pool at Ringwood Hollow, near Ithaca, N.Y. It was also taken about the waters of the cove just east of the field station. It is an inconspicuous shore bug that frequents the moss and will be taken only when, disturbed in its haunts, it takes to the open areas, even venturing upon the water for a short run. These insects are not as safe upon such a footing as are the little Microvelias which they superficially resemble. Their bodies are sufficiently covered with a fine pile so that, if perchance they do capsize, they have a fair chance of escape. On one occasion a specimen in the laboratory became submerged accidentally. It walked upside down under the surface film as upon a ceiling, stopping now and then to clean the antennae and limbs as it frequently does when in its normal environment. The body was surrounded by a layer of air which held it up to the surface film. It finally escaped by crawling upon a bit of moss projecting from the water.

"Mating. The first adult hebrid was taken by Mr. C. H. Kennedy on June 4, at Ringwood Hollow. On June 22 the bugs were mating in numbers. The male mounts the female and remains in copulation for varying periods of time.

"Oviposition. Bugs brought to the laboratory on June 22 were confined in large petrie dishes. These petries were prepared for them by placing some moist sand in the bottom and adding a few sprigs of moss. On June 26 the moss was examined superficially under the binocular and no eggs discovered. A more careful examination with dissecting needles revealed some of the yellowish white eggs, already showing the red eye spots, hidden between closely approximated leaves. Some of them seem to lie on the upper concave side beneath the pale green sheath of the moss leaf, as shown in the figure. For the most part they were concealed between the leaf and stem.

"In an endeavor to determine whether the female would ever place the eggs in the tissues of plant stems, some females were confined in a small stender dish with a leaf of Moneywort, a soft dead sedge, and a variety of moss having the leaves widely separated and directed outward, thus providing no hiding place for the eggs. Eggs were laid in the mat or tangle of rootlets at the base of the moss, and, in one instance, the tip of one leaf was glued to the one above it and here three eggs were found.

"Incubation. Eggs laid perhaps June 22 showed red eye-spots by the 26th, and hatched two days later, which would give about a week for incubation. More data is really to be desired on this point.

"Hatching. In watching the hatching process of this little bug it was seen that upon issuing from the egg, it casts a thin transparent membrane, which surrounds each appendage separately and is of the nature of a true molt....

"Number of Instars. Not determined for this species, due to the fact that the writer found it necessary to drop the rearing in its midst. Thus data upon maturity, fecundity, etc., are to be desired.

"Longevity. Bugs were kept under observation for some two months and the females were laying for the latter half of that time. Doubtless the bugs would have lived much longer.

"Food Habits. In the laboratory the bugs fed upon plant lice, midges, mosquitoes, etc., dropped

upon the moist earth for them. They would gather about a carcass in numbers. What their source of staple food supply may be in nature was not determined on account of the difficulties involved and the lack of sufficient time.

"Behavior. Like the Microvelias, they endeavor to keep their bodies clean, and performed a toilet quite as elaborate as Bueno has described for Microvelia americana.

"The Egg. Its size is 0.625 mm. by 0.325 mm. This represents the size shortly before hatching. Somewhat more slender when deposited. The eggs are large for the size of the bug. One female measuring 0.925 mm. across the prothorax contained four well-developed ova, each measuring 0.625 mm. by 0.25 mm. Figures of the female abdomen and of the egg are drawn to the same scale.

"Shape. Elongate oval: ends rounded; length about twice the width.

"Color. Pearly-white, changing to yellowish-white as embryo develops within. Some appear to be surrounded by a transparent gelatine. Under the low-power compound surface of the egg is seen to be covered by short, irregular arranged elevations.

"In the case of those containing well developed embryos the eyes show as pink spots and a pair of black dots lie on the ventral side near the apex of the head.

"Description of the First Instar Nymph

"Size. Length, 0.608 mm.; width, 0.325 mm.

"Color. Eyes dark red, body dark in color.

"Structural Peculiarities. Body plump, head relatively large, prolonged before the eyes so that the head is about two-fifths the length of the entire body. Body sparsely clothed with rather stiff hairs. Limbs similarly clothed, the pubescence being shorter, especially on the tarsal segments. Antennae four-segemented. Third segment a trifle more slender and a little longer than the first. The fourth is about as long as the other three together, the outer third tapering asymetrically to tip. Limbs are stout, and tarsi one-segmented, ending in two apical claws. A single dorsal pore on the anterior margin in the median line of the fourth abdominal segment.

"Morphological Studies. Aside from the external structures studied by taxonomists, no morphological work has come to the attention of the writer."

Butler (1923:222-224) presents his observations of two European species thus:

"A family of very small insects of subaquatic habits and of world-wide distribution; only a small number of species have hitherto been described, of which five are palearctic, and of these we have but two in Britain. Very little is known of their feeding habits; American species have been fed in the laboratory on aphids, mosquitoes, etc., which were dropped on the moist earth for them; of course their habits in the open may be different....

"/Hebrus pusillus Fallen/ The ova and nymphs are unknown. They are never dimorphous but always fully winged. It lives on Lemna, Sphagnum, etc., especially the former, and is subaquatic in habit. The pile on the under part of the body is impervious to wetting. They were found one summer in a nearly dried-up bog. As there was no standing water, the insects selected the deepest parts of hollows in the ground, such as those caused by irregular shrinkage, foot prints of cattle, etc. Here they were more or less in the shade, coolness and damp....

"/Hebrus ruficeps Thoms/ The ova are unknown. The nymphs are like the brachypterous form of the imago. The imago is to be found all the year around. Nymphs may be obtained during the summer. The overwintering forms of the imago are considerably darker than those that are newly formed at the end of the summer, and they are also rather larger, at least the females.

"The species is dimorphous, the brachypterous form being the usual one. The macropterous is very rare. They live amongst the wettest Sphagnum and are subaquatic in habits. Some were inclosed in a tube with wet Sphagnum and lived for some weeks. They were not observed to feed and could feed only on the Sphagnum if they did take any food during that time."

Hungerford and Beamer (1925:256) write: "This family of tiny surface striders is not very richly represented in our

collections...." On October 8 and 9, 1923 Hungerford and Beamer took 135 specimens of Hebrus consolidus Uhler from the margins of a small pool near Lawrence, Kansas.

> "Hebrus burmeisteri L. & S. was described from Pennsylvania. The specimens taken at Ithaca, New York, by the senior author and called H. concinnus Uhler by him is quite distinct from our Kansas species. The New York species has the lateral margins of the prothorax more constricted, the scutellum more plainly notched at the tip and the nervures of the wing of different shape. Hebrus concinnus Uhler is described as being 2¼ to 2⅜ mm. long and the New York species is not as large. We are now inclined to believe that the New York species should be called Hebrus burmeisteri L. & S. although there is practically no description of this species and it must be a guess at the best."

Blatchley (1926:607-608) states that Hebrus concinnus Uhler:

> "....occurs in muck, masses of weeds and beneath boards near ponds; also gliding over the surface of pond waters or crawling over mud flats adjacent thereto....
>
> "/Hebrus consolidus Uhler/ is often taken by sweeping low herbage along margins of ponds and sometimes with Notomicrus nanulus (Lec), Bidessus exigus (Aube) and other small water beetles on the under side of partly immersed boards....
>
> "/Hebrus bilineatus Champion/ occurs beneath boards and other cover about the margins of ponds and ditches, often in company with consolidus. Common at Ft. Myers in muck of an extinct wet weather pond....
>
> "/Merragata brunnea Drake/ Numerous examples taken from amongst masses of water shield, Brasenia pupurea (Michx.) in small ponds...."

Drake and Harris (1943:41-42) inform us:

> "The members of this family are tiny, plump-bodied insects of subaquatic habits. They frequent the quiet margins of ponds, lakes, sloughs, and sluggish streams, and rafts of floating vegetation. Because of their small size and retiring habits, careful search is necessary if one is to

> collect them. In common with other water-striders, the hebrids are supposed to be predatory in nature. When disturbed in their haunts they frequently run ashore or take to the open areas, walking and running on the surface film....
>
> "/Lipogomphus lacunifera Berg/ The senior author during the months of November and December 1938 and January 1939 collected specimens in large numbers on the leaves of aquatic plants and near the shore of the ponds and along the banks of quiet waters of slow-moving streams at Tigre, Buenos Aries and Lujan, Prov. of Buenos Aries, Argentina..."

Poisson (1944:90) was translated thus: The biology of Hebrus is not well known; the rearing is difficult; the jar one uses should not contain water but Sphagnum or a carpeting of moist moss; it must be covered with gauze to permit evaporation thus preventing too great a saturation of the atmosphere. If this precaution is not taken the covering of water-proof hairs become wet and the insects drown. Authors do not agree as to the food used by these insects.

The first mating of H. pusillus Fall. and H. ruficeps Thoms. is observed in late May in middle and southern France, depending on the temperature. Copulation resembles that in the Gerridae. The male usually mounts the female for a short time only. The eggs are relatively large. They are nearly one-fourth the length of the body of the female. They are fastened by a sticky secretion to the leaves of mosses or Lemna. With a temperature of 18 to 20 degrees the incubation period of Hebrus ruficeps Fall. and Hebrus pusillus Thoms. is 8 to 10 days.

The nymphs lack ocelli, their antennae four segmented, and their tarsi have a single segment. They have a dorso-abdominal scent gland located medially on the margin of the fourth abdominal segment.

As may be inferred from the preceding accounts, our knowledge of the natural history of the Hebridae is incomplete. The accounts by Uhler, Torre-Bueno, Hungerford and Blatchley indicate that Hebrus concinnus Uhler may be found in different types of habitats. Uhler collected his specimens at the roots of grass and on muddy ground near pools of water. Bueno found H. concinnus Uhler to be abundant on the damp edges of a cranberry bog. Hungerford records it among the moss and grass clumps and upon the moist earth of the shores of an upland meadow pool. Blatchley located individuals on muck, masses of weeds and beneath boards near ponds and also gliding over the surface of pond waters or crawling over mud flats. There are three reports of Hebrus consolidus Uhler. Uhler discovered them at the roots of grass on muddy soil adjacent to pools of water and on grass and weeds growing out of a pool of water. Hungerford and Beamer found them on margins of a small pool. Blatchley states that they may be taken by sweeping low herbage along the margins of ponds. The only other North American species discussed, Hebrus bilineatus Champ., was taken by Blatchley from beneath boards and other cover about the margins of ponds and ditches.

Two European species, Hebrus ruficeps Thoms. and Hebrus pusillus Fall. have been discussed by Brauer (1909:37), Kuhlgatz (1911:180), and Butler (1923:222-223). Brauer found them inshore for the most part, gregarious, on and in bodies of water with abundant vegetation. He states that they have a preference to moors of Sphagnum. He took them also from peat diggings and on damp shore sand and between stones, and often

in flood debris. Kuhlgatz chiseled them out of a sheet of ice that covered Sphagnum. Butler says they live in Sphagnum, Lemna, etc., and are subaquatic in habit.

Merragata hebroides White has been studied slightly by Drake (1917:101) and with the exception of one collecting note by Blatchley (1926:612) this is the only study made of this genus.

Hungerford (1920:87) has studied the feeding habits of Hebrus concinnus Uhler and has been quoted in nearly all of the references where feeding habits of the family have been discussed.

Mating, oviposition, incubation periods, hatching processes and the number of instars have been partially studied by Hungerford (1920) for Hebrus concinnus Uhler. Butler and Poisson give some information on two of the European species.

Ecology

My own studies of the Hebridae were made in areas which were visited from time to time over a period of three years. Each time a station was visited, physical and ecological factors were carefully recorded along with factors thought to influence the lives of the hebrids. Insects that might serve as food or might prey on shore bugs, including hebrids, were listed. Birds, frogs, and fish that feed along the shore, and any animal, such as muskrats, that cut food that later would wash ashore to form a mat of decaying vegetation which would serve as shelter, were likewise recorded.

Areas Studied

Kansas

Collecting was done in three counties, all in the northeastern part of the State. Eight collecting stations were in Douglas County, one in Leavenworth County and one in Atchison County.

Douglas County

The first station is three miles west of Lawrence, and one-half mile south of highway 40 (T. 12 s., R. 19 E., SE¼, NW¼ of section 34).

Physical factors. Water flows from a spring situated approximately thirty-five feet above the bed of a small creek. The flow is partly diverted in order to supply water for livestock that is pastured in the area. Two stock troughs are filled by the continuous flow from the spring. The surplus is diverted to one side and forms a pool three feet wide and approximately ten feet long. Pieces of limestone are scattered along the bank and in the bottom of the pool and in the stream bed.

The soil is a fine clay which becomes soft when wet and exceedingly hard when baked dry by the sun. Large cracks which extend several inches into the soil are formed as the area dries in late summer.

There is little organic detritus owing to the nature of

the stream and the lack of vegetation. Animals wading along the edge of the stream also tend to stir up the bottom with the result that the decaying material is washed away.

The spring is situated on the south side of the hill and is exposed to the drying southwest winds. These winds are hot and strong in the late spring and early summer. The light is strong. There are two small osage orange trees shading the pool, one on the west and the other on the north. The direct rays of the sun fall on the water most of the day. Because the shore is trampled by cattle there is little grass or other types of plants which would increase the small amount of shade.

Biological factors. There is little variety in the types of plant life. Spirogyra and water-cress were the predominant plants in the pond. Some grass, cropped short by the cattle, grew on the bank.

Collembola were the most abundant of the insects present. A few small Staphylinidae scurried for cover when the slabs of limestone were turned over. Grasshoppers were common along the bank. Tabanidae larvae were observed in the mud at the edge of the water. Several spiders were uncovered when the stones were turned over.

There was little shelter for the hebrids. They were found along the stones at the edge of the water.

The second station is on the southeast shore of Lone Star Lake, approximately thirteen miles southwest of Lawrence, Kansas. The lake is formed by a dam backing up the water of Washington Creek.

Physical factors. The soil along the shore is clay. Wave action has undercut the shore and formed a horizontal ledge six to twelve inches wide out over the water. Dead grass hangs over the ledge. There is considerable leaf mold along the shore. Dead grass and other dead plants form a decaying mat of organic material. Owing to the nature of the shore, drift material does not pile up. The decaying leaves and grass hold the moisture and provide an ideal habitat for Hebrus burmeisteri L. & S. The top layer drys out but the under material, being spongy in nature, remains damp. The shore is protected from the wind by the large trees on the hill above.

Biological factors. Aquatic plants, with the exception of Spirogyra and some blue-green algae, are lacking. The shore has an abundant growth of grass. There are a few sumac bushes scattered along the bank and on the hillside above.

Numerous Microvelia sp. and Mesovelia sp., both adults and nymphs, were observed. Collembola of several species were present in great numbers along the edge of the water and under the damp leaves. Mosquito larvae were abundant; each dipper of water taken would contain from eight to fifteen of them. Dytiscidae and Hydrophilidae were numerous. Isopods were common in the damp drift.

Of the higher animals present, frogs were the most common form. A few small minnows were observed swimming near the shore. These minnows are surface feeders and there is the possibility

that they feed on shore bugs which run out on the surface of the water.

Shelter for the shore bugs was provided by the dead grass and decaying leaves. This material absorbs and retains sufficient moisture to meet the needs of the hebrids.

The third station is on the shore of Lake View, an oxbow lake formed when the Kansas River changed its course. This lake, about three-fourths of a mile long and about eighty rods across the widest place, is a little more than three miles northwest of Lawrence.

Physical factors. The shore of the lake is composed of fine silt that has settled out of the water. A person sinks into the ooze to above the ankles. The water level of the lake fluctuates rapidly depending on the rainfall. The rapid run-off from the hills along the shore carries fine clay into the lake. This material settles to the bottom and as the water evaporates, the clay is exposed.

Decaying plant material is piled in windrows along the shore by the waves and wind. A number of windrows are produced as the water level becomes lower in late spring and early summer. This material is spongy in nature and holds moisture as the exposed shore dries. When the wind comes from the west or southwest it has an unobstructed sweep for a distance of nearly a half mile and waves with white-caps pound the shoreline. Since the species of the genus Hebrus are not well adapted to resist

wave action many of them probably drown. Light is strong at this station as there are no trees to shade the shore. The only protection from the sun is the beach drift.

Biological factors. With the exception of algae, plant growth is lacking. Collembola were numerous. Staphylinidae and Carabidae were the most common beetles. A few adult flies and an occasional mosquito were recorded. Frogs were the most abundant of the vertebrate animals seen. A small flock of sandpipers was observed running along the shore, where there were raccoon tracks. Several species of fish are in the lake. The only shelter for the hebrids was the decaying vegetation on the shore, and they were collected by submerging this material in the water.

The fourth station is also at Lake View. It is approximately a mile west of station three. The Santa Fe Railroad has graded a dike across the west end of the lake where the lake makes a right angled turn to the north. There is a highway grade about forty rods north of the railroad. Water is impounded between these two embankments.

Physical factors. The water level fluctuates depending on the amount of rainfall. Run-off from the fields near this part of the lake supplies most of the impounded water. This pond is connected to the lake by culverts under the railroad dike and to a marsh north of the road by culverts under the road.

The shore above the water level is sandy whereas that part which is occasionally submerged is covered with muck. Being in

a protected area, the pond provides an excellent habitat for water plants and as the water level falls they die, decay and leave a spongy mass that holds moisture.

Light is strong. There are no trees along the shore to provide shade from the direct rays of the sun. Spirodele polyrhiza (L.) Schleid. covers half of the surface of the water. This plant supplies shade for the submerged organisms. Cattails, sedges and an aquatic buttercup grow along the edge of the water. Spirogyra spp. grows abundantly in the water around the stems of the former plants and increases the amount of shade for the insects in the water. Many species of grasses and dicotyledonous plants grow along the shore above the water line. These plants help to shade the area along the edge of the water and give some protection to the shore bugs. These plants help also to slow the evaporation of the moisture in the detritus along the shore.

Biological factors. Insects were abundant. Merragata hebroides White and Merragata brunnea Drake were both taken, with M. hebroides White being the more numerous. A patch of Spirodela the size of the hand would yield from thirty to fifty specimens of the latter species. Brachypterous individuals outnumbered the long-winged forms four to one. Hydrometra martini Kirk., Microvelia spp. and Mesoveliidae were common. Notonecta undulata Say was observed in the water. This species will capture surface insects as well as those that dwell in the water. Therefore it is a possible predator of hebrids. Gerrids

possibly are surface predators. They were recorded as abundant. Families of Coleoptera were identified as follows: Gyrinidae, Hydrophilidae, Dytiscidae, Staphylinidae, Carabidae, Coccinellidae and Curculionidae. Several species of Diptera were seen. Stratiomyiidae and Tabanidae were taken in larval form at the edge of the water. Collembola swarmed in the damp material along the shore and on the floating vegetation in the water. Naiads of dragonflies and damsel-flies, larvae of hydrophilid, dytiscid and gyrinid beetles, and larvae of Trichoptera were present. A dytiscid larva was observed feeding on a Merragata hebroides White. Red-winged black birds, northern yellow-throated warblers, kildeer, dickcissels and eastern song sparrows were seen to feed on insects along the shore.

The fifth station is at Green's Lake in Lawrence. Collecting was done on the southeast shore of the lake.

Physical factors. The lake is more or less circular and about one-fourth mile in diameter. It was formed by water filling an abandoned clay pit. A small dam was constructed across the south end, forming a small pond. This part is connected to the larger part by a culvert.

The soil around the lake is heavy clay. Organic detritus washes up on the shore. This material consists mostly of leaves, small stems of plants and twigs from the trees along the shore. The water level does not change much and as a result, the decaying material is always saturated with moisture.

The area is well protected from the wind, because the lake is in a depression and because there are trees on the sides of

the hills above the lake which also protect the shore from the wind. Light is strong but direct sunlight falls on the shore only part of the day.

Biological factors. The trees shading the area are mostly oaks and willows. There are a few planted shrubs, including spiraea and yews. Blue grass and iris have also been planted along the shore. A slender moss grows on the shore above the edge of the water. Cattails and willows grow above the water and the leaves of water lilies float on the surface of the water. Spirogyra spp. and a blue-green algae form a tangled mass along the edge of the shore below the water line. Scattered pieces of Ceratophyllum spp. with strands of algae attached to them were observed.

There were many insects. Staphylinidae, Carabidae, Histeridae, Gyrinidae, Hydrophilidae and Haliplidae were common. Dragon-fly and damsel-fly naiads along with the larvae of some of the above beetles were the most numerous under water predators. Several families of Hemiptera were collected. Two genera and four species of Hebridae were taken. Several specimens of Ranatra fusca P. B. crawled along the submerged stems of the cattails and willows. Gerrids were present in swarms on the surface of the water. Mesoveliids and veliids ran out on the water as they were disturbed. Cardinals, robins, house wrens, purple martins, English sparrows and song sparrows were observed to feed along the shore.

The sixth station is approximately five miles northeast of Lawrence on the shore of an oxbow lake. It is north of highway 40 and on the east side of the north-south country road.

Physical factors. Water for the lake is supplied by run-off from the hills above the shore. In the early spring, rainfall is heavy and there is an abundance of water. As the season advances the showers decrease in number, the water level lowers, and by late summer the lake may be completely dry. While the lake was dry during the summer of 1946 the area was burned over. No more insects of the genus Merragata White were taken after the area was burned, although they were exceedingly abundant in the spring of 1946.

The soil along the shore is clay. When it is wet it is soft and sticky. It has considerable decaying vegetable matter in it. Aquatic plant life grows well in this type of habitat. There was an abundant growth of both submerged and emergent types.

This station is not protected from the wind or sun. The hills along the shore are low and there are no trees near. Typha latifolia L., Sagittaria spp., and Persicaria spp. give but little shelter from the strong spring winds and the direct rays of the sun.

Biological factors. Persicaria spp. was the most abundant plant. It formed a tangled mass of growth at the edge of the water and on the marshy area along the shore. The dead and

decaying stems provided a mat that covered the soil. The sedges grew a short distance above the water line. The cattails and arrowheads grew in the water. The leaves of Potamogeton spp. and Spirodela polyrhyza (L.) Schleid. floated on the surface of the water. Spirogyra spp., Myriophyllum spp., and Vaucheria spp. growing beneath the water made collecting with an aquatic net difficult. They formed nearly a solid mass which gave an ideal habitat for Merragata hebroides White and M. brunnea Drake.

Two genera of Notonectidae (Buenoa and Notonecta), Corixidae, Belostomatidae, Nepidae (Ranatra fusca P. B.), Saldidae, Veliidae, Gerridae, Mesoveliidae, Hydrometridae (Hydrometra martini Kirk.) and Hebridae were all taken by members of the entomology class on May 26, 1946. It was an ideal collecting station.

Muskrats were present and several of their large mounds were seen out in the water. Material which they had cut and not carried away was strewn along the shore. This material provided additional cover for the shore bugs. There were only a few birds. Red-winged blackbirds, kildeer, black terns, song sparrows and two pairs of northern yellow-throated warblers were recorded.

Station seven is located on the same oxbow lake, northeast of Lawrence, as station six.

The eighth station is at a small artificial, spring-fed pool on the golf course at the Lawrence Country Club on the west side of the town of Lawrence.

Physical factors. The pool is fed from a spring that flows from the west side of the valley which cuts across the golf course in a north-south direction. This pool of water is retained by a concrete basin. An overflow pipe at the south end regulates the water level.

There was considerable decaying vegetable matter on the bottom of the pool. Several tumble weeds had blown into the water and were serving as a trap for Spirogyra spp.

The pool is not protected from the wind or the sun. The direct rays of the sun fall on the surface of the water all day. Wind from any direction except the west will blow across the pool. The sides of the hill and a few trees above give a little shelter from wind directly from the west.

Biological factors. Algae were the only plants found in the pool. The algae formed floating mats on the surface and tangled masses on the submerged tumble weed. Merragata hebroides White were found in the masses of algae. Insect life was not abundant. Mosquito larvae were the most common form. Stratiomiidae larvae and puparia were taken from the algae.

Leavenworth County

The ninth station is at the southeast end of Lake Tonganoxie. It was abandoned during the summer of 1947 because the lake was drained to enable the Kansas Forestry, Fish and Game Department to remove the coarse fish. The lake was drained while I was in Michigan, thus I was unable to follow the development as the water was lowered. When I returned to Kansas in September I searched for hebrids along the shores of the small pools of water left in the basin. None was found there.

Physical factors. This artificial lake, formed by damning the valley of Nine Mile Creek, has a surface area of 175 acres. The soil along the shore is clay. There are outcroppings of limestone in places and slabs of this material are found along the beach. The wind blows drift material up on the shore. As decay progresses in this detritus, a spongy mass is formed which retains moisture.

The area where the station was situated is protected on the east, south and partially on the west. Wind from the north or northwest caused waves to wash the shore. Trees grew immediately above the water line. Their branches shaded the shore and the direct rays of the sun fell on the beach for only short periods of the day. Indirect light was strong because the light was reflected from the surface of the water onto the shore.

Biological factors. Except for the trees, plant life along the shore was lacking. Some Spirogyra spp. grew in the water. A small blue-green algae was also growing on the stones that were washed by the waves.

Insect life was plentiful in the mass of decaying detritus. Collembola were found in enormous numbers. When the moist leaves were turned over, the soil beneath them was black with these tiny insects. Carabidae and Staphylinidae were numerous. Dystiscidae, Hydrophylidae, and Haliplidae were collected along the shore. Stratiomyiidae and Tabanidae larvae were scooped out of the ooze immediately below the water line. Blood worms were washed out of the mud as the shore was wetted in the search for hebrids.

Shore birds are common in the spring migration. Spotted sandpipers, upland plovers, kildeer, and lesser yellow-legs were observed. Coots and grebes searched along the shore for food. I have opened grebes and have found their stomachs filled with water plants (Chara spp.). Species of Merragata and the eggs of these shore bugs were found on Chara spp. and other water plants. Surely individuals of Merragata must be taken along with the water plants when the grebes feed on this material. Stomach analysis of several species of grebes by Wetmore (1924) indicated some Hemiptera but no specimens of Merragata were included in the lists.

Houses of muskrats were observed in the shallow water. Materials cut by these animals washed up on the shore and helped to increase the amount of shelter for the shore bugs.

Protection for the insects was provided only by the material washed in by the waves. The shore was bare of plant life. The nature of the soil and action of the waves were the reasons for the lack of living vegetation.

Atchison County

The tenth station is situated on the north side of a shallow pond on the northeast end of the Muscotah marsh, one and one-half miles south of the town of Muscotah. This is an area entirely different from any other in the State of Kansas. Here a raised marsh is formed surrounded by a semi-permanent swampy region. This swamp is fed by artesian water.

Physical factors. The water in the pond comes from an artesian well that flows continuously. The area around the pond is a marshy, spongy mass. It reminds one of the northern sphagnum bogs. Horr and McGregor (1948:197-200) have given a complete description of the area and include a list of the plant species found there.

The soil is black and rich in organic material. Partially decayed leaves, roots and stems make up a large part of this material. Snail shells are abundant.

The area around the marsh changes with the season. During the spring and fall the raised part is surrounded by water. In the summer the water surrounding the mounds disappears and the area becomes dry, right up to the mounds. These mounds always remain moist. The pond is separated from the marsh by a dike. The flow of water from the artesian well is sufficient to keep water in it all of the year.

The area is well lighted but owing to growth of tall marsh plants the soil is partly shaded. Trees do not grow in the wet soil. A few small willows are scattered along the shore but none is located at the station.

Biological factors. There is a large variety of species of plants at this station. Sedges are dominant with Scirpus validus Vahl. being the most abundant. Carex annectans Bickn. forms a thick undergrowth beneath the sedges. Argrostis alba L. is the dominant grass. The surface of the pond has scattered patches of Lemna perpusilla Torr.

There is an abundant insect population. Corixidae, Notonectidae, Belostomatidae, Nepidae, and Hebridae were collected. Semiaquatic bugs and shore bugs of several families were identified. This group included Mesoveliidae, Hydrometridae, Gerridae, Saldidae and Gelastocoridae. Collembola were numerous. They were taken on the shore and from among the plants growing in the water.

The area is pastured and the animals come to the pond to drink. Their foot-prints fill with water and provide protected pools from which shore bugs can be collected. Muskrats are present in numbers; they have houses scattered over the pond and also have holes in the bank. Some of the aquatic plant material that they cut for food is left over and washes up on the shore; there it provides shelter for the shore bugs.

Birds of many species are attracted to this area. The following species were recorded: Kildeer, spotted sandpiper, coot, mallard duck, red-winged black bird, song sparrow, dickcissel, meadow lark and horned lark. Most of these birds feed on the insects along the shore. They would probably include hebrids in their feeding.

Michigan

Collecting stations were established in two counties at the upper tip of the southern peninsula of the State. Seven collecting stations were in Cheboygan County and three in Emmet County.

Cheboygan County

The eleventh station is at Pine Point on the northeast end of Douglas Lake, along the shore of a beach pool.

Physical factors. While the water is high in the spring the pool is connected to the lake and is filled with water. As the season advances the water level of the lake lowers and the pool is separated from the lake by a sand bar. By late summer the water may be gone from the pool but the bottom retains moisture and fall rains replace some of the water lost earlier.

The soil is yellow sand. This is covered by decaying vegetation to a depth of about three inches. Snow packs this material down each winter forming layers which can be separated. The lower layers are compressed while the upper layers are more spongy. Moisture is retained in this mass when the pool dries, providing a habitat suitable for hebrids.

The station is well protected. The forest surrounds it on three sides. It is exposed on the north side. Heavy growths of shrubs and marsh plants give the shore bugs further protection from the wind and sun.

Biological factors. Plant growth is abundant at this station.

Plant species serving as shelter for the hebrids were collected and identified as follows: Campanula uliginosa Rydb., Eupatorium sp., Scutellaria galericulata L., Potentilla palustris (L.) Scop., Cystopteris bulbifera (L.) Bernh., Myrica gale L., Phragmites communis Trin., Eleocharis sp., Clamagrostis canadensis((Michx.), Scitpus americanus Pers., Osmunda cinnamomea L., Typha latifolia L., Climacium dendroides (L.) Web. & Mohr., and Calliergomella cupidata (Hedw.) Loeske. The hebrids preferred the areas where the moss grew.

While water remains in the pool the insect population is high. Many families of aquatic and semiaquatic Hemiptera are common. Hydrometridae, Nepidae, Belostomatidae, Corixidae, Notonectidae, Hebridae, Mesoveliidae, Gerridae, and Saldidae were collected. Predaceous larvae of Hydrophilidae and Dytiscidae capture insects in and on the water. The species of the latter family have been recorded as feeding on hebrids. Hyla crucifer crucifer Wied. and Rana pipiens Schreber were the only amphibians seen at this station.

Many species of birds nest and feed in the area. Those identified include the following: Northern yellow-throated warbler, yellow warbler, oven bird, red-eyed vireo, eastern song sparrow, red-eyed towhee, indigo bunting, rose-breasted grosbeak, sandpipers, lesser yellow-legs, herring and ringed-billed gulls, balck and mallard ducks.

The twelfth station is at the mouth of Carp Creek. This creek is a swift, cold, clear stream that has its origin in springs at the head of a gorge south of Douglas Lake. It empties into the north end of Burt Lake. Whenever fallen limbs or dead trees float downstream and come to rest along the shore, they change the direction of the current. Ever-changing sand bars are formed by the current as these objects become lodged for a while and then become loosened again. Shore bugs of various kinds are found on these sand bars.

This station is well protected. Both sides of the stream have a dense growth of evergreen trees. The stream course is in a north-south direction at the station. Thus the sun shines on the west bank in the morning and on the east bank in the afternoon. Vegetation is sparse on the sand bars.

Biological factors. Thuja occidentalis L. is the most abundant species of plants. Larix laricina (DuRoi) Koch, Picea mariana (Mill.) BSP, and Abies balsamea (L.) Mill., are also growing along the bank. A fine moss, Cratoneuron filicinum (Hedw.) Roth covers most of the sand bar at the station. This is a procumbent growing moss. Other species of plants growing on the bar were: Carex rostrata Stokes, Equisetum Fluviatile L., Sparganium americana Nutt., Mimulus ringens L. and Panicium spp. along with other sterile grasses.

Insects are not abundant in this type of habitat. Hemiptera are few and difficult to find. Saldid nymphs, a few specimens

of Microvelia and two genera of Hebridae were collected. Collembola were surprisingly few in number. I have usually found them well represented in this type of habitat.

Station thirteen is on Carp Creek about one-half mile above station twelve.

Physical factors. This habitat differs greatly from that found at station twelve. In former years beaver worked in this stream. They constructed dams which changed the course of the stream. As the old dams decayed, portions broke away permitting the water to rush through. Here the new channel was formed. As the water receded from behind the dam, a pool was formed above the dam in the old stream bed. As the years passed this water became impounded, leaving small deep pools. They are now supplied with water by seepage from the hills above.

The soil is yellow sand covered over with a layer of decaying detritus varying in depth from a few inches to well over a foot. The station is well protected from the sun and wind. Plant growth is heavy. Trees filter out the direct rays of the sun from the south and from the west. Indirect light is strong. The clear water of the stream reflects the rays of the sun onto the bank.

Biological factors. Plant species were identified as follows: Drepanocladus exannulatus var. Rotae (deNot.) Grout, Ceratoneuron filicinum (Hedw.) Roth, Spirodela polyrhiza (L.) Schleid, Typha latifolia L., Eleocharis sp. and sterile grass.

Insects are abundant in this habitat. The following aquatic and semiaquatic insects were collected and identified: Microvelia sp., Hydrometra martini Kirk., Ranatra fusca P. B., Hebrus buenoi D. & H., Mesoveliidae, Notonectidae, Corixidae, Saldidae, Gerridae and Belostomatidae. Predatory insects other than Hemiptera were identified as follows: Carabidae, Hydrophilidae larva and adults, Dytiscidae larva and adults, Trichoptera larvae, dragon-fly and damsel-fly naiads. Insects that serve as a food supply for the hebrids were: Collembola, mosquito larvae, and blood worms.

Birds inhabiting the area were: Indigo buntings, swamp sparrows, chipping sparrows, great blue heron, short-billed marsh wren, yellow warblers, northern yellow-throated warblers, nuthatches and chickadees.

Mice and shrews were collected and identified as follows: Sorex cinereus cinereus (Kerr), Blarina brevicauda kirtland Boule and Moulthrop, Synaptomys cooperi cooperi (Baird), Microtus pennsylvanicus pennsylvanicus Ord and Zapus hudsonius brevipes Zimmerman. The shrews were probable predators on hebrids and the mice cut grasses that acted as a protecting cover for these insects.

Station fourteen is at Nelson Lake, in Hebron Township, on the south side of section 15.

Physical factors. The lake is a temporary body of water. During the wet spring season it is well filled and covers an

area of approximately 160 acres. Even at this time of year it is shallow, the greatest depth not exceeding ten feet. Summers are usually dry in this region and such a body of water is short lived. The entire area is usually dry by the first week in August except a narrow dredged strip along each side of the road.

The soil is yellow sand. It is covered with decaying plant material for a brief period in early summer. Eramacausis takes place and all of this material disappears by late summer. The shore bugs follow the receding moisture to the bottom of the excavation. These insects are found among the roots of the plants or under boards and old logs that retain some moisture.

Protection is lacking at this station. There are no trees to deflect the wind. The rays of the sun are filtered out to some extent by the smaller plants. The decaying mass of vegetation provides little because it is present for only a short period in the summer.

Biological factors. Plant growth is thin and scattered. It varies in species from aquatic to marsh types. The bottom of the lake has an abundant growth of Eleocharis spp. but this little plant is too small to supply much protection. Other species were as follows: Potamogeton spp., Eleocharis acicularis (L.) R. & S., Triglochin palustris L., Scirpus acutus Muhl., Anacharis occidentalis Michx., and Equisetum praeatum Raf.

Even though this is only a temporary body of water insects are numerous. Predatory Hemiptera in various stages of their

life cycle were abundant. Those collected and identified were as follows: Runatra fusca P. B. eggs, nymphs and adults; Notonectidae, nymphs and adults; Gerridae, nymphs and adults; Belostomatidae, eggs, nymphs and adults; Hydrometra martini Kirk. nymphs and adults; Microvelia sp. nymphs and adults; Mesoveliidae, nymphs and adults; Saldidae, nymphs and adults; and Hebrus buenoi D. & H. nymphs and adults. Other predatory insects were naiads of dragon-flies and damsel-flies; larvae of dytiscids, hydrophilids, Trichoptera and Tabanidae.

The bird population varies with the amount of water in the lake. The following were recorded: Black and mallard ducks, grebes, coots, great blue herons, american bittern, short-billed marsh wrens, red-winged blackbirds, kildeer and spotted sandpipers.

Station fifteen is along the bank of a slow moving stream called Fontinalis Run. The stream runs from north to south at the station.

Physical factors. This stream drains a cedar bog. The water is cold and is colored by the decaying plant material from the bog. The shore of the stream is covered by refuse from an old logging operation. There are decaying logs along the shore beneath which there are several feet of flocculent ooze. I had to collect with care at this station, since it would be difficult for a person to get out of the ooze if he slipped into it.

The direct rays of the sun light the station all of the day. There are no trees or shrubs to protect the insects from this bright light. The station is not protected from the wind.

Biological factors. Hebrids were taken by submerging two species of moss that grew on the logs. Drepanocladus exannulatus (DeNot.) Grout grew as an emergent type of plant and Philonotis fontana (Hedw.) Brid., a reddish-stemmed, upright growing moss covered the tops and sides of the logs. The insect population was not large on the logs. The following insects were collected and identified: Hydrometra martini Kirk., Microvelia sp., Mesoveliidae, Hebrus buenoi D. & H., and Staphylinidae.

Station sixteen, at Nigger Creek in Mullet Township, is on the east side of the creek and on the north side of the road that bisects section six.

Physical factors. This is a marshy, spring-fed area along the creek. Water seeps through it all of the time. When the substratum is depressed water flows into the depression from the bank side and passes out toward the stream side. The substratum is composed of decaying detritus and black soil rich in organic matter. The substratum is exceedingly spongy. Water is present in this mass all of the time.

Biological factors. Plant species are numerous. The more common ones that were collected were identified as follows: Cratoneuron filicinum (Hedw.) Roth, Climacium dendroides (L.), Web. & Mohr., Calliergonella cupidata (Hedw.) Loske, Cornus asperifolia Michx., Eleocharis smallii Britton, Carex cristata

Schwein., Scirpus sylvaticus L., Sparganium minimum Fries., and Equisetum palustre L.

The more common families of insects were as follows: Carabidae, Gerridae, Notonectidae, Belostomatidae, and Saldidae. Hebrus buenoi D. & H. was taken also.

Station seventeen is on the bank of a little creek that bisects section 15 of Inverness Township where the Cheboygan-Pellston road crosses the stream.

Physical factors. This little marshy area along the stream closely resembles station sixteen. The marsh is spring fed. The water flowing through the moss is exceedingly cold. The substratum is rich black soil with a cover of moss and other marsh plants. As the plants die and decay they provide an abundance of vegetable matter for the soil. This material forms a spongy mass that retains moisture.

Biological factors. Mosses were the dominant plants at this station. Brachythecium rivulare (Bry.) Eur. and Philonotis fontana (Hedw.) Brid., were the species from which hebrids were taken. There were only three other plant species growing at the station. They were identified as follows: Carex vesicaria L., Iris versicolor L., and Alnus incana (L.) Moench.

Collembola, Mesoveliidae, Microvelia sp., and Hebrus buenoi D. & H. were the only insects taken at the station.

Emmet County

Station eighteen is at the gravel pit north of Pellston on the east side of highway 31.

Physical factors. The water level of the pool changes rapidly. The water drains into the gravel pit from the surrounding area. During the late spring and early summer the pool is well filled. By the first week in August the water has seeped away and the bottom of the pool is dry. The soil is yellow sand with a vein of gravel a few feet below the surface of the soil. There is little organic matter in the soil owing to eramacausis.

The area is nearly without protection. Scattered grass grows along the bank. A few bushes with moss growing beneath them give protection to the shore bugs. These bushes grow only at the north end of the pool. Light is strong because the rays of the sun fall on the shore and are also reflected from the surface of the water. The small area where the moss grows is the only place that retains moisture after the pond dries in late summer.

Biological factors. The moss Drepanocladus exannulatus (Guemb.) Warst. and the shrub Cornus stolonifera were the only plants at this station. The insect population is large while water is in the pool. Specimens taken and identified were as follows: Stratiomyiidae larvae, mosquito wrigglers, dragon-fly naiads, damsel-fly naiads, Belostomatidae (adults and nymphs), Notonectidae (adults and nymphs), Dytiscidae (nymphs and adults), Hydrophilidae (adults, eggs and nymphs), Mesoveliidae, Ranatra fusca P.B. (eggs, nymphs and adults), and Hebrus buenoi D. & H.

Many birds feed along the shore. They were identified as follows: Kildeer, spotted sandpipers, red-winged blackbirds, black ducks, yellow warblers, indigo buntings, and song sparrows.

Station nineteen is at Wilderness State Park near the geographer's camp. This station is on the shore of an artificial pond.

Physical factors. The water for the pond is supplied by several small streams that have their origin in cedar swamps. The water is colored from the decaying matter in the swamps. The pond is shallow and the water becomes warm during the hot summer days. The soil is yellow sand. A flock of Canada geese living on the pond dropped part of their fecal material on t he shore increasing the amount of organic matter. A thin mass of decaying vegetation serves as a hiding place for the shore bugs. Chara sp. grows in a thick tangle below the surface of the water. As the level of the water lowers this material is left on the shore and increases the amount of shelter for the shore bugs. Trees along the shore filter the rays of the sun from the shore. Light is reflected from the surface of the water to the shore. The pond is so large that the shore is exposed to winds from the south, east and north. When the hebrids were frightened out onto the surface of the water they were blown back to the shore.

Biological factors. Plant growth other than the Chara does not affect the hebrids because it is too far above the water line. One undetermined species of moss grows in a small patch

at one end of the collecting station. The hebrids were not restricted to the area in which the moss grew. Insect species are abundant here but owing to time limitation I collected only two species. Nepa apiculata Uhler and Hebrus buenoi D. & H. were taken.

Station twenty is one-half mile north and one-half mile east of Brutus, along the south side of the road that passes through a blueberry bog in section 23 of Maple River Township.

Physical factors. The water in the ditch where the station was situated comes from the bog. This water is highly colored from the decaying matter in the bog. The soil is yellow sand. Decaying vegetation covers the bank of the ditch. Plant growth is lacking at the edge of the water. There is no protection from the wind or sun. The shore is exposed from all directions.

Biological factors. A few scattered patches of moss grow at the station. This is the only plant life at the station. Only a few species of insects were observed. Collembola were the most common. Mites were plentiful and some of the hebrids were parasitised by mites. Hebrus buenoi D. & H. was the species of Hebridae taken.

Other Collecting Areas

Collecting was done in many other places but collecting stations were not established. However, one of these should be discussed. During the summer of 1948 Mrs. Elizabeth Sprague

collected insects at Nichol's Bog in Cheboygan County. She had collected a pair of hebrids from this bog. They were identified as Hebrus burmeisteri L. & S.

Nichol's Bog is surrounded by a sphagnum mat. Two species of plants were dominant along the border of the mat. Sphagnum Girgensohnii Russ. and Chamaedaphne calyculata (L.) Moench. formed a support for the following: Eleocharis Smallii Britton, Dulichium arundinaceum (L.) Britton, Salix spp. and sterile grasses. Hebrus burmeisteri L. & S. were taken at Vincent Lake, Cheboygan County, in a similar type of sphagnum.

Summary

The following conclusions have been made from these habitat studies.

Physical factors

1. Moisture is necessary for the members of the family Hebridae. Species of the genus Hebrus Curtis will submerge themselves voluntarily as do the species of Merragata White.
2. The type of soil has not been a deciding factor in their choice of habitat.
3. Soil cover is important; some type of a moist cover in which to hide is essential.
4. Wind does have some effect on the species of Hebridae because they are small and can be blown across the surface of the water.

5. Light is not a deciding factor. Hebrids are taken in densely shaded areas as well as in open areas.

Biological Factors

1. Species of Hebridae are not limited to habitat by plant species.
2. Insect associations are similar in like habitats.
3. Vertebrate animals provide shelter in the form of waste material.
4. Hebrids are parasitised by mites.
5. Predaceous larvae feed on hebrids.

Field Techniques

Collecting Methods

Collecting equipment consisted of an aspirator, a fine-meshed tea strainer two inches in diameter, a long-handled dipper, record sheets, note book, and bottles with screw tops in which to put the hebrids. A number two pencil gave a lasting legibility not obtained with a number four pencil - especially when records were saturated with water or alcohol.

Sweeping with an insect net never proved successful. Three other methods of collecting were attempted. One method was that of wetting leaves. Two variations of the wetting methods were used. The mass of material was slowly submerged in which instance the hebrids would remain on the surface of the water. They were taken into the strainer and then drawn into the

aspirator. Water was thrown on the beach when the submerging methods were found impractical. The insects would run toward higher soil and could then be collected into the aspirator. This latter method was used more than the former method for collecting the species of the genus Hebrus Curtis.

The second method, use of an aquatic net, was successful in collecting the species of Merragata White. These species are more aquatic than those of Hebrus Curtis and when disturbed go under water rather than to higher ground. Algae, Spirodela, and Lemna could be scooped into the net. As the water drained off, the Merragata would come from among the plants and run up the sides of the net. They could then be taken with the aspirator. The tea strainer was substituted at times when the aquatic net was too large to be successful in small pools. If plant growth was tall the aquatic net was useless.

The third method was to blow smoke from a cigar or pipe close to the roots of plants. The plants were then carefully parted and as the insects rushed out they were collected in the aspirator. This method was devised to replace method number one when water was difficult to get or in situations where plant growth was short and thick. For example, this method worked well on the mats of Sphagnum.

Preparation of Collecting Containers.

When a number of insects were collected in the aspirator they were removed and placed in collecting bottles containing a few stalks of moist moss or a piece of damp absorbent paper. If

sufficient moisture was not present the insects would be dead by the time they reached the laboratory. If the material was too moist the hebrids would get caught in the surface film and drown. They will not live for more than three hours in a completely dry container.

Kinds of Food and Methods of Collecting Food. Hungerford (1920: 90) found that hebrids fed on freshly killed insects. At the beginning of my study, insects alone were fed to the hebrids. Later I noticed that microcrustaceans were nearly always present where hebrids occurred and suspected that the microcrustaceans might serve as food for the hebrids. A Birge cone net was used to collect microcrustaceans and other zooplankters which were substituted for the insect food. The species of both Hebrus and Merragata used these organisms as food.

In summer at the Biological Station a carbon arc light is used to attract insects for the entomology class. Midges come to this light in tremendous numbers and it was an easy matter to get them for the hebrids. The Diptera were anesthetized with a few drops of chloroform and placed in the dishes with the hebrids. In order to continue this type of feeding, wild cultures of Drosophila were started in the last week of the summer session. These flies were used during the winter when other kinds of food were unobtainable. The hebrids fed as well on them as they did on the midges.

Microcrustaceans and other zooplankters were collected in Douglas Lake in the summer and in Potter's Lake at the University

of Kansas in the fall and spring. Each day approximately 5 cc. of the concentrate were placed in the hebrid culture dishes with a small pipette.

Laboratory Techniques

Preparation of Culture Dishes

When the insects were brought in from the field they were placed in large finger bowls with glass covers. These were prepared in several ways.

First method. Sand was placed along one side of a stender with a bit of moss over it in order to establish a habitat as nearly as possible like the one in which the insects were found. Water was then added so as to form a small pool on the opposite side. The hebrids were then placed in the moss. Later this method was modified by the addition of Salvinia natans (L.) Hoffman to the surface of the water. This decreased the mortality rate and was used in all of the dishes containing the species of Hebrus.

Second method. Climacium dendroides (L.) Web. & Mohr., an upright growing moss, was selected and used in finger bowls with water beneath the moss. As some of the hebrids were found in moss over water, this appeared as a suitable type of habitat.

Third method. In selecting a habitat for the species of Merragata, floating plants were placed on the water in finger bowls. Species of Merragata were then placed on these plants.

Fourth method. Stones were used in the dishes in place of the sand. Moss was added to the containers. Neither Hebrus nor Merragata was able to withstand the attraction of the surface film. Spirodela polyrhiza (L.) Schleiden and Salvinia natans (L.) Hoffman were added to decrease the amount of water surface. After these plants were added the hebrids were able to survive.

Summary of Habitat Requirements

1. A habitat providing a water surface with some type of floating support is required for the species of Hebrus.
2. The species of Merragata will live on an exposed surface if a small amount of emergent material is present.
3. The species of Hebrus require a habitat containing only a small amount of exposed water surface.

Feeding Methods

First method. Stender dishes were prepared with washed sand, a stem of moss and distilled water. Young and adults were then placed in the dishes. If the hebrids lived and if the young continued to grow, these insects would have to get their food from the moss. The adults lived for a period of twelve to fourteen days. The young lived for a period of one to three days. they were not feeding on the moss.

Spirodela polyrhyza (L.) Schleiden, Lemna and Salvinia natans (L.) Hoffman were substituted with the same results.

Second method. Midges and flies were given as food. Otherwise stenders were prepared in the same manner as in the first method. Adults and young were placed in the dishes, one to each dish. Five or six freshly anesthetized insects were placed in the dishes in the morning. At night they were removed and replaced with freshly killed insects. This kind of food proved satisfactory. The nymphs continued to grow and the adults did not die. To provide a further check on this kind of food, eggs were removed from the brood dishes before eclosion and were placed in habitats similar to the above. When the eggs hatched the young insects were supplied with insect food and the hebrids grew into adults.

Third method. Young and adult individuals were provided with insect food but the mosses were omitted. Stenders were prepared with a piece of absorbent paper in the bottom and moistened with tap water. The insects developed normally. The nymphs completed their metamorphosis.

Fourth method. Stenders were prepared with absorbent paper and moistened with a concentrate of zooplankters. Individual insects were put in the dishes. To conserve time, well embryonated eggs were placed in the dishes. As the nymphs hatched they were fed fresh zooplankters once a day. When the material in this dish became stagnant another stender was prepared as above and the insects transferred to it.

Summary. 1. Hebrids do not live on plant material.

2. Hebrids can live on insect material alone.

3. Hebrids can live on zooplankters alone.

Preparation of Mating Dishes

Two-inch stenders were used as mating containers. An absorbent paper disc was placed in the bottom and a stem of Climacium dendroides (L.) Web. & Mohr. was added. To facilitate the checking for eggs the length of stem was limited to two centimeters.

Selecting of Pairs

Several hebrids were drawn into the aspirator and transferred to a stender that had been previously lined with a moist absorbent paper disc. Two or three drops of ether were then placed on the paper and the dish covered. As the hebrids became anesthetized one male and one female of the same species were removed to the prepared mating dishes. Care must be taken to control the amount of moisture when the anesthetized insects are transferred. If the containers are too moist the hebrids will drown before the anesthesia wears off.

Removal of Eggs from Mating Dishes.

As the eggs were discovered they were removed to separate incubating dishes. If the eggs were laid far enough apart on the stem to permit separate removal a section containing one egg was removed and each section placed in a separate dish. An

absorbent paper disc moistened with two or three drops of water lined the bottom of the dish. The moss was placed on the paper. The mating dishes were checked morning and night for eggs.

Preservation of Chorion and Exuviae.

At the completion of eclosion each egg shell and exuviae were preserved in 70 percent alcohol. The exuviae of each following ecdysis was also preserved.

Preservation of Eggs and Nymphs

Complete series of eggs and nymphs of all species studied were preserved in 70 percent alcohol. Slides were made from this group of specimens. The eggs and nymphs were removed from the alcohol and mounted in a drop of Elvanol (lacto-phenol) and covered with a number two cover glass. The polyvinyl alcohol acts as a clearing agent and mounting medium. The formula was furnished by James Williams of the University of Michigan as follows:

Type B - Grade 70-05 Elvanol ------ 20 gm.
Water (distilled) ---------- 100 cc.

Lactic acid ---------- 50 cc.
Phenol (full strength)---------- 50 cc.

Add water to the Elvanol slowly as in making gravy thickening, heat in water bath with constant stirring until mass becomes clear, then strain through several layers of cheese cloth; to this add the lacto-phenol in the following proportion: 60 parts Elvanol to 40 parts of lacto-phenol. Let the material stand until a clearing line is formed and use the material above the clearing line.

Life History Studies of the Family Hebridae

Hebrus Curtis

Description of the adults. The body of the species of the genus Hebrus is covered with a silvery pile. There are a few long setae on the antennal segments and the same kind of setae occur on the legs. There is a comb of coarse spines on the inner side of each tibia at the distal end.

Cleaning activities. These little bugs must keep the setae of the body clean and dry. If the body becomes wet the insect experiences a difficult time. They cannot keep above the surface of the water. They drown quickly unless an object is near upon which they can crawl. Therefore the cleaning and drying process is a continuous one. As they walk on the surface of the water the setae of the tarsi can be seen to adhere to the surface film. The insect stops at once to clean and dry the tarsi by pulling the setae of the tarsi through the tibial comb. After a few more steps the setae again become moist and must be dried. Cleaning and drying of the tarsi are not in any particular order.

The setae of the antenna are cleaned by the antenna being drawn between the front tibiae. The tibial comb is pushed from the base of the antenna toward the distal end. The rostrum is combed in the same manner as the antenna.

Feeding activities. By means of the rostrum the insect probes for food continuously. The terminal segment of the beak is short. The segment is thrust beneath the surface film if the bug is walking on the water or it is bent forward at right angles to the rest of the rostrum while the insect is moving on other surfaces. The remainder of the rostrum may be carried at a 45-degree angle with the body, it may be carried at right angles to the body, or it may be carried slightly ahead of the body.

When a hebrid comes within two or three millimeters of a freshly anesthesized insect it stops and waves its antennae in the general direction of the insect. The rostrum is thrust slightly forward and the hebrid slowly approaches the intended food. The distal segment is bent forward at nearly a right angle to the rest of the beak. When the beak touches the body of the anesthetized insect the stylets of the hebrid are inserted beneath the exoskeleton and the body juices are extracted.

Daphnia and other zooplankters may be caught in the surface film. They may live for several hours while held by this terrific force. While these little animals are thus entrapped the beak of a hebrid may touch one of them. The hebrid will insert its stylets and pull the microcrustacian out of the water. It is carried to the dry surface of a floating leaf and its body juices are withdrawn. The leaves of the Spirodela and Lemna may have a number of the exoskeletons of the tiny crustaceans on them.

Hebrids are cannibalistic and will destroy newly emerged individuals. For this reason the young had to be separated from the adults and the nymphs from one another in order to prevent their killing one another. They will also attack other kinds of insects as they emerge from the last nymphal instar or pupa. Chironomids are easy prey for the hungry hebrids. Several hebrids have been observed to feed on a single emerging chironomid. However, these insects are not predaceous in the usual sense of the word. They can not successfully attack an active insect that can move quickly away. The hebrids will feed only when the prey is injured or during the molting period while the insect is teneral. The zooplankters must be caught in the surface film or trapped in the axils of the leaves of the moss before the hebrids kill the zooplankters.

Mating. The male mounts the female from any direction. His body is then rotated until he faces in the same direction as the female. After he is oriented he usually remains quiet for a period of a few seconds. Then he does a kind of dance on the back of the female. The body of the male is raised high on the hind legs and he strokes the back of the female with his tarsi. In some cases the antennae are also used in the stroking process. This dance lasts from forty-five seconds to a minute or a little longer.

At the close of the dance the body is lowered and a second series of movements begins. The male swings his body from side

to side in a horizontal direction. This motion is quite rapid and of only a few seconds duration. Then the male lifts himself high anteriorly and grasps the margins of the thorax of the female with the claws of his front feet. The position of the tarsi varies depending on the size of the pair of insects. When the male is smaller than the female the male rests his tarsi on the disc of the female's pronotum. The tip of the abdomen of the male is then lowered over the posterior part of the female's abdomen. The horizontal motion is repeated and the parameres of the male stroke the vagina exterior of the female. The aedeagus is then inserted at the proximal end of the vagina exterior. The period of copulation varies from a few seconds to more than a minute. The aedeagus may be withdrawn and the entire performance repeated.

Copulation is necessary before the female will lay. Males were removed from the mating dishes after copulation. Three days was the longest period any female laid after the male was removed. The females never laid more than five eggs after the male was removed. When the males were again placed in the dishes, copulation occurred and the female would resume laying.

Oviposition. Oviposition is the same in all five species of Hebridae studied. The eggs are laid singly in an irregular transparent gelatin. The amount of this material varies from a mass several times the volume of the egg to just enough to cover the egg. The eggs are attached to some object by the gelatin.

In the laboratory, oviposition was usually in the axils of the leaves of moss plants. The hebrids preferred a moss with rather large leaves that grew close together on the stem. Specimens of Climacium dendroides (L.) Web. & Mohr. were found to be best suited for this purpose. Mosses with small leaves or with leaves widely separated would not be used by the hebrids. In cases where this type of moss was tried, the female glued the eggs to the stones and among the filaments of blue-green algae that grew on the sides of the stenders. Occasionally eggs were placed at the tip of a leaf. When this was done the leaf directly above was also attached to the gelatin that enclosed the egg. The egg would hang suspended in the gelatin between the two leaves.

Each female would lay from one to three eggs per day. The females were sporadic in laying. They would lay from three to five days in succession then skip several days. Food or temperature did not seem to be the controlling factors in the number of days in succession that a female would lay. I have been unable to ascertain the total number of eggs laid by any one female in her life time. One female of Hebrus buenoi D. & H. laid thirty-eight eggs in four months. She laid eggs during the winter as indicated by the young observed from time to time throughout the school year of 1947-1948. My school duties prevented me from keeping close check on the continuous laying of this female.

Life Histories of Three Species of the Genus Hebrus

Hebrus burmeisteri L. & S.

Females of Hebrus burmeisteri L. & S. were collected on May 4, 1946, and brought into the laboratory. The first eggs, found on May 8, were deposited in the axils of the moss leaves. The eggs were glued to the leaves by the gelatinous mass enclosing the eggs. There were three eggs in this group.

The Egg (Plate vi; fig. 2)

Hungerford (1920:90) described the egg of a species he called Hebrus concinnus Uhler. Later, Hungerford and Beamer (1925:89) upon restudying the adults decided that the species was Hebrus burmeisteri L. & S., as did Drake and Harris (1943: 50) when they examined the same specimens.

Size. Length 0.528 mm. to 0.558 mm.; width, 0.218 mm. to 0.270 mm. There is an increase in size as the embryo develops. This increase varies from 0.600 mm. to 0.730 mm. in length and 0.270 mm. to 0.330 mm. in width.

Shape. Elongate oval; ends rounded, nipple attached to end with micropyle.

Color. Pearly white, changing to yellowish-white as embryo develops, red eyespots develop a few days before eclosion. Eyespots appear on end containing micropyle.

Eclosion. The first break in the chorion of the egg begins near the anterior end above the dorsal side of the insect.

This break develops into a longitudinal split that extends forward from above the scutellum of the insect, continuing until it passes around the anterior end of the egg and then continues into the opposite side. The length of this split is not always the same. Some of the emerging nymphs rupture the chorion for nearly half of the length of the side opposite the initial rupture while others split it for only about one-fourth of this distance. After the rupture is started the abdomen of the nymph makes a series of contractions and expansions. This action induces pressure on the split by the abdomen moving forward in the egg and causes the chorion to tear farther. Continuation of this abdominal movement forces the pronotum through the opening. The pronotum then provides more leverage against the torn portion of the covering and causes the chorion to tear faster. As the opening increases in size more of the anterior part of the nymph becomes visible. The head is the first section of the body to become freed. The rest of the body is pushed out of the egg by a series of peristaltic-like contractions of the abdomen. The posterior legs aid in getting the last part of the chorion off of the abdomen.

The newly emerged insect is covered with a thin membrane. Wheeler (1899:291) in discussing Blatta and Coryphora called this membrane the embryonic cuticle. Hungerford (1920:90) called it a post-embryonic molt; Sikes and Wigglesworth (1931: 165) a cuticular or serosa membrane, while Snodgrass (1935:34)

used the term "cuticular embryonic membrane." This membrane has a series of projections on the distal border of each abdominal tergite. These are not hairs or spines but appear to be a rough edge along the tergum. Hungerford (1920:104) describes them for Mesovelia mulsanti White as "backward pointing pegs on the thin membrane." The sterna lack these projections. Possibly these projections provide traction for the insect while it frees itself from the egg. The projections are not necessary on the under side of the body because the legs supply pressure against the chorion. The legs on each side move in unison with the contractions of the abdomen. This membrane is shed immediately after the nymph emerges from the egg. The abdomen of the nymph begins to contract beneath this membrane in the same peristaltic-like motions that the insect uses in freeing itself from the egg. The abdomen is moved slowly at first and faster when the membrane ruptures. The posterior part of the membrane can be seen to loosen and to be pushed back from the distal part of the abdomen. A rupture occurs in the membrane above the pronotum of the insect and continues forward to near the center of the frons. The nymph then frees itself in the same fashion as in molting from the exoskeleton. The membrane is thin and milky-white in color.

The time required for this process to become complete varies from one minute and ten seconds to thirteen minutes and fifteen seconds. There are pauses in the molting process that last from a few seconds to six minutes.

The First Instar (Plate I)

Size. Variable, greatest length 0.62 mm., shortest 0.52 mm.

The newly emerged insects are exceedingly difficult to measure while alive owing to their constant movement. They avoid strong light and attempt to find shade under the leaves of the moss. It is impossible to obtain the same measurements before death and after killing with 70 percent alcohol. The first instar is so soft that it is impossible to handle it. If an anesthesia is used the insect will fall to the bottom of the container as the ether takes effect. The position of the little insect will usually be such that accurate measurement can not be made without some manipulation. When a needle makes contact with the body of the insect the moisture causes the insect to adhere to the needle. The surface tension of the liquid has greater strength than the exoskeleton of the insect. Thus any attempt to dislodge the insect with a second needle always met with failure. If the needle with the insect attached is lowered into the liquid the capillary attraction of the liquid will carry the insect higher on the needle.

In attempting to find a better method, 70 percent alcohol was used to kill the insects before they were measured. A few cubic centimeters of alcohol were drawn into a medicine dropper. The alcohol was dropped on the insect carrying it to the bottom of the dish. The insect could then be drawn into the medicine dropper and removed to a watch glass. Shrinkage always occurred

before the insect could be measured. This shrinkage was easily observed in the legs of the insect; the sides of the legs would have a concave appearance. A slight twisting of the legs of some specimens was also noticed. There was a definite contraction of the abdomen. The sides of the head also became narrower and in some specimens considerably so. In the living insect the sides of the head were convex from the rostrum to the eyes. After the alcohol treatment this area became concave. It was impossible to determine the amount of shrinkage in the length of the insect.

Color. Body milky-white, eyes red.

The head. With four rows of long, coarse setae on dorsal surface of head, each row containing three setae; antenna four-segmented, first three segments nearly same size and shape, distal segment longer than combined length of basal segments, diameter of distal segment nearly equal to each proximal segment, all segments with setae; ocelli lacking; beak four-segmented, long, reaching nearly to posterior end of abdomen, first two segments short and nearly equal in size, third segment longest, being nearly as long as other three combined, fourth segment nearly as long as combined lengths of first two segments.

The thorax. First tergite largest with two rows of setae, second and third tergites nearly same size, with but one row of setae, rows of setae on pronotum along anterior and posterior borders, row on second and third tergites across middle of segments, numerous minute setae scattered over surface of tergites;

wing pads not differentiated; coxa of leg small and trapeziform, trochanter slightly larger than coxa, having galiform appearance, femur and tibia of nearly same length, tarsus one-segmented, with pair of claws at distal end, with filiform empodium between claws, pulvillae absent, all segments of legs covered with setae, row of comblike spines on distal end of tibia, minute setae which clothe remainder of body lacking on legs.

The abdomen. Each tergum with row of coarse setae, minute setae scattered over entire surface of segments; with median pore on anterior border of fourth tergite (opening of scent gland); caudal appendages lacking.

Activities of first instar group. The insect cleans the tarsal setae continually to prevent the feet from becoming wet. As the insect walks along the surface of the water the setae become moist. The comb on the tibia is used to remove the moisture and to fluff the setae. The water on the setae causes them to adhere to one another and the comb is used to separate the setae again. One of the greatest dangers for first instar individuals is the surface tension of the water. If the tarsus becomes wet it sinks below the surface film. The insect struggles to free the entrapped part and may submerge a second tarsus. As the effort to regain a footing on the surface is continued more of the appendage becomes moistened and sinks farther into the water. If the front feet are involved, the beak and tylus become wet causing a greater downward pull against which a continued

effort to escape only speeds up the final and usually fatal submersion of the body.

The rostrum is frequently brushed to remove moisture. There are a few scattered setae on the proximal end of the beak. These are combed by the process already described for the adults. This combing and drying may be necessary to prevent moisture from raising along the rostrum.

The body is brushed by the anterior and posterior legs. The median pair are occasionally used but they have a limited movement. The legs are cleaned by one another. When the insects are crawling over the emergent vegetation they do not clean and dry themselves as often as they do on the surface of the water. On moist sand they do not clean or dry themselves for long periods of time.

The stadium. Variation of this period is from three to five days. This variation was studied in an attempt to determine the controlling factors. When two or more eggs were laid by one female in one day they were placed in the same dish. If they hatched on the same day they were not segregated. Thus factors of food and temperature would be constant for all specimens in any one dish. Specimens did not all molt at the same time even though the conditions were the same for all individuals in this one dish. The reason for the time variation was not determined.

Ecdysis. There is a line of weakness in the shape of a Y beginning as a median longitudinal line through the terga of the

thorax and running anteriorly to the head. The line divides into two parts a short distance beyond the base of the head and follows along a graceful curve above the eyes and then passes down around the front of the eyes to the parietal region. At ecdysis a rupture occurs along this line of weakness and the insect emerges through this rupture in the exoskeleton.

The mechanical process of ecdysis is initiated by the increase in size of the insect and with the intake of air at the proper time. Air is swallowed and the digestive tract which becomes distended, increases the pressure on the body fluids. Knab (1909:68) observed the process of swallowing air by several other species of insects. After the initial rupture is made in the exoskeleton and the top of the head of the emerging insect becomes visible, air can be seen to pass through the pharynx and esophagus.

After the initial rupture is effected, the emerging insect begins to work its way out of the exuviae. Two types of movements are employed in aiding the insect to push its way through the rupture. The first type is a peristaltic-like motion of the abdomen which forces the posterior part of the body forward in the exuviae. Following these motions, a lateral pivoting is induced with the center of the swing at about the middle of the mesothorax. These movements enable the insect to force the prothorax through the opening. There is a period of a few seconds of intensive struggle followed by a few seconds of rest. As the

prothorax is evaginated, the legs are partially drawn out of their enclosing sheath. The head is pulled part of the way out of the head capsule by an upward and backward thrust of the legs. This motion frees about one-fourth of the head. Then the first two types of motion are repeated. The terga of the thorax are pushed upward forcing the exuviae to tear along the base of the abdomen. This tear extends laterally between the abdomen and metathorax and varies in extent from nearly one-third to one-half the distance across the insect. The pleurae are visible after this action. The head is drawn out for nearly three-fourths of the distance freeing the eyes. Continued action frees the thorax and head from the exuviae. The legs are then pulled from the exuviae. A final push of the legs brings the abdomen out and the molt is complete.

The Second Instar (Plate I)

Size. Length, 0.968 mm. to 0.981 mm.; width, 0.51 mm. to 0.55 mm.

Color. Body milky-white, changing to straw color in four to six hours; eyes red.

The head. Length nearly one-third total body length; width 0.308 mm. to 0.330 mm.; ocelli lacking; four longitudinal rows of coarse setae, other setae scattered over surface of dorsum; antenna four-segmented, first and second segments similar in size and shape, slightly longer than wide, third segment longer and more slender than either of first two, length four times width, fourth segment longest, nearly as long as combined length of

first three, all segments with scattered setae; beak four-segmented, extending to anterior border of third ventral segment of abdomen, shape and segmental ratio of beak same as that of first instar.

The thorax. Pronotum largest sclerite of thorax, mesothorax and metathorax nearly same size; two rows of coarse setae on pronotum, one row along anterior border, second row along posterior border, scattered setae between these two rows, row of shorter setae in front of each row of coarse setae, two rows of setae on shoulders arranged diagonally and consisting of three setae per row, minute setae scattered over surface of pronotum; mesonotum with single row of setae midway between anterior and posterior borders, second row of setae on shoulder; wing pads lacking on mesonotum; metanotum with row of setae on posterior border and second row on anterior border, minute setae scattered over surface of metanotum; wing pads lacking on metanotum; legs similar to first instar.

The abdomen. With row of setae near posterior margin of each abdominal segment, other setae scattered over surface of segments; opening of dorsal gland on anterior border of fourth segment; caudal appendages lacking.

Activities of second instar group. The cleaning and drying activities of the second instar individuals are similar to those of the first instar individuals. However, the insect of the second instar is larger and the exoskeleton is more rigid. The insects are now able to overcome the danger of the surface tension

of the water to a greater degree. The legs are longer and as the body is held higher from the surface of the water it does not make contact with the surface film as easily. Drowning caused 68 percent of the fatalities in first instar groups while only 9 percent of second instar groups drowned.

The stadium. The variation of this period for individuals of this instar is from six to eight days. Continuation of the study of this variation that I began with first instar groups did not result in answering the question as to why there is a difference in this period.

Ecdysis. The exoskeleton of the second instar has a line of weakness similar to that described for the first instar. Molting procedure is similar to first instar individuals. The time required for the insect to emerge varied from forty minutes to one hour and twelve minutes.

The Third Instar (Plate I)

Size. Length, 1.05 mm.; width across abdomen, 0.62 mm.

Color. Body milky-white upon emerging from second instar, becoming straw color in five to seven hours; eyes dark red.

The head. Length of head approximately one-third of total linear measurement of insect; width measured across ocular region, 0.34 mm.; ocelli lacking; setae more abundant than on head of second instar, rows of setae no longer distinguishable; antenna four-segmented, first segment slightly curved, length twice breadth, second segment longer than first, with length

slightly more than twice width, third segment longer than first, more slender than either of first two, length approximately five times breadth, distal segment long as combined length of first three, maximum width of fourth segment approximately same as second; short setae scattered over surfaces of all segments; beak four-segmented, extending to third ventral segment of abdomen, general shape and segmental ratio similar to that of first instar.

The thorax. Pronotum with scattered setae, setae more abundant than in second instar, two oval pits near medial longitudinal line; mesonotum with setae scattered over surface; wing pads lacking; metanotum larger than that of second instar individuals but otherwise unchanged; legs with segmental ratio same as second instar, all segments with scattered setae, row of short spines on distal end of tibia.

The abdomen. Rows of setae described for second instar present, others scattered abundantly over surface of segments; opening of dorsal gland on anterior border of fourth segment; caudal appendages lacking.

Activities of third instar group. The activities of this group are the same as those described for the first and second instar groups. Death by drowning is infrequent in the third instar group. Individuals of this group are larger and stronger than the individuals of the first and second instar groups. If third instar individuals are caught in the surface film, a short

struggle frees them. Cannibalism occurs when several insects inhabit the same dish.

The stadium. Variation of this period is from six to thirteen days for individuals in this group. Most of them molted in seven days.

Ecdysis. This process is the same as that described for the first and second instar individuals. The time needed to shed exuviae varied from thirty-six to ninety-three minutes. Three individuals were observed to molt. The initial rupture of the exuviae was made before timing was begun, thus the actual time is slightly longer than indicated. The long period of ninety-three minutes occurred in the morning. My notes state that it was a cold morning. This may account for the longer period of time required for the insect to free itself from the exuviae.

The Fourth Instar (Plate I)

Size. Length, 1.31 mm.; width across abdomen, 0.77 mm.

Color. Body milky-white upon emerging from exuviae of third instar, changing to straw color in four to six hours, final color darker than third instar individuals; eyes dark red.

The head. Length of head nearly one-third total linear measure of body; width across ocular region, 0.426 mm.; ocelli lacking; setae of head more numerous than in third instar individuals; antenna four-segmented, first segment longer than second and slightly curved, second segment shortest, third segment nearly as long as combined length of first and second

segments, fourth segment longest, nearly as long as combined length of first three segments; beak four-segmented, reaching beyond anterior border of third abdominal segment when at rest against venter, segmental ratio of beak unchanged from that of third instar.

The thorax. Pronotum similar to that of third instar; metanotum partially covered by mesonotum; wing pads indicated by evaginations of posterior borders of mesonotum and metanotum.

The abdomen. Larger but otherwise similar to third instar.

Activities of fourth instar groups. Similar to third instar groups.

The stadium. Variation of this period is from six to thirteen days. When the control groups reached this instar all groups had changed so much in time requirements that this part of the study was abandoned.

Ecdysis. The line of weakness in the exoskeleton is present in this instar also. Molting procedure is similar to that of third instar. The length of time required by the insects to complete molting varied from sixteen minutes to fifty-six minutes.

The Fifth Instar (Plate I)

Size. Length, 1.67 mm.; width across abdomen, 0.97 mm.

Color. Body milky-white upon emerging from exuviae, changing to straw color, change complete in thirty-six hours.

The head. Length nearly one-third total body length; width across ocular region, 0.61 mm.; ocelli lacking; setae similar to

those of fourth instar; antenna four-segmented, first segment longer than second, second segment shortest, third segment nearly as long as first, length of fourth segment not quite one-third of combined linear measurement of first three segments, all segments with setae scattered over their surfaces; beak four-segmented, extending to middle of third sternum, first two segments short, nearly cuboidal in shape, third segment longest, fourth segment nearly as long as combined length of first two segments.

The thorax. Pronotum much larger in proportion to other sclerites than in fourth instar individuals, setae abundant and scattered; mesonotum with wing pads extending backward beyond middle of third abdominal tergum and cover pads of metathorax, wing pads of one side widely separated from those of other side and with oval depression between pads; metanotum nearly concealed by mesonotum; legs similar to fourth instar individuals.

The abdomen. Setae more abundant than in fourth instar individuals. In cleared specimens, sexes can be separated by differences in genital capsules. The vagina exteriors of females and parameres of males are visible through exoskeleton.

The stadium. Variation of this period is from five to nine days.

Ecdysis. The same line of weakness in the exoskeleton is present in the fifth instar as was described for the other instars. The insect uses the same method in freeing itself from the exuviae as that described for the other instar individuals. The time required for the molting process to become completed was not determined for individuals of this instar.

The Adult

The newly emerged adult is yellowish-white. The eyes are dark red. As the adult frees itself from the exuviae of the fifth instar the wings are pulled out of the wing pads. The wings have a shrunken and wrinkled appearance. As the body fluids are forced into the wings they expand slowly to their full extent in approximately fifteen minutes.

Sclerotization is slow. The adult insects require from five to eight days to develop their full colors. During this time the adults are exceedingly cuatious. Any sudden motion near the insect will cause it to flee from the direction of motion. Other insects in the same container will cause this newly formed adult to exhibit extreme caution. If one of the other hebrids approaches this adult it will move away before body contact can be made. After the color change has become complete this "fear" disappears.

Summary

1. Time required for the complete development of individuals of this species varies from twenty-six to forty-eight days.
2. One sex does not develop faster than the other.
3. All nymphal instars lack ocelli.
4. The antenna is four-segmented in the nymphs.
5. All nymphal instars have one-segmented tarsi with two claws.

6. Setae increase in number as insect changes from one instar to next.
7. Activities of individuals of all instars are similar.
8. The method employed in ecdysis is identical for individuals of all instars.
9. The Y-shaped line of weakness of the integument occurs in all nymphal individuals.
10. Newly emerged insects are milky-white with a gradual color change to a darker color.

Hebrus buenoi D. & H.

Females of this species brought into the laboratory on July 24, 1946, were laying July 26. The eggs were placed on the moss leaves in the same manner as described for Hebrus burmeisteri L. & S.

The Egg (Plate II; fig. 1)

Size. Length, 0.47 mm. to 0.56 mm.; width, 0.19 mm. to 0.25 mm.

Length.

No.	Fresh	1 day	2 days	3 days	4 days	5 days	6 days
1	0.53mm.	0.53mm.	0.54mm.	0.55mm.	0.56mm.	0.56mm.	0.56mm.
2	0.53mm.	0.54mm.	0.54mm.	0.55mm.	0.56mm.	0.56mm.	0.56mm.
3	0.50mm.	0.50mm.	0.52mm.	0.54mm.	0.56mm.	0.56mm.	0.56mm.
4	0.56mm.	0.56mm.	0.58mm.	0.62mm.	0.62mm.	0.62mm.	0.62mm.
5	0.50mm.	0.51mm.	0.52mm.	0.53mm.	0.53mm.	0.53mm.	0.53mm.
6	0.47mm.	0.47mm.	0.48mm.	0.48mm.	0.48mm.	0.48mm.	0.48mm.
7	0.50mm.	0.52mm.	0.53mm.	0.53mm.	0.54mm.	0.54mm.	0.54mm.

Width

No.	Fresh	1 day	2 days	3 days	4 days	5 days	6 days
1	0.22mm.	0.22mm.	0.23mm.	0.26mm.	0.28mm.	0.28mm.	0.28mm.
2.	0.20mm.	0.20mm.	0.22mm.	0.24mm.	0.26mm.	0.28mm.	0.28mm.
3.	0.22mm.	0.22mm.	0.25mm.	0.27mm.	0.27mm.	0.27mm.	0.27mm.
4	0.25mm.	0.25mm.	0.28mm.	0.30mm.	0.30mm.	0.30mm.	0.30mm.
5	0.22mm.	0.22mm.	0.24mm.	0.26mm.	0.27mm.	0.27mm.	0.27mm.
6	0.19mm.	0.19mm.	0.22mm.	0.25mm.	0.25mm.	0.25mm.	0.25mm.
7	0.20mm.	0.20mm.	0.22mm.	0.24mm.	0.25mm.	0.25mm.	0.25mm.

Incubation period. Varied from ten to twenty-two days. Two eggs hatched in ten days, six in eleven days, nineteen in twelve days, three in thirteen days, one on fourteenth day, one on fifteenth day, and one on twenty-second day. Red eyespots appeared during incubation as follows: four individuals fifth day; eight individuals sixth day; two individuals seventh day.

Shape. Elongate oval; ends rounded, with nipple attached to end containing micropyle.

Color. Pearly white, changing to cream as embryo developed.

Eclosion. Similar to Hebrus burmeisteri L. & S. Time required for first instar individuals to free themselves from egg and embryonic membrane varied from fourteen to twenty-six minutes.

The First Instar

Size. Variable, shortest length, 0.56 mm., longest, 0.75 mm.

Color. Body milky-white darkening to light straw in one to two hours, eyes dark red.

The head. Four rows of setae on dorsum of head; antenna four-segmented, first segment extending short distance forward of tylus, proximal half slightly constricted, second segment shortest, barrel-shaped, third segment approximately same length

as first, much constricted at base, fourth segment nearly as long as combined length of first three, widening for nearly three-fourths of length, tip conical; all segments with setae scattered over their surface; ocelli lacking; beak four-segmented, first two segments small, nearly cuboidal, third segment longest, widening for first third of its length then narrowing slightly for rest of distance, fourth segment nearly as long as combined length of first two segments.

The thorax. Pronotum largest tergum, with two rows of coarse setae, one on anterior border and second row on posterior border, minute setae scattered over entire surface of tergum; mesonotum and metanotum approximately same size, each with row of coarse setae across middle of tergum, minute setae scattered over surface of tergum, wing-pads lacking; legs similar to first instar individuals of Hebrus burmeisteri L. & S.

The abdomen. Nine segments in abdomen; each tergum with row of coarse setae across middle, row of long fine setae near anterior border of each tergum, other long setae scattered thinly over surface of each tergum, minute setae on lateral border of each tergum; opening of scent gland on anterior border of fourth tergum; caudal appendages lacking.

Activities of first instar individuals. Similar to those of first instar individuals of Hebrus burmeisteri L. & S.

The stadium. Variation of this period is from five to nine days.

Ecdysis. Similar to first instar individuals of Hebrus burmeisteri L. & S. Time required for molting was not determined for individuals of first instar of Hebrus buenoi D. & H.

The Second Instar (Plate II)

Size. Length, 0.81 mm.; width across abdomen, 0.50 mm.

Color. Body milky-white upon emerging from exuviae of first instar, gradually darkening to straw color, final color darker than first instar individuals.

The head. Length nearly one-third total body measurement; four rows of coarse setae on dorsum, smaller setae scattered over surface of vertex and frons; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to first instar, with setae scattered over surface of segments; beak four-segmented, extending backward to middle of second ventral segment of abdomen, shape and segmental ratio similar to first instar.

The thorax. Prothorax with abundant setae, two rows of coarse setae, one near anterior border and second near posterior border of tergum, with row of small setae along anterior border, three rows of small setae extending across tergum between two rows of coarse setae; two pits near longitudinal medial line; mesonotum and metanotum with abundant setae, arranged similar to first instar; wing-pads lacking.

The abdomen. Setae arranged similar to first instar; caudal appendages lacking; opening of scent gland on anterior border of fourth tergum.

Activities of second instar individuals. Similar to individuals of Hebrus burmeisteri L. & S.

The stadium. Variation of this period is from four to nine days.

Ecdysis. Molting procedure is similar to individuals of Hebrus burmeisteri L. & S. Time required to complete molting is approximately twenty-eight minutes.

The Third Instar (Plate II)

Size. Length, 1.06 mm.; width across abdomen, 0.67 mm.

Color. Body milky-white upon emerging from exuviae of second instar, darkening gradually to straw color, darker than second instar individuals; eyes dark red.

The head. Length nearly one-third of total body measurement; setae similar in arrangement to those of second instar; ocelli lacking, antenna four-segmented, first and third segments nearly equal in length, second segment shortest, fourth segment slightly shorter than total length of first three segments, all segments with setae scattered over their surface; beak four-segmented, extending backward to middle of second ventral segment of abdomen, shape and ratio of segments similar to second instar.

The thorax. Setae similar in arrangement to the setae of second instar, prothorax with two pits near medial longitudinal line of tergum; mesothorax and metathorax with slight swellings along anterior border of each tergum, swellings indicate wing-pads developing, swellings of mesothorax larger than those of metathorax.

The abdomen. Arrangement of setae similar to second instar; caudal appendages lacking; opening of scent gland on anterior border of fourth tergum.

The stadium. Variation of this period is from five to nine days.

Ecdysis. Molting procedure similar to second instar individuals. Time required for individuals of this instar to molt was not determined.

The Fourth Instar (Plate II)

Size. Length, 1.45 mm.; width across abdomen, 0.82 mm.

Color. Body milky-white, darkening to straw in from four to six hours; eyes dark red.

The head. Length approximately one-third total body measurement; setae abundant on dorsum; ocelli lacking; antenna four-segmented, first segment extending beyond tylus, second segment shortest, third segment approximately same length as first, more slender than first, base of third segment constricted into slender pedicel, fourth segment longest, nearly as long as combined length of second and third segments; all segments with setae scattered over their surface; beak four-segmented, reaching middle of third sternum, shape and segmental ratio similar to third instar.

The thorax. Pronotum increased in size in proportion to rest of body in comparison to third instar; with two pits near medial longitudinal line, setae abundant; mesonotum with wing-pads extending to middle of metanotum; metanotum with wing-pads

extending posteriorly onto first abdominal segment for approximately one-sixth of distance across tergum.

Activities of fourth instar individuals. Similar to third instar individuals.

The stadium. Variation of this period is from five to seven days.

Ecdysis. Molting procedure is similar to that described for other instar individuals.

The Fifth Instar (Plate II)

Size. Length, 1.75 mm.; width across abdomen, 0.95 mm.

Color. Body of newly emerged fifth instar individual creamy-white changing to dark straw in from six to eight hours; eyes dark red.

The head. Length approximately one-fourth total body measurement, setae more numerous than in fourth instar; ocelli lacking; antenna four-segmented, first segment extending approximately one-fourth of its length beyond tylus, second segment shortest, third segment approximately same length as first, fourth segment nearly equal to combined length of second and third; beak four-segmented, extending backward to anterior border of third sternum, shape and segmental ratio similar to fourth instar.

The thorax. Terga with abundant setae; pits farther forward on pronotum of fifth instar than on fourth instar; wing-pads of mesonotum cover those of metanotum, both pair extending backward beyond middle of third abdominal tergum, wing-pads of mesonotum wider than those of metanotum, wing-pads of one side

widely separated from those of other side, oval depression between distal ends of wing-pads.

Activities of fifth instar individuals. The activities of the individuals of the fifth instar are similar to those described for individuals of the other instars.

The stadium. Variation of this period is from five to six days.

Ecdysis. Molting procedure is similar to that of fourth instar individuals of this species. Time required for the insect to free itself from the exuviae varies from eighteen minutes to forty-five minutes.

The Adult

The body of the newly emerged adult is yellowish-white and the eyes are red. This color darkens slowly, individuals requiring from seven to nine days for the complete change. While this change is taking place, the adult individuals of Hebrus buenoi D. & H. show the same fear until color change is completed as did individuals of Hebrus burmeisteri L. & S.

The wings are drawn out of the wing-pads as the adult emerges from the exuviae of the fifth instar. The wings are wrinkled and shrunken in appearance. The body fluid expands the wings as the fluid is forced into the wing veins. The wings are expanded in from fifteen to twenty minutes after the adult has become completely emerged from the exuviae.

Notes on Life Cycle of Individuals

No.	Egg Laid	Hatched	1st Molt	2nd Molt	3rd Molt	4th Molt	5th Molt
Nigger Creek No. 6	July 9	July 21	July 28	Aug. 4	Aug. 13	Aug. 19	Aug. 24
West of Nelson No. 7	July 11	July 23	July 30	Aug. 7	Aug. 12	Aug. 18	Aug. 24
Township No. 14	July 14	July 26	Aug. 4	Aug. 8	Aug. 14	Aug. 19	Aug. 25
Township No. 15	July 16	July 26	Aug. 3	Aug. 8	Aug. 13	Aug. 18	Aug. 24

Summary

1. Time required for complete development of individuals of *Hebrus buenoi* D. & H. varies from thirty-four to sixty-two days.
2. All nymphal instars lack ocelli.
3. Antenna are four-segmented in nymphal instars and five-segmented in the imago.
4. Tarsi are one-segmented in nymphal instars and two-segmented in imago.
5. Setae change in number and arrangement as insect advances from one instar to next.

6. Activities of individuals of all instars are similar.
7. Molting activities are similar with individuals of all instars.

Hebrus sobrinus Uhler

(Plate III)

Females taken at Green's Lake on May 8, 1948, were laying on May 11. The eggs were placed in the axils of the moss leaves.

The Egg

Size. Length varies from 0.66 mm. to 0.74 mm.; width varies from 0.228 mm. to 0.330 mm.

Shape. Elongate oval; eggs of Hebrus sobrinus Uhler are narrower in proportion to length than are eggs of Hebrus burmeisteri L. & S. or Hebrus buenoi D. & H. Eggs of Hebrus sobrinus Uhler have nipple on end containing micropyle.

Color. Freshly laid egg grayish-white, changing to cream as incubation time lengthens.

Incubation period. Varies from nine to twelve days; red eyespots appear in four to five days varying with individual eggs; outline of embryo appears clearly two days before hatching;

head of embryo toward end containing micropyle.

Eclosion. Hatching procedure is similar to that described for individuals of Hebrus burmeisteri L. & S. and Hebrus buenoi D. & H. The nymph molts its embryonic membrane immediately after hatching.

The First Instar (Plate III)

Size. Length of newly emerged insects varies from 0.81 mm. to 0.78 mm.

Color. Body of newly emerged insect creamy-white, changing gradually to a light clay in approximately six hours after hatching; eyes bright red.

The head. Length approximately one-fourth total body measurement; four rows of coarse setae on dorsum, other setae scattered over surface of head; ocelli lacking; antenna four-segmented, first segment extending beyond tylus for approximately one-half diameter of segment, second segment shorter than first, slightly constricted at base, third segment approximately same length as first segment, base constricted into slender pedicel, fourth segment longer than combined length of first three segments; all segments with setae scattered over their surface; beak four-segmented, extending backward to middle of fifth ventral segment of abdomen, first two segments short and approximately equal in size, third segment longer than combined length of other three segments, fourth segment longer than combined length of first and second segments, conical at tip.

The thorax. Pronotum largest tergum, with two rows of coarse setae, one row near anterior border and second row near posterior border; mesonotum and metanotum each with single row across middle of tergum; wing-pads lacking; legs similar to first instar individuals of Hebrus burmeisteri L. & S.

The abdomen. Nine segments in abdomen, each tergum with row of coarse setae across middle; opening of scent gland near anterior border of fourth tergum; caudal appendages lacking.

Activities of first instar individuals. Responses to stimuli are similar to those responses discussed for individuals of Hebrus burmeisteri L. & S.

The stadium. This period varies from four to six days.

Ecdysis. Molting procedure of first instar resembles that described for Hebrus burmeisteri L. & S.

The Second Instar (Plate III)

Size. Length 1.7 mm.; width across abdomen, 0.62 mm.

Color. Body of newly emerged insect creamy-white, gradually changing to clay in approximately thirty-six hours; eyes bright red changing gradually to dark red.

The head. Length approximately one-third of total body measurement; setae scattered abundantly over entire surface of dorsum; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to first instar; beak four-segmented, extending backward to middle of third ventral segment of abdomen, shape and segmental ratio similar to first instar.

The thorax. Setae more numerous than in first instar, rows no longer differentiated in second instar; wing-pads lacking; legs with segmental ratio similar to first instar.

The abdomen. Two rows of setae on each tergum, row of coarse setae along posterior border and another row of smaller setae anterior to first row, other setae scattered over surface of terga; opening of scent gland near anterior border of fourth tergum; caudal appendages lacking.

Activities of second instar individuals. Reactions of individuals of second instar similar to those of individuals of Hebrus burmeisteri L. & S.

The stadium. Variation of this period is from five to nine days for different individuals.

Ecdysis. Molting procedure for second instar individuals is similar to that discussed for Hebrus burmeisteri L. & S. Individuals vary from sixteen to forty-eight minutes in freeing themselves from the old exuviae.

The Third Instar (Plate III)

Size. Length, 1.17 mm.; width across abdomen, 0.62 mm.

Color. Body of newly emerged insect creamy-white, changing gradually to clay in approximately thirty-six hours; eyes of newly emerged individual bright red changing to dark red.

The head. Length approximately one-third total body measurement; setae numerous and scattered over dorsum; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to second instar; rostrum four-segmented, extending

backward to middle of third ventral segment of abdomen, shape and segmental ratio similar to that described for second instar.

The thorax. Setae similar in arrangement and number to those on thorax of second instar; wing-pads indicated by evaginations on posterior border of mesonotum and metanotum; legs similar to first instar.

The abdomen. More setae than in second instar, arrangement of rows similar to that of second instar; opening of scent gland near anterior border of fourth tergum.

Activities of third instar individuals. Responses to stimuli by individuals of third instar is like that described for third instar Hebrus burmeisteri L. & S.

The stadium. Variation of this period is from six to eleven days.

Ecdysis. Molting procedure is similar to that discussed for individuals of Hebrus burmeisteri L. & S. Individuals of Hebrus sobrinus Uhler required from fourteen to fifty-seven minutes to free themselves from the old exuviae.

The Fourth Instar (Plate III)

Size. Length, 1.39 mm.; width across abdomen, 0.68 mm.

Color. Newly emerged individuals creamy-white changing gradually to clay, final color darker than that of individuals of third instar; eyes light red upon emerging but changing to dark red.

The head. Length slightly less than one-third total body measurement; setae similar in arrangement and number to those

described for third instar; ocelli lacking; antenna four-segmented, first segment extending nearly one-half its length beyond tip of tylus, base globose, diameter of first segment greater than any of the other segments, second segment shortest, third segment approximately same length as first, base constricted into narrow pedicel, fourth segment approximately as long as combined length of first and second segments; all segments with setae scattered over their surface; beak four-segmented, first two segments short, cuboidal in shape, third segment approximately as long as combined length of other three segments, widening slightly for first third of length then decreasing gradually toward distal end, distal end slightly narrower than proximal end; fourth segment longer than combined length of first and second segments, conical in shape.

The thorax. Terga with setae scattered abundantly over their surface; wing-pads of mesonotum longer than those of metanotum; legs similar in shape and segmental ratio to third instar.

The abdomen. Setae not in distinct rows as in third instar, greatly increased in number from third instar; opening of scent gland near anterior border of fourth tergum.

Activities of fourth instar individuals. Activities of individuals of fourth instar similar to those discussed for individuals of Hebrus burmeisteri L. & S.

The stadium. Variation of this period is from six to seven days for different individuals.

Ecdysis. Molting procedure is similar to that discussed for individuals of Hebrus burmeisteri L. & S.

The Fifth Instar (Plate III)

Size. Length, 1.81 mm.; width across abdomen, 0.88 mm.

Color. Body of newly emerged nymph creamy-white, gradually changing to dark clay in approximately forty-eight hours; eyes of newly emerged insect light red changing to dark red.

The head. Length approximately one-fourth of total body measurement; setae abundant on dorsum; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to that of fourth instar; beak four-segmented, extending backward to middle of second abdominal segment, similar in shape to that of fourth instar.

The thorax. Setae abundant on terga; wing-pads extending backward to middle of fourth abdominal tergum, wing-pads of mesonotum completely cover those of metanotum, wing-pads of metanotum slightly shorter than those of mesonotum; pair of pits near medial longitudinal line of each tergum. Oval depression between wing-pads described for individuals of Hebrus burmeisteri L. & S. absent.

The abdomen. Setae scattered abundantly over surface of all terga; opening of scent gland near anterior border of fourth tergum.

Activities of fifth instar individuals. Responses to various stimuli by individuals of fifth instar similar to those described for fifth instar individuals of Hebrus burmeisteri L. & S.

The stadium. Variation in this period is from nine to twenty days for different individuals.

Ecdysis. Molting procedure was not observed for individuals of this instar.

The Adult

The newly emerged adult is creamy-white, with light red eyes. Black setae are scattered over the body. The color darkens gradually for five to eight days. The wings of the newly emerged adult are short and wrinkled. The wings elongate and straighten as the body fluid is forced into the veins. The antennae are five-segmented and ocelli are present.

Summary

1. Time required for complete development of individuals of this species varies from thirty-nine to sixty-two days.
2. All nymphal instars lack ocelli.
3. Antenna is four-segmented in nymphal instars and five-segmented in the imago.
4. Tarsi are one-segmented in all nymphal instars.
5. Setae change in arrangement and number as the individual develops.
6. Activities of individuals of all instars are similar.
7. Newly emerged individuals of all instars are creamy-white changing gradually to clay color. Older nymphs are darker than younger nymphs.

Life Histories of Two Species of the Genus Merragata White

Merragata hebroides White

Members of the genus Merragata are more aquatic in habit than are those of the genus Hebrus. Merragata was rarely taken on the shore whereas Hebrus was rarely taken on the water. I have never observed individuals of the genus Hebrus submerge themselves willingly while those of the genus Merragata quickly enter the water when disturbed. Individuals of Merragata hebroides White are poor fliers. They will attempt flight when an object approaches them. I have seen them rise from twelve to eighteen inches above the surface of the water and fly for a distance of five or six feet. These insects will often use their wings to increase their speed when running over the surface of the water.

A group of Merragata hebroides White was collected at Brown's Marsh northeast of Lawrence on May 26, 1946. The females of this group were laying on May 27. The eggs were placed on the leaves of moss in a manner similar to that described for Hebrus burmeisteri L. & S. Eggs were also deposited under filaments of algae growing on stones and in the small holes on the surface of the stones. The eggs were attached by a gelatin like that described for Hebrus burmeisteri L. & S.

The Egg (Plate IV; fig. 3)

Size. Length of freshly laid egg, 0.46 mm.; width, 0.27 mm.

Shape. Oval elongate; nipple on end containing micropyle.

Color. Freshly laid egg milky-white, changing gradually to light cream as embryo develops.

Incubation period. Varies from nine to twleve days; red eyespots show in from four to six days; segments of antenna, legs and beak distinguishable two days before eclosion; long black setae appearing at same time; abdominal segments also visible two days before eclosion.

Eclosion. The chorion ruptures in the same manner as that described for Hebrus burmeisteri L. & S. The embryo works its way out of the egg by a series of peristaltic-like movements of the body. The embryo is enclosed in an embryonic membrane like that described for individuals of the first instar of Hebrus burmeisteri L. & S. The embryonic membrane is molted immediately after the embryo frees itself from the egg.

The First Instar (Plate IV)

Size. Length, 0.49 mm.; width across abdomen, 0.27 mm.

Color. Body of newly emerged nymph milky-white, changing gradually to light clay; eyes light red changing to deep crimson; color change complete in approximately six hours.

The head. Length approximately one-third of total body measurement; four rows of setae on dorsum, other setae scattered over surface of dorsum; ocelli lacking; antenna four-segmented, first segment longer than second, globose at base, second segment shortest, barrel-shaped, third segment equal in length

to first segment, base constricted into narrow pedicel, fourth segment shorter than combined length of first and second segments; all segments with setae scattered over their surface; beak four-segmented, extending backward to middle of sixth abdominal segment, first segment short, cuboidal, second segment approximately one-fourth longer than first segment, third segment longest, nearly as long as combined length of other three segments, fourth segment approximately as long as combined length of first and second segments, conical in shape.

The thorax. Two rows of setae on pronotum, one row near anterior border and second row near posterior border; mesonotum and metanotum each with single row near posterior border of each tergum; wing-pads lacking; legs similar to first instar Hebrus burmeisteri L. & S.

The abdomen. Nine segments in abdomen; each tergum with row of coarse setae extending laterally from near medial longitudinal line, no setae on area along medial longitudinal line; opening of scent gland on anterior border of fourth abdominal tergum; caudal appendages lacking.

Activities of first instar individuals. Response to nearby movements, such as removal of the cover of the stender, is quick and usually results in submergence of the insect. In breaking through the surface film which ordinarily supports the insect, it elevates the posterior end of its body until it is almost vertical with the water surface; the hind legs are then brought

upward and forward over the head and make contact with the water. The surface film becomes attached to the legs and literally a "sheet" of water is drawn over the insect. Wetting of the body itself is prevented by a thin layer of air trapped in the setae which clothe most of the insect. The legs, beak and compound eyes are not enclosed by this layer of air. The antennae are pushed back against the head and thorax as the water covers the insect. The insect, after becoming submerged, can walk on the under side of the surface film. Also, it can swim slowly through the water by a walking motion of the legs. I have never observed one to use its legs in a coordinated swimming motion. When the insect is on emergent vegetation it will walk down the stem forcing its way beneath the surface. When the insect is on floating plants, such as Lemna sp., it will walk over the edge of the leaf and submerge itself by clinging to the under side of the leaf. The nymphs have difficulty penetrating the surface film. Usually several attempts must be made before they are successful. Even after the insects have succeeded in submerging, the layer of air around the bodies may be thick enough to buoy them to the surface again.

The insects have been observed to feed on zooplankters caught in the surface film. The nymphs also fed on freshly killed insects that were dropped into the dishes. I have never observed them to feed on plant material.

The stadium. This period varies from three to seven days.

Ecdysis. There is a line of weakness in the exoskeleton beginning as a medial longitudinal line on the posterior border of the metanotum. This line of weakness extends forward to a point near the posterior border of the vertex where it divides to form a Y. The branches of the Y extend forward above the compound eyes and continue on to the parietal region. The initial rupture of the exoskeleton occurs through this line of weakness, progressing forward to a point approximately midway on the parietal region. As the emerging insect forces its way through the opening, the exuviae tears along the thoracic-abdominal border of the terga. The insect forces its body out of the old exuviae by motions like those described for first instar individuals of Hebrus burmeisteri L. & S. Time required to free themselves from the old exuviae varied from eight to thirty-six minutes.

The Second Instar (Plate IV)

Size. Length, 0.65 mm.; width across abdomen, 0.34 mm.

Color. Body of newly emerged nymph milky-white, changing gradually to clay; eyes light red changing to deep crimson; approximately twelve hours necessary for color change to be completed.

The head. Length approximately one-third total body measurement; setae not in rows as in first instar but scattered abundantly over dorsum; ocelli lacking; antenna four-segmented, first segment not reaching tip of tylus, base globose, second segment

shortest, expanding slightly from proximal to distal end; third segment approximately same length as first segment, with base constricted into narrow pedicel, fourth segment longer than combined length of first and second segments, conical in shape; all segments with setae scattered over their surface; beak four-segmented, extending backward to anterior border of third ventral segment of abdomen, shape and segmental ratio similar to that described for first instar.

The thorax. Setae increased in number from that of first instar, two rows of coarse setae on pronotum, other setae scattered over surface of pronotum; also increase in setae on mesonotum and metanotum from that of first instar; wing-pads lacking; legs similar to first instar.

The abdomen. Setae more abundant than in first instar; opening of scent gland near anterior border of fourth tergum; caudal appendages lacking.

The stadium. This period varies from two to four days.

Ecdysis. Molting procedure is like that described for first instar individuals.

The Third Instar (Plate IV)

Size. Length, 0.92 mm.; width across abdomen, 0.48 mm.

Color. Body of newly emerged nymph milky-white changing gradually to clay; eyes light red changing to dark crimson; final color of insect darker than second instar.

The head. Length slightly less than one-third total body measurement; setae abundant on dorsum giving head exceedingly hairy appearance; ocelli lacking; antenna four-segmented, first three segments approximately same length, first segment globose at base, third segment with base constricted into narrow pedicel, fourth segment slightly shorter than combined length of first and second segments; all segments with setae scattered over their surface; beak four-segmented, extending backward to middle of third abdominal segment; shape and segmental ratio similar to first instar.

The thorax. Setae like those of second instar; mesonotum with two evaginations indicating developing wing-pads, evaginations extending backward approximately one-eighth of distance across metanotum; metanotum with but slight swellings indicating development of wing-pads.

The abdomen. Like that of second instar.

Activities of third instar individuals. Responses to stimuli by third instar individuals are like those of first instar individuals.

The stadium. This period varies from two to three days.

Ecdysis. Molting procedure is like that described for first instar individuals.

The Fourth Instar (Plate IV)

Size. Length, 1.15 mm.; width across abdomen, 0.55 mm.

Color. Body of newly emerged nymph milky-white changing

gradually to dark clay; eyes light red changing to dark crimson.

The head. Length one-third total body measurement; setae as in third instar; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to that described for third instar; beak four-segmented, extending backward to middle of second abdominal segment, shape and segmental ratio similar to that described for first instar.

The thorax. Setae scattered abundantly over terga; wing-pads of mesonotum extending backward to middle of first abdominal segment, wing-pads of metanotum covered by those of mesonotum, extending only to anterior border of second abdominal segment; legs similar in shape and segmental ratio to those of first instar.

The abdomen. Setae like those of third instar; opening of scent gland near anterior border of fourth tergum; caudal appendages lacking.

Activities of fourth instar individuals. This insect responds to stimuli in the same manner as that described for first instar individuals.

The stadium. Variation of this period is from three to seven days for various individuals.

Ecdysis. Molting procedure is like that described for first instar individuals.

The Fifth Instar (Plate IV)

Size. Brachypterous form: length, 1.35 mm.; width across abdomen, 0.71 mm. Macropterous form: length, 1.65 mm.; width

across abdomen, 0.79 mm.

Color. Both brachypterous and macropterous forms. Body of newly emerged nymph milky-white changing gradually to dark clay; eyes light red changing to dark crimson.

The head. Both brachypterous and macropterous form. Length one-third of total body measurement; setae abundant; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to third instar; beak four segmented, extending backward to anterior border of first abdominal segment, shape and segmental ratio similar to first instar.

The thorax. Brachypterous form: Abundant setae; wing-pads elongated but slightly from that of third instar, extending backward to middle of second abdominal segment, wing-pads of mesonotum longer than those of metanotum. Macropterous form: Abundant setae; wing-pads extending backward to anterior border of fourth abdominal tergum; wing-pads of mesonotum completely cover wing-pads of mesonotum.

The abdomen. Alike in both forms; with abundant setae; opening of scent gland near anterior border of fourth abdominal tergum.

Activities of fifth instar individuals. Responses to stimuli by individuals of this instar are like those of individuals of first instar.

The stadium. Variation of this period is from three to six days for different individuals.

Ecdysis. Molting was not observed for individuals of this instar.

The Adult

The adult is milky-white when newly emerged from fifth instar exuviae. The body is covered with coarse black setae. The eyes are bright red. The wings are folded and wrinkled, expanding slowly as the body fluid is forced into the veins and in approximately forty-five minutes are completely expanded. The adults have two ocelli. The antenna is apparently four-segmented. There is a small segment between the third and fourth segments that is not counted, since cleared specimens show this segment plainly but it is difficult to see in uncleared antenna. There is an annulation at the base of the fourth segment.

Notes on Life Cycle of Individuals

No.	Egg Laid	Hatched	1st Molt	2nd Molt	3rd Molt	4th Molt	5th Molt
M-7	July 16	July 27	July 30	Aug. 1	Aug. 3	Aug. 7	Aug. 14
M-8	July 17	July 28	Aug. 4	Aug. 6	Aug. 8	Aug. 14	Aug. 17
M-8-3	July 17	July 28	Aug. 1	Aug. 5	Aug. 8	Aug. 12	Aug. 17
M-10	July 20	Aug. 1	Aug. 6	Aug. 9	Aug. 12	Aug. 19	Aug. 23
M-11	July 22	Aug. 1	Aug. 5	Aug. 8	Aug. 11	Aug. 14	Aug. 20
M-16	July 24	Aug. 2	Aug. 7	Aug. 10	Aug. 14	Aug. 17	Aug. 23

Summary

1. All nymphal instars lack ocelli.
2. The antennae are four-segmented in nymphal instars.
3. Tarsi are one-segmented in nymphal instars.
4. Time required for various individuals to become adults varies from twenty to thirty-six days.
5. Setae increase in number and arrangement in successive instars.
6. Activities of all instars are alike.
7. Molting procedure is alike with individuals of all instars.

Merragata brunnea Drake

Merragata hebroides White and Merragata brunnea Drake were collected in the same localities; for example, at Lakeview and at the oxbow lake three miles northeast of Lawrence, Kansas. Merragata brunnea Drake was not so plentiful as Merragata hebroides White. The membrane of the wings of Merragata brunnea Drake are white whereas the membrane of the wings of Merragata hebroides White are smoky with four white spots.

Females brought into the laboratory on May 28, 1947, were laying on May 29. Eggs were placed on the moss leaves and under algae in the same manner as that described for Merragata hebroides White

The Egg

Size. Freshly laid eggs vary in length from 0.36 mm. to

0.408 mm.; width varies from 0.180 mm. to 0.198 mm.

Shape. Similar to the eggs of Merragata hebroides White.

Color. Like that of Merragata hebroides White

Incubation period. Variation of hatching time is from eight to twelve days. The egg enlarges as the embryo develops, increase in size stopping in four to five days. Red eyespots show through the chorion in four to seven days. Segments of the antennae, legs and beak are distinguishable two days before eclosion. Long black setae appear on the dorsum as the segments of the body begin to show.

Eclosion. Identical to individuals of Merragata hebroides White.

The First Instar (Plate V)

Size. Length, 0.55 mm.; width across abdomen, 0.29 mm.

Color. Body of newly hatched nymph milky-white changing gradually to light clay; eyes light red.

The head. Length approximately one-fourth total body measurement; setae like those described for first instar Merragata hebroides White; ocelli lacking; antenna four-segmented; first segment extending forward for approximately three-fourths the length of tylus, base globose, second segment shortest, barrel-shaped, third segment slightly longer than first, base constricted into narrow pedicel, fourth segment slightly longer than combined length of first and third segments; beak four-segmented, extending backward to middle of third segment

of abdomen, shape and segmental ratio similar to first instar Merragata hebroides White.

The thorax. Two rows of coarse setae on pronotum, one row near anterior border and second row near posterior border, other setae scattered over surface of pronotum; mesonotum and metanotum each with one row across middle of terga, other setae scattered over surface of terga; wing-pads lacking; legs similar to first instar Merragata hebroides White.

The abdomen. Nine segments in abdomen; each tergum with row of coarse setae extending laterally from near medial longitudinal line, medial longitudinal space without setae; opening of scent gland near anterior border of fourth tergum.

Activities of first instar individuals. Responses to stimuli by first instar individuals of Merragata brunnea Drake are like those discussed for first instar individual Merragata hebroides White.

The stadium. This period varies from three to six days.

Ecdysis. Molting procedure of first instar individual Merragata brunnea Drake is like that discussed for Merragata hebroides White.

The Second Instar (Plate V)

Size. Length, 0.68 mm.; width across abdomen, 0.25 mm.

Color. Body of newly emerged nymph milky-white changing gradually to light clay; eyes bright red.

The head. Length approximately one-third of total body length; coarse setae scattered over dorsum; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to first instar; beak four-segmented, shape and segmental ratio similar to first instar.

The thorax. Like second instar Merragata hebroides White.

The abdomen. Like second instar Merragata hebroides White.

Activities of second instar individuals. Responses to stimuli by second instar individuals are like those described for second instar individuals of Merragata hebroides White.

The stadium. Variation of this period is from three to four days.

Ecdysis. Molting procedure of individuals of this instar is like that described for individuals of second instar Merragata hebroides White.

The Third Instar (Plate V)

Size. Length varies from 0.81 mm. to 0.83 mm.; width across abdomen varies from 0.41 to 0.45 mm.

Color. Body of newly emerged nymph milky-white changing gradually to clay; eyes bright red.

The head. Length slightly less than one-third of total body measurement; setae abundant on dorsum; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to second instar; beak four-segmented, shape and segmental ratio similar to second instar.

The thorax. Setae increased in number from second instar; rows of setae not distinguishable on pronotum; wing-pads lacking; legs with segmental ratio and shape similar to second instar.

The abdomen. Setae abundant on terga; not in rows; opening of scent gland near anterior border of fourth tergum.

Activities of third instar individuals. Responses to stimuli of the third instar individuals are similar to those described for individuals of the first instar.

The stadium. Variation of this period is from three to four days for different individuals.

Ecdysis. I did not observe individuals of this instar molt.

The Fourth Instar (Plate V)

Size. Length varies from 1.32 mm. to 1.39 mm.; width across abdomen, 0.66 mm to 0.68.mm.

Color. Body of newly emerged nymph milky-white changing gradually to dark clay; eyes bright red.

The head. Length slightly more than one-fourth total body measurement; setae abundant; ocelli lacking; antenna four-segmented, shape and segmental ratio similar to third instar; beak four-segmented, extending backward to anterior border of first abdominal segment, shape and segmental ratio similar to conditions in first instar.

The thorax. Dorsum of thorax with exceedingly hairy appearance; setae scattered abundantly over terga; wing-pads of

mesonotum and metanotum extending backward to anterior border of second abdominal tergum, wing-pads of mesonotum completely cover those of metanotum.

The abdomen. Like that of third instar.

Activities of fourth instar individuals. Responses to stimuli of fourth instar individuals are like those of first instar individuals.

The stadium. Variation of this period is from five to six days for different individuals.

Ecdysis. I did not observe fourth instar individuals molt.

The Fifth Instar (Plate V)

Size. Length varies from 1.61 mm. to 1.69 mm.

Color. Body of newly emerged nymph milky-white changing gradually to dark clay; eyes bright red.

The head. Length approximately one-fourth total body length; setae like those described for fourth instar; ocelli lacking; antenna four-segmented, shape and segmental ratio same as described in third instar; beak four-segmented, extending backward to middle of third sternum.

The thorax. Setae abundant on all terga; wing-pads of mesonotum and metanotum extend slightly beyond anterior border of fourth abdominal tergum, wing-pads of mesonotum completely cover those of metanotum.

The abdomen. Like that described for fourth instar nymph.

Activities of fifth instar individuals. Responses to stimuli by this insect are like those described for the first instar.

The stadium. This period varies from five to six days.

Ecdysis. Molting procedure was not observed for individuals of this instar.

The Adult

The newly emerged adult is milky-white changing gradually to the adult colors in six to eight days. The time for color change to become complete varies with different adults as with the nymphs. The eyes are light red upon emerging from exuviae; and this color is retained by the adults. There are two ocelli. The tarsi are two-segmented. The antennae are similar to those described for adults of Merragata hebroides White.

Summary

1. The developmental period is approximately the same as that of Merragata hebroides White.
2. All nymphal instars lack ocelli. Imago has ocelli.
3. Antennae of nymphs are four-segmented.
4. The adults have a minute segment, between third and fourth segments, which is lacking in the nymphal instars.
5. The nymphal instars have a single tarsal segment; imago has two.

6. Setae increase in number, and arrangement changes as insect develops from one instar to the next.
7. Activities of all nymphal instars are alike.

Generic Crosses in the Family Hebridae

Crosses of species in the family Hebridae were attempted as follows: Hebrus burmeisteri L. & S. male with Merragata hebroides White virgin female; Merragata hebroides White male with Hebrus burmeisteri L. & S. virgin female; Hebrus buenoi D. & H. male with Merragata hebroides White virgin female; Merragata hebroides White male with Hebrus buenoi D. & H. virgin female; Hebrus sobrinus Uhler male with Merragata hebroides White virgin female; Merragata hebroides White male with Hebrus sobrinus Uhler virgin female; Hebrus buenoi D. & H. male with Merragata brunnea Drake virgin female; and Merragata burnnea Drake male with Hebrus buenoi D. & H. virgin female.

No offspring were produced. Eggs were laid by one female Hebrus buenoi D. & H. that was crossed with Merragata hebroides White but they did not hatch. It is concluded from the results of these attempted crosses that dimorphism is not present and that the genera are distinct.

Summary

1. Parameres of holotype males and paratype males were studied from available species. Differences were found by which species, but not genera, could be separated.
2. Adults of the genera Merragata and Lipogomphus have a four-segmented antenna while the adults of Hebrus have a five-segmented antenna.

3. Males of Lipogomphus have a spur on the distal end of the hind tibia which is lacking on the males of Merragata.
4. Separating species by ratio of segments of the antenna was impossible owing to the small size of the antenna and the difficulty encountered in attempting to place the antenna so their segments could be seen from the same plane.
5. Eggs were placed in a gelatinous mass by the females of all species studied.
6. The chorions of all of the eggs studied had microscopic sculpturing om their surfaces.
7. Eclosion is identical for individuals of all species studied.
8. Incubation periods of eggs studied varied from three to five days in actual hatching time for an individual female.
9. Individuals molted the embryonic membrane as soon as they were freed from the chorions.
10. The stadium of individuals of each instar varied from three to six days.
11. Nymphs of all species studied have a four-segmented antenna, single tarsal segment and opening of scent gland near the anterior border of fourth abdominal segment.
12. Feeding habits of all individuals studied were alike.

13. Individuals of the genus Merragata were more aquatic in their habits than were those of the genus Hebrus.

ACKNOWLEDGMENTS

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of the species could not have been determined. Dr. Reece I. Sailer supplied specimens from the United States National Museum.

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PLATE I

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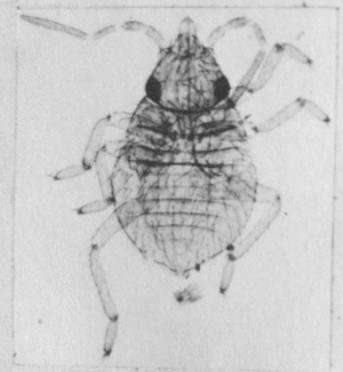

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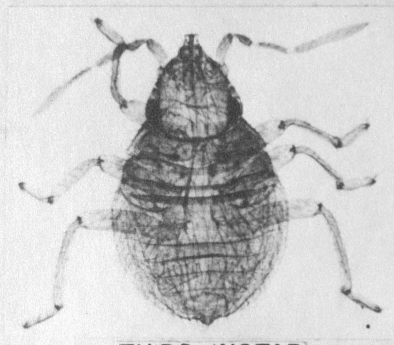

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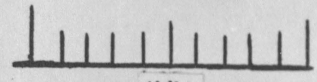

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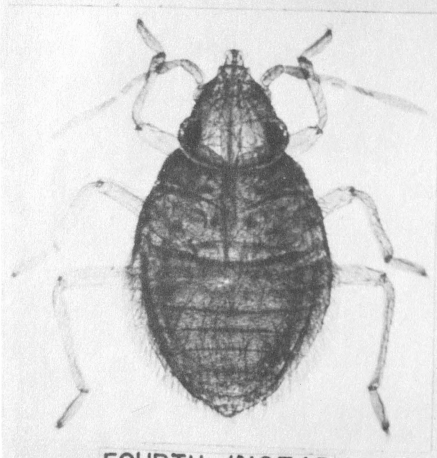

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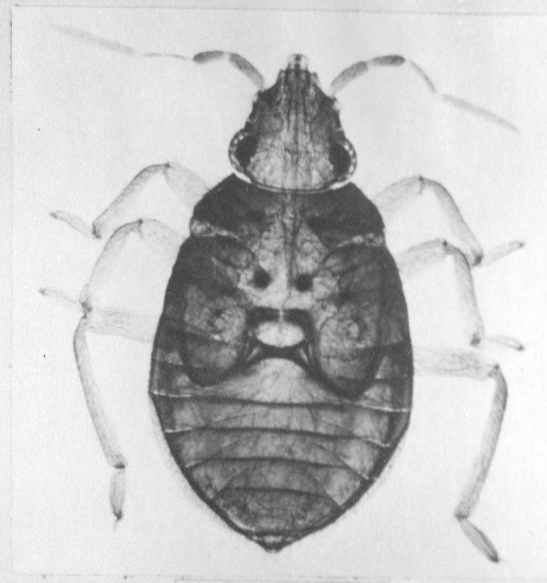

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HEBRUS BURMEISTERI L. & S.

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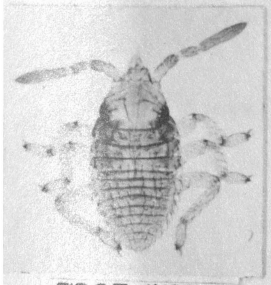

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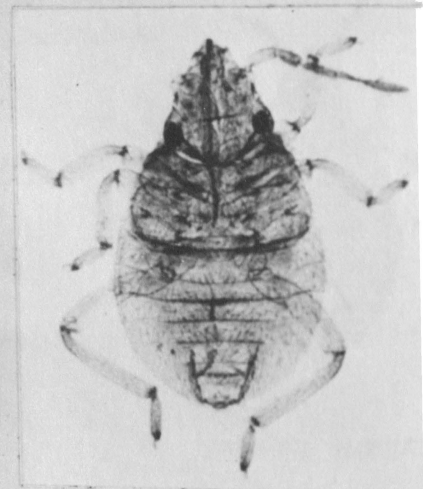
FIG. I



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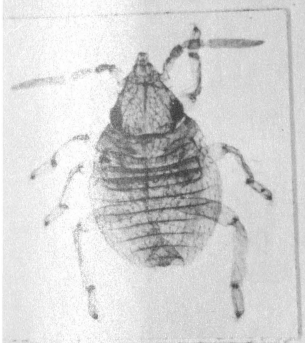

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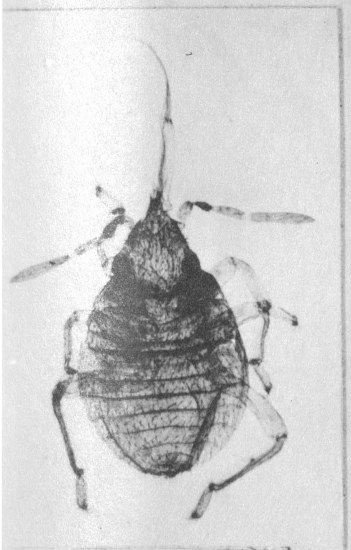

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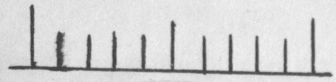

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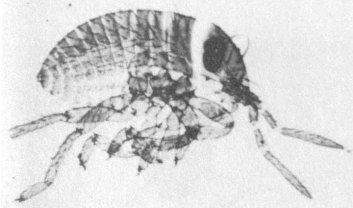
HEBRUS BUENOI D. & H.

PLATE III



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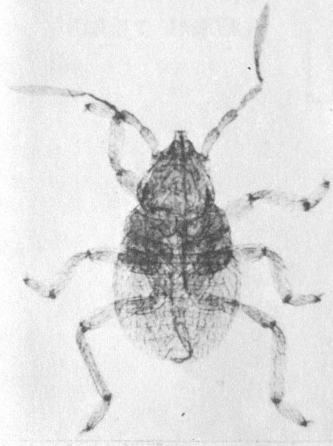

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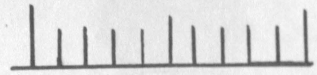

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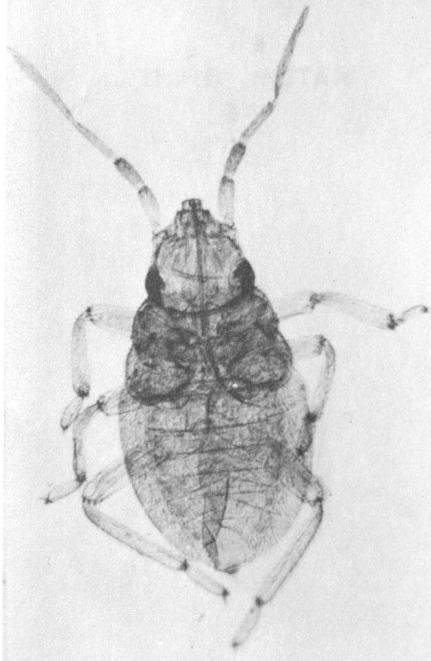
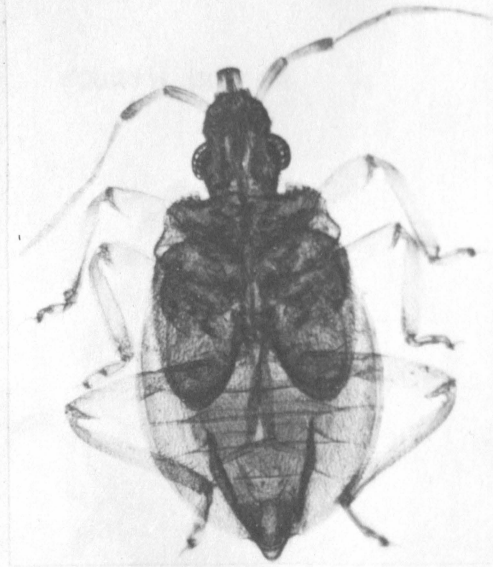


FOURTH INSTAR



FIFTH INSTAR

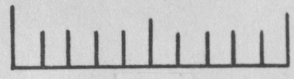
HEBRUS SOBRINUS UHLER

PLATE IV

FIRST INSTAR

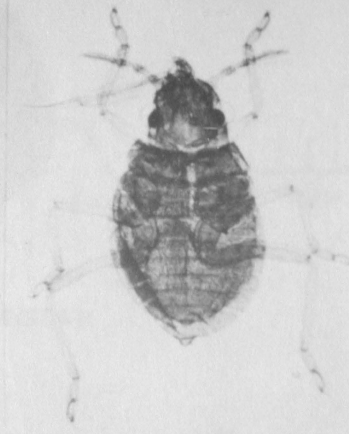
EGG

SECOND INSTAR



IMM.

THIRD INSTAR



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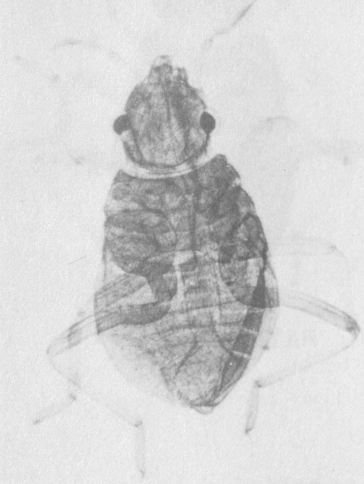
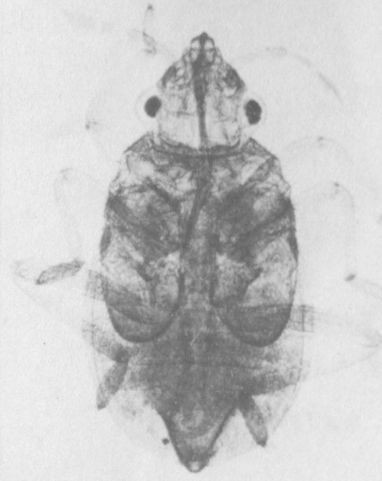


FIFTH INSTAR
BRACHYPTEROUS FORM



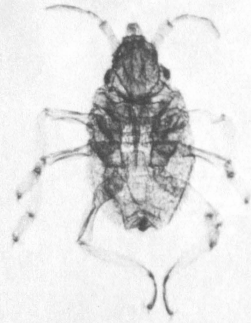
FIFTH INSTAR
MACROPTEROUS FORM

MERRAGATA HEBROIDES WHITE

PLATE V

FIRST INSTAR

SECOND INSTAR



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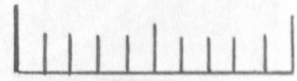

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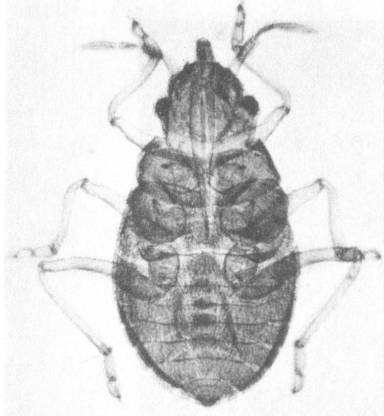

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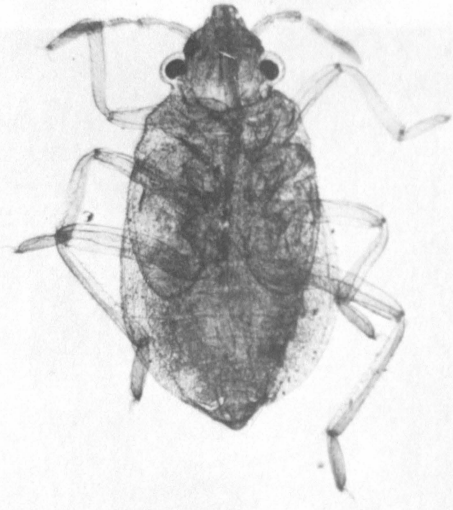


FIFTH INSTAR

MERRAGATA BRUNNEA DRAKE

PLATE VI

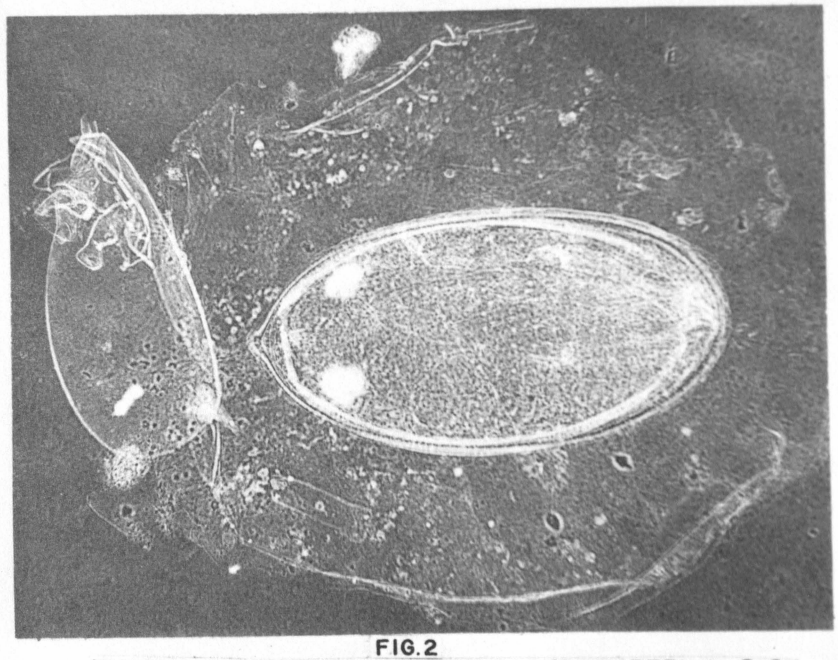


FIG. 2
EMBRYONATED EGG OF *HEBRUS BURMEISTERI* L. & S.

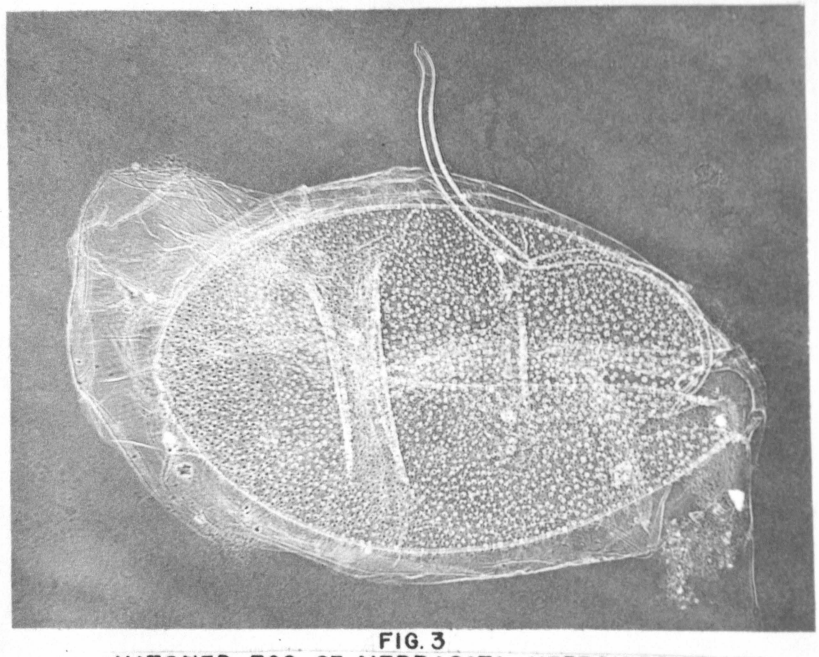


FIG. 3
HATCHED EGG OF *MERRAGATA HEBROIDES* WHITE

PLATE VII

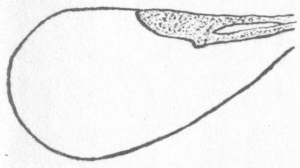


FIG. 4
MERRAGATA BRUNNEA DRAKE

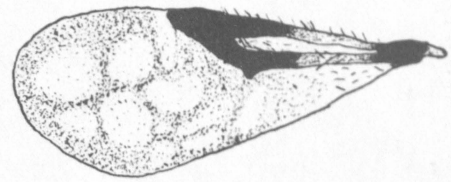


FIG. 6
HEBRUS BUENOI D. & H.

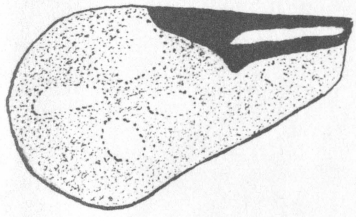


FIG. 5
MERRAGATA HEBROIDES WHITE

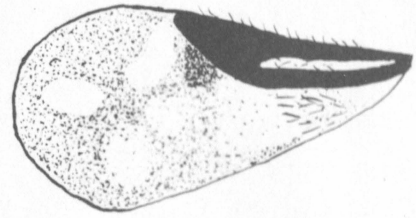
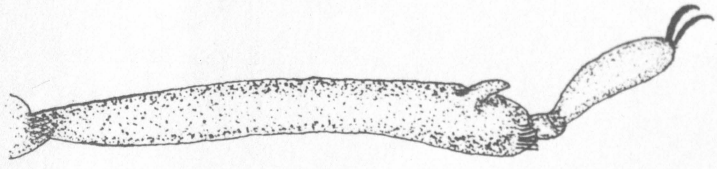


FIG. 7
HEBRUS BURMEISTERI L. & S.



POSTERIOR TIBIA OF LIPOGOMPHUS LACUNIFERA BERG
SHOWING SPINE ON MALE'S LEG

PLATE VIII

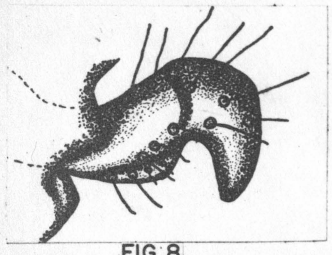
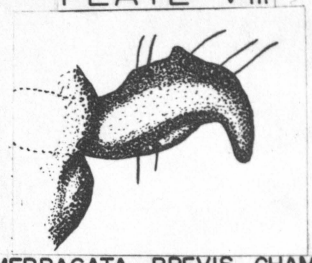


FIG. 8
LIPOGOMPHUS LACUNIFERA BERG



MERRAGATA BREVIS CHAMP
FIG. 9

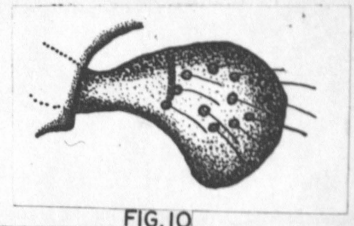
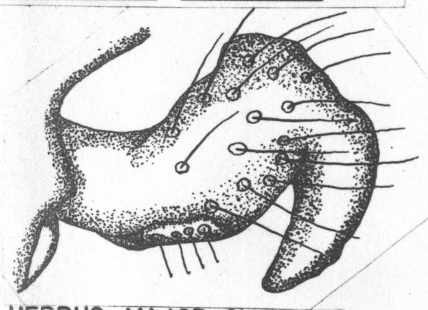
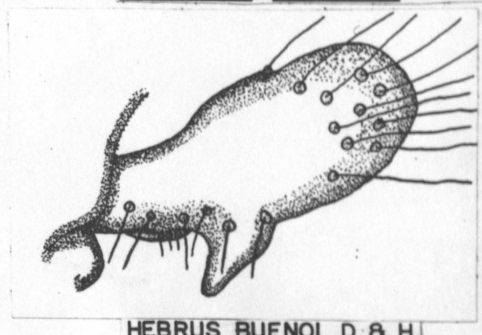


FIG. 10
MERRAGATA HEBROIDES WHITE

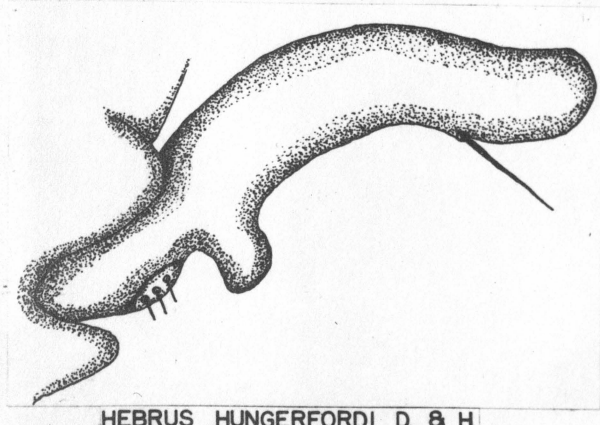


HEBRUS MAJOR CHAMPION
FIG. 11

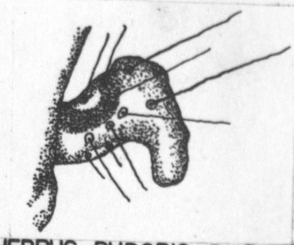


HEBRUS BUENOI D. & H.
FIG. 13

HEBRUS CONSOLIDUS UHLER
FIG. 14

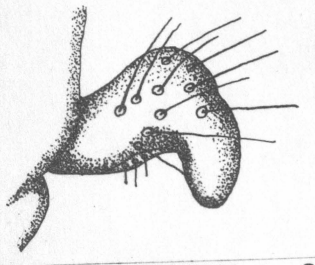


HEBRUS HUNGERFORDI D. & H.
FIG. 12

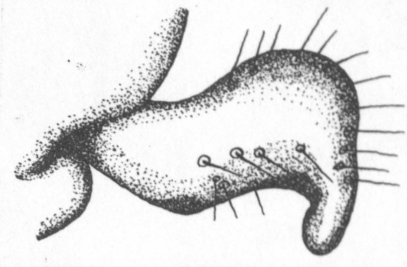


HEBRUS PUDORIS D. & H.
FIG. 15

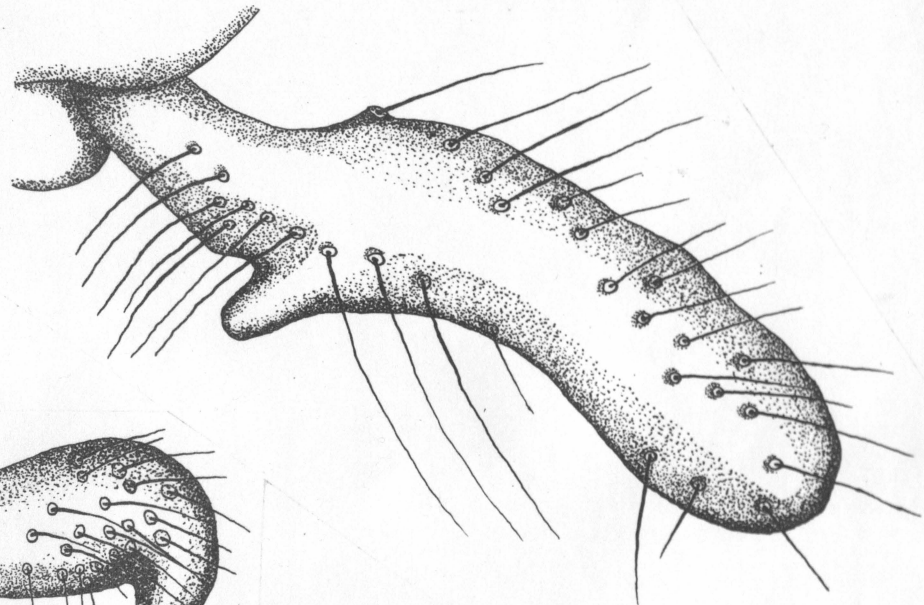
PLATE IX



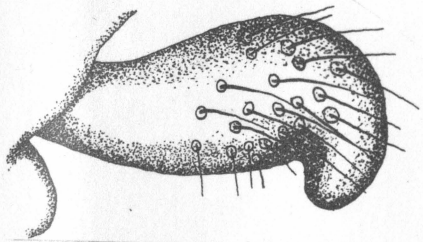
HEBRUS BURMEISTERI L. & S.
FIG.16



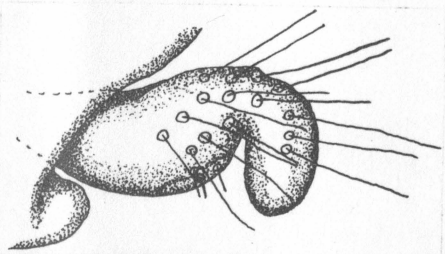
HEBRUS PRISCUS D. & H.
FIG.17



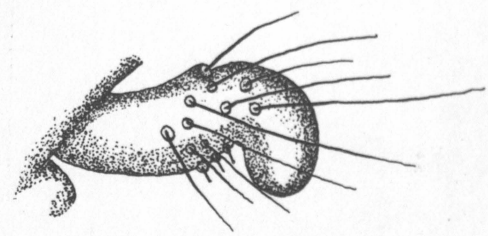
HEBRUS COMATUS D. & H.
FIG.18



HEBRUS CONCINNUS UHLER
FIG.19

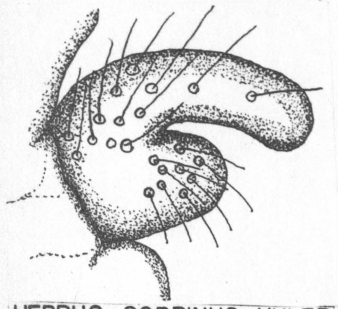


HEBRUS BEAMERI N. S.
FIG. 20

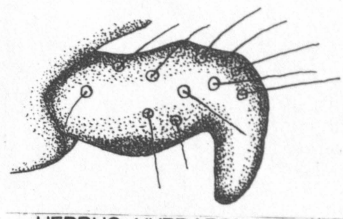


HEBRUS NUBILUS D. & H.
FIG. 21

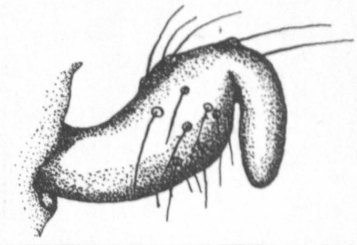
PLATE X



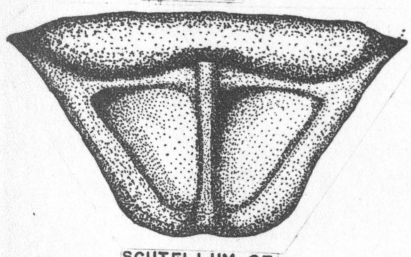
HEBRUS SOBRINUS UHLER
FIG. 22



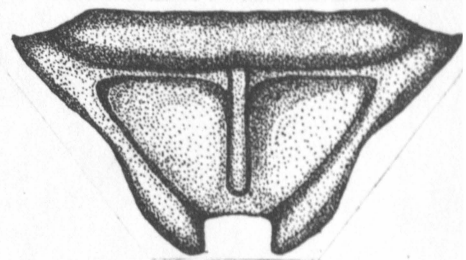
HEBRUS HUBBARDI N. SP.
FIG. 23



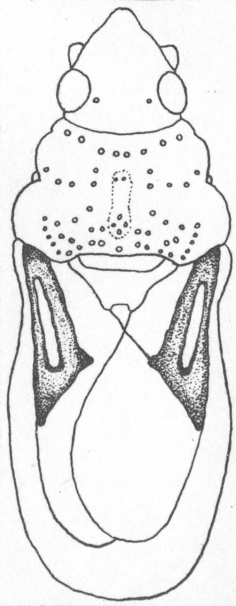
HEBRUS PLAUMANNI N.SP.
FIG. 24



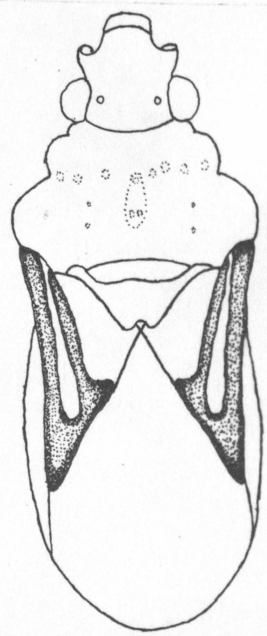
SCUTELLUM OF
HEBRUS BURMEISTERI L. & S.
FIG. 25



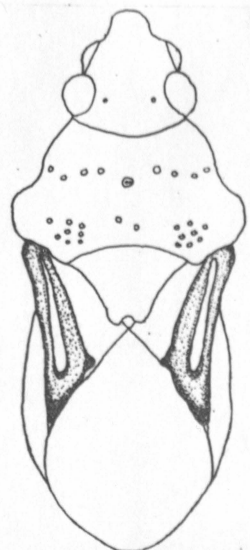
SCUTELLUM OF
HEBRUS BUENOI D. & H.
FIG. 26



HEBRUS BEAMERI N.SP.
FIG. 27



HEBRUS PLAUMANNI N.SP.
FIG. 28



HEBRUS HUBBARDI N.SP.
FIG. 29

PLATE XI

FIG. 29
POOL SOUTH OF THE IRON BRIDGE, CARP CREEK, CHEBOYGAN CO., MICHIGAN.

FIG. 30
LAKEVIEW, DOUGLAS CO., KANSAS.

PLATE XII

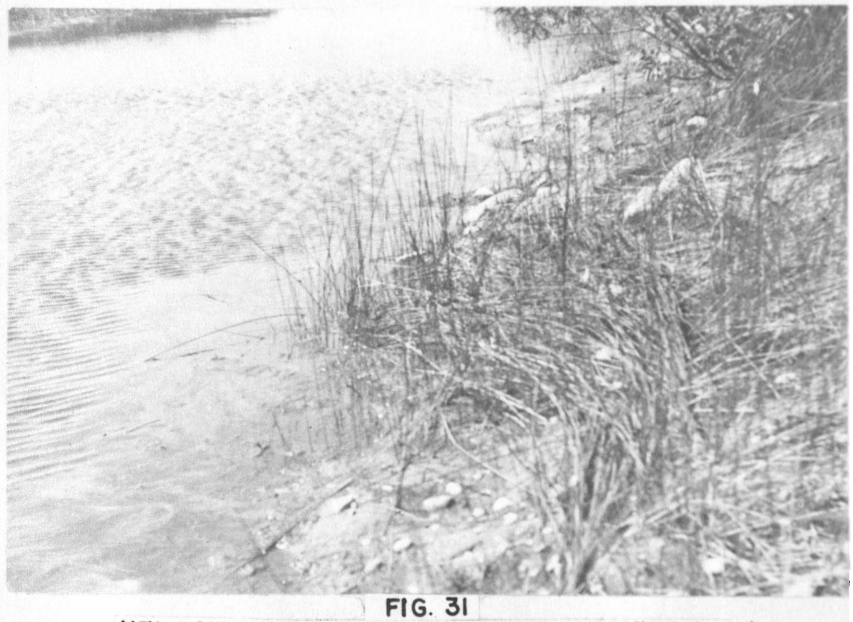


FIG. 31
NELSON LAKE, CHEBOYGAN CO., MICHIGAN.

FIG. 32
GREEN'S LAKE, LAWRENCE, KANSAS