

STUDIES ON THE FAUNA OF CURAÇAO AND OTHER  
CARIBBEAN ISLANDS: No. 50.

THE HETEROPTERA OF THE NETHERLANDS  
ANTILLES - I

FOREWORD

GERRIDAE, VELIIDAE, MESOVELIIDAE (Water Striders)

by

R. H. COBBEN

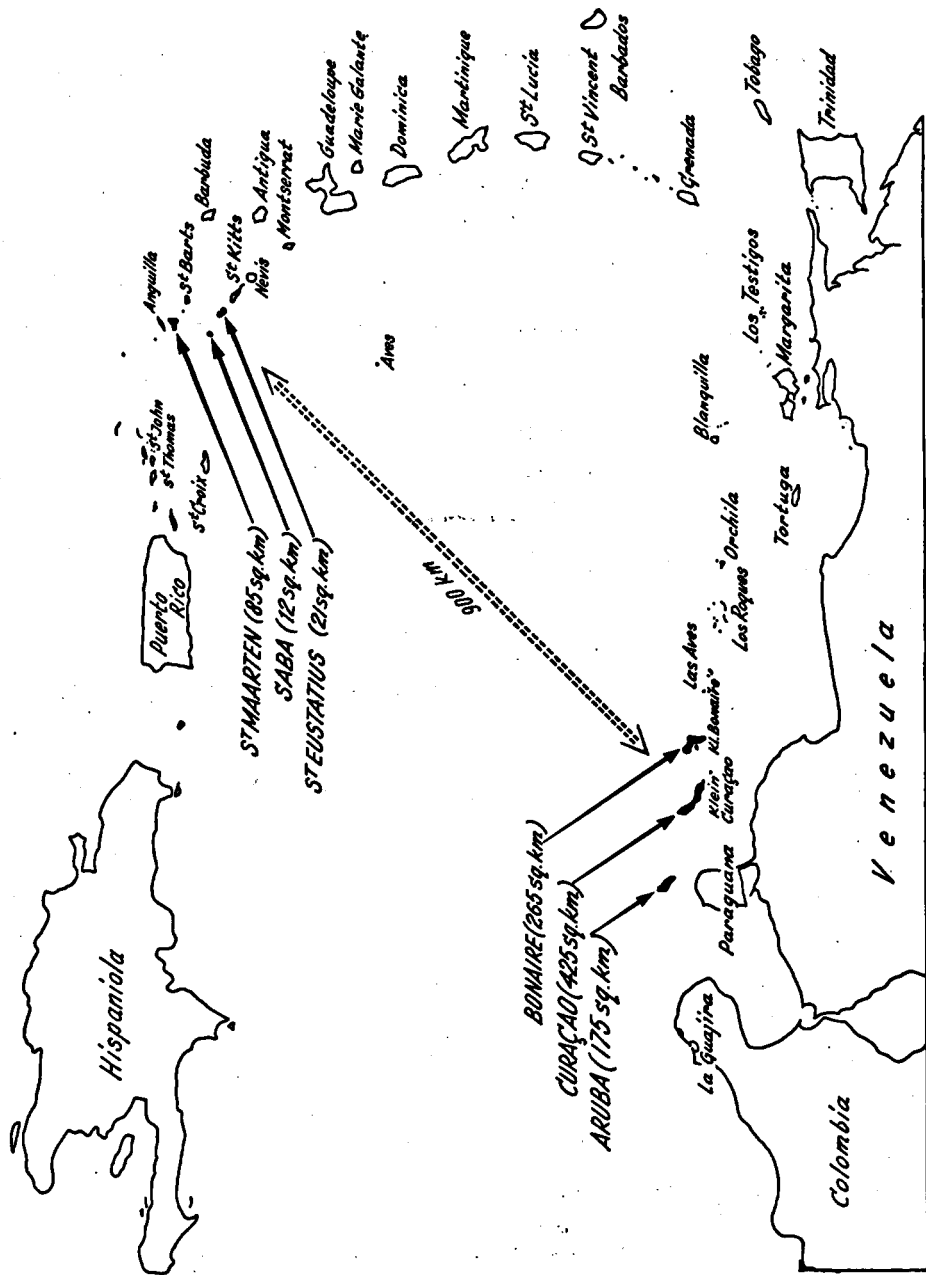
(Laboratorium voor Entomologie, Landbouwhogeschool, Wageningen)

The data concerning the heteropterous fauna of the Netherlands Antilles from which the following series of contributions has been compiled are chiefly the result of an entomological study trip lasting from September 1956 until July 1957. The investigations were carried out under the auspices of, and sponsored by, the *Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen* (Foundation for Scientific Research in Surinam and the Netherlands Antilles), with financial assistance from the Government of the Netherlands Antilles.

I wish to express my appreciation to the Foundation for making it possible for me to undertake this mission.

The periods of residence on the islands concerned were as follows:

Curaçao	7th October – 20th November 1956; 12th January – 1st April 1957; 5th June – 7th July 1957.
Bonaire	3rd May – 5th June 1957.
Aruba	1st April – 3rd May 1957.
St. Martin	20th November – 9th December 1956; 9th – 12th January 1957.
Saba	9th – 27th December 1956.
St. Eustatius	27th December 1956 – 9th January 1957.



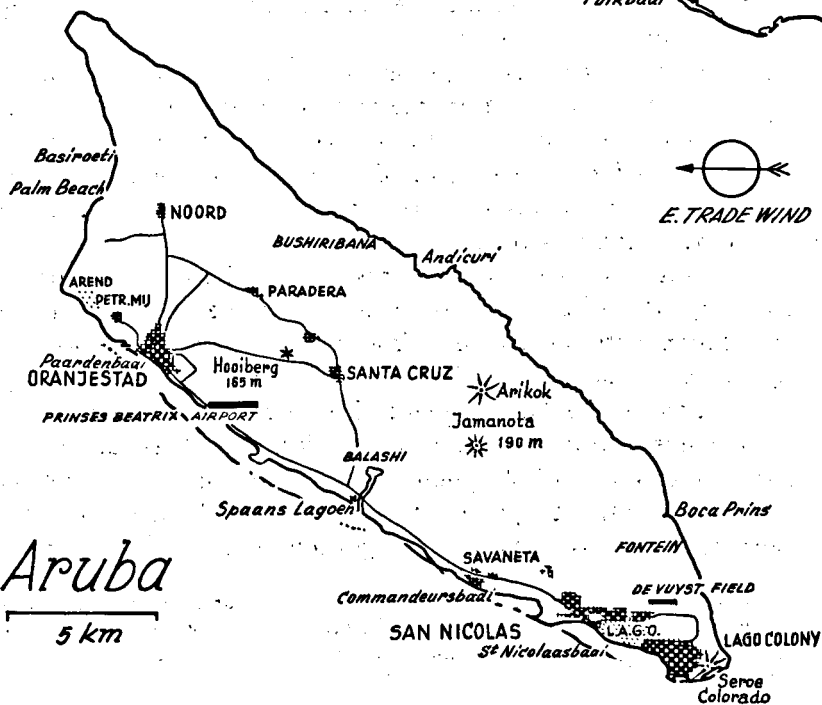
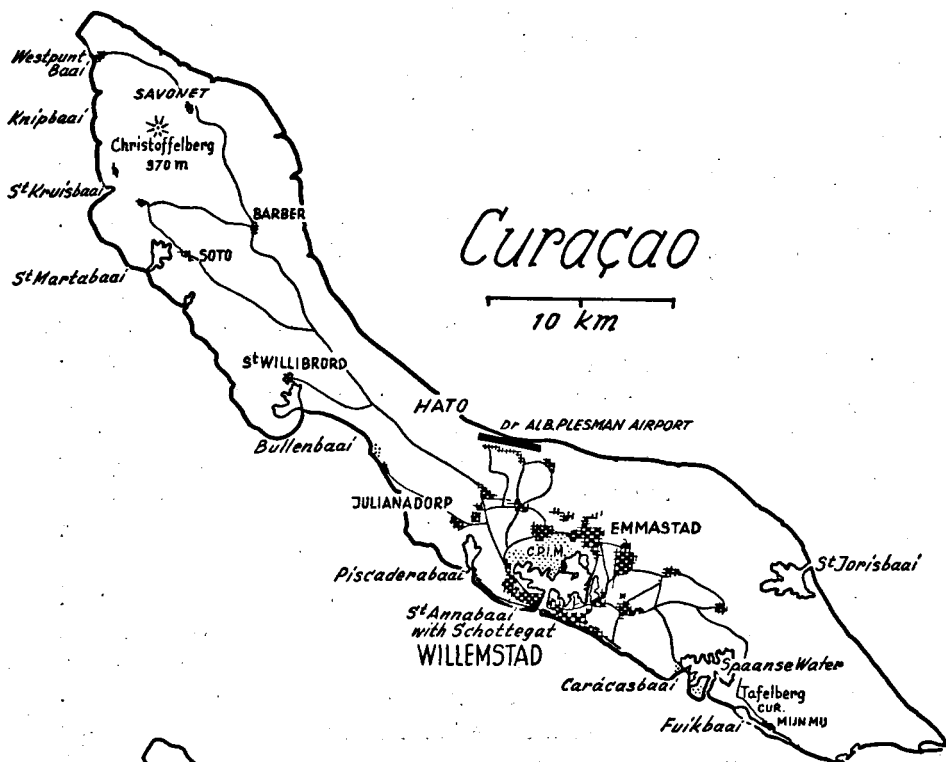
As can be seen from the above, field surveys were carried out in Curaçao, the largest island of the Netherlands Antilles (425 sq. km), during three different periods, viz., in the wet season, the transitional season, and the dry season. The work of collecting went on so intensively, in all the various habitats, up to the very last day, that in the final weeks of our stay in Curaçao no specimens whatever were caught which did not belong to species we had already encountered. As a result of this we feel that our Curaçao collections are fairly complete and, as regards the hemipterous fauna proper, more representative than the collections made from the other islands. The sampling on the latter can only claim to be reasonably complete when considered as pictures of the situation at a certain time.

Since, however, on each of the islands it is possible to find natural or artificial localities where the influence of the dry season on flora and fauna becomes considerably reduced, the data collected will nevertheless enable a comparison to be made between the hemipterous fauna of Curaçao on the one hand and that of the remaining, smaller islands on the other.

In our investigations emphasis was placed on the fauna and ecology of the *Heteroptera* or true bugs, to which the present series relates, and the *Homoptera Auchenorrhyncha* or leaf hoppers s.l., which are to form the subject of another series of publications. However, many insects of other orders were also collected, and special attention was paid to insect pests.

From 15th January 1957 onwards I was assisted in the work by my wife, whose passage was arranged by the above-mentioned Foundation, with financial help from the *Stichting Wetenschappelijk Onderzoek Suriname – Nederlandse Antillen WOSUNA* (Netherlands Foundation for the Advancement of Research in Surinam and the Netherlands Antilles). Mrs. COBBEN (formerly Miss L. MEIER), herself a graduate of Wageningen, took care of the experiments carried out with 35 species of Hemiptera, and made numerous Faure preparations of the larval stages collected during our surveys.

A short historical summary of the entomological research on the Netherlands Antilles carried out up to the end of 1950 has been compiled by GEIJSKES & WAGENAAR HUMMELINCK (1951), *IXth Intern. Congr. Entom.* Amsterdam, 4 pp.). Since



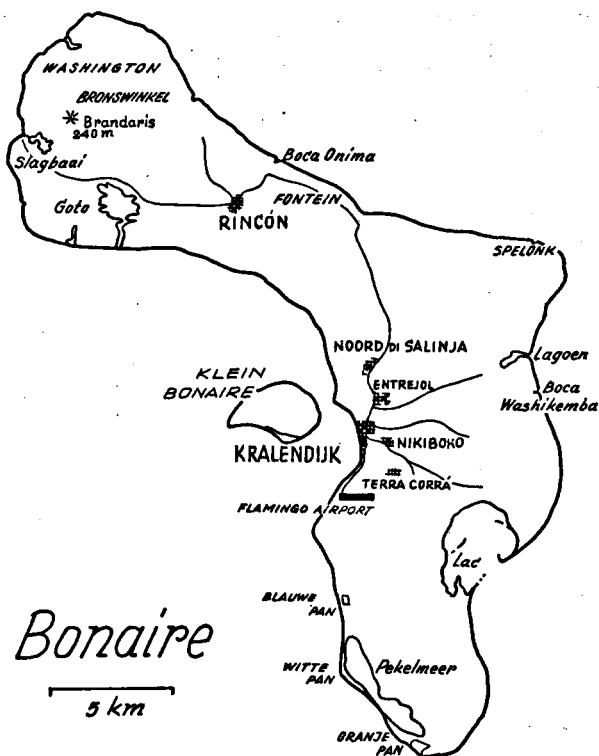
then, further papers of a pure entomological nature concerning these islands have appeared in the present Series, viz., in Volume IV (JONGE POERINK, *Cicindela*; VAN DER KUYP, *Culicinae*; BURGERS, *Anastrepha*); Volume V (MARCUSZI, *Tenebrionidae*; VAN DER KUYP, *Culicinae*); Volume VI (WAGENAAR HUMMELINCK, *Megacephala*); Volume IX (WYGODZINSKY, *Thysanura* and *Machilida*; MARCUSZI, *Tenebrionidae*), and Volume X (BUCK, *Anthicidae*).

Attention is drawn to the following terms, which are often used in different meanings but which here cover the areas as stated:

West Indies . . . . .	Antilles, Bahamas, Florida Keys, Bermuda, Cayman Islands, Swan Island, Old Providence, San Andrés
Antilles . . . . .	from Cuba to Trinidad and Aruba
Greater Antilles . . . . .	from Cuba to Puerto Rico
Lesser Antilles . . . . .	from Virgin Islands to Trinidad and Aruba
<i>Windward Group</i> . . . . .	from Virgin Islands to Grenada (Bovenwindse Eilanden, Islas de Barlovento, Iles sur le Vent, Inseln über dem Winde)
Leeward Islands . . . . .	(British usage) from Virgin Islands to Dominica
Windward Islands . . . . .	(British usage) from Martinique to Grenada
<i>Leeward Group</i> . . . . .	from Los Testigos to Aruba (Benedenwindse Eilanden, Islas de Sotavento, Iles sous le Vent, Inseln unter dem Winde)

The islands of the Leeward Group (Aruba, Curaçao, Bonaire) lie within an area of low rainfall which extends along the north coast of South America. Rain is very irregular in quantity as well as in distribution; it falls chiefly in heavy, short-lived showers, which are often only of local importance. Generally speaking, it is scanty from February to September. The total amount of precipitation during these months is about 200 mm in Curaçao and Bonaire, and less than 150 mm in Aruba. In the 'rainy season', from October to January, the average precipitation amounts to 300–350 mm.

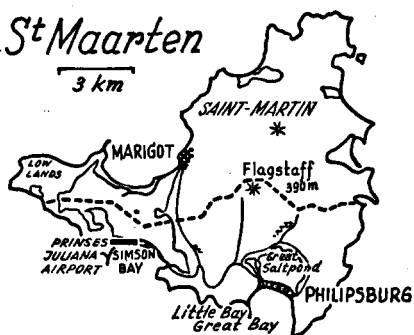
The islands of the Windward Group (St. Martin, Saba, St. Eustatius) may receive about twice as much rain as those of the Leeward Group, viz., about 1100 mm per year. But there too, precipitation is very erratic from year to year and month to month, and long droughts may occur.



**Saba**  
3 km



**St Maarten**  
3 km



**St Eustatius**  
3 km



The average annual temperature in Aruba, Curaçao and Bonaire is 27.5°C. September is considered to be the hottest month (average monthly maximum 32°C, minimum 26°C), January and February the coolest months (average monthly maximum 28.7°C, minimum 23°C).

On St. Martin, Saba and St. Eustatius – situated about 900 km farther northeast – the months of July, August and September are the hottest (average maximum 30.5°C, minimum 26°C), January and February the coolest (average maximum 27.5°C, minimum 22.5°C).

The prevailing trade winds are easterly. These sea winds blow very steadily, with only slightly diminished force even during the night, at a mean velocity of about 5–7 m/sec. in the Leeward Group, 3.5–5 in the Windward Group. The first lie just south of the most southerly hurricane track, while the second can expect a hurricane period which usually lasts from July until September.

About one third of the Leeward Group area consists of limestone rock. The non-calcareous soil consists of igneous and sedimentary rock of varying composition.

In the Windward Group limestones are common on St. Martin, while they are absent on Saba, and only form a peculiar, steeply dipping wall on the south coast of St. Eustatius.

Owing to the unfavourable rainfall conditions the vegetation has a pronounced xerophytic character. On the islands of the Leeward Group, desert-like conditions even prevail in some spots, and a more luxuriant vegetation is only to be found on a few sheltered or irrigated places.

In the Windward Group, on the other hand, a luxuriant vegetation occurs on the higher parts of Saba (up to about 850 m) and St. Eustatius (up to 600 m). This is caused by the much higher rainfall, whose values have been recorded in the lowlands, and the clouds which often are surrounding the mountain tops.

Further data on environmental factors in the Netherlands Antilles may be found in *Studies on the Fauna of Curaçao, etc.*, Vols. I (1940, No. 1), II (No. 4), IV (1953, No. 17), and V (1954, No. 23), VI (1955, No. 25), and VII (1957, No. 29); VEENEN-

BOS' *A Soil and Land Capability Survey of St. Maarten, St. Eustatius, and Saba* (1955); and STOFFERS' *The Vegetation of the Netherlands Antilles* – published by the Foundation for Scientific Research in Surinam and the Netherlands Antilles.

Looking back on an unforgettable sojourn in the West Indies, we would like here to express our thanks to all who helped to make the expedition such a success, and in particular to: Dr. P. WAGENAAR HUMMELINCK, promotor of the trip, for his assistance, which was excellent in all respects; Professor J. DE WILDE, Director of the Laboratorium voor Entomologie, Wageningen, for the ample facilities he gave us; Mr. J. E. HEESTERMAN, who smoothed my path at the outset of my venture, in the fabulous island of Trinidad; Dr. G. A. C. HERKLOTS and Mr. J. WOOLLCOMBE, who arranged comfortable quarters for me in the Imperial College for Tropical Agriculture at St. Augustine, Trinidad, and Professor T. W. KIRKPATRICK, who made available to me working accomodation in his laboratory, where I was able to prepare for the projected surveys by consulting collections and the library; the GOVERNMENT of the Netherlands Antilles for help in the matters of transport and housing; Dr. J. S. ZANEVELD, at that time Director of the Caribbean Marine Biological Institute (Carmabi), Curaçao, who provided us with a large workroom for experimental work, and who, together with his staff, was always alert to opportunities of helping us; the Managing Director of what was then the CURAÇAOSCHE PETROLEUM INDUSTRIE MAATSCHAPPIJ (C.P.I.M.; now: Shell Curaçao) and the General Manager of the AREND PETROLEUM MAATSCHAPPIJ ('Eagle'), Aruba, for the provision of accommodation; Mr. B. J. DE JONG, graduate biologist, for valuable information concerning Curaçao insects and for his help in identifying plants; and Frater M. ARNOLDO, who also made us acquainted with the local flora. We are also very grateful to Messrs. E. VAN DER KUIP (Aruba), E. PIETERS KWIERS (Bonaire), M. MELTSE (St. Martin), J. FERWERDA (Saba) and P. A. VAN DEN HEUVEL (St. Eustatius) for their greatly valued help in our researches on the respective islands, and also to the members of the NATUURWETENSCHAPPELIJKE WERKGROEP NEDERLANDSE ANTILLEN (Natural Science Study Group for the Netherlands Antilles), for their assistance and interest, which made our task easier. To all these persons, and last but not least to our hostesses, we wish to express our gratitude for their generous hospitality.



The material collected has been deposited in the collections of the Laboratorium voor Entomologie, Wageningen. Unless otherwise stated, types and duplicates will be presented to the Rijksmuseum van Natuurlijke Historie, Leiden, when the present series of articles has been completed.

**AMPHIBICORISAE: GERRIDAE, VELIIDAE, MESOVELIIDAE**

The water striders on which this paper is mainly based were collected by the author during an expedition lasting from October 1956 to July 1957 (see Foreword, p. 1). In addition, Dr. P. WAGENAAR HUMMELINCK (Utrecht) accumulated rich material in the years 1930, 1936–1937, 1948–1949 and 1955. Professor H. J. MAC GILLAVRY (Amsterdam) also collected quite a number of specimens in 1930. I wish to thank both collectors warmly for putting their material at my disposal for examination and treatment in this paper; the material collected by them is indicated by WH and MG, respectively. I am also indebted to the directors of the Zoölogisch Museum of Amsterdam and the Rijksmuseum van Natuurlijke Historie, Leiden, where both collections are deposited, for the opportunity they gave me of studying them.

The material covered in this paper comprises the following species:

- Limnogonus guerini*, from Aruba, Curaçao, Bonaire, and St. Martin;
- Trepobates taylori*, from Aruba, Curaçao, and Bonaire;
- Trochopus plumbea*, from Aruba, Curaçao, and Bonaire;
- Microvelia pulchella*, from Aruba, Curaçao, Klein Curaçao, Klein Bonaire, Bonaire, Saba, and St. Martin;
- Microvelia longipes*, from Aruba, Curaçao, Bonaire, St. Eustatius, and St. Martin;
- Mesovelia mulsanti*, from Aruba, Curaçao, Klein Curaçao, Bonaire, and St. Martin;
- Mesovelia amoena*, from Curaçao, Bonaire, and St. Eustatius.

I have refrained from giving exhaustive diagnoses since all the species mentioned here are known to be widely distributed through-

out the West Indian region and even beyond it, and consequently further morphological details can be found in the literature of the subject. The many detailed figures may compensate for this lack of verbal description. I am indebted to Mr. M. P. VAN DER SCHELDE, draughtsman of the Laboratorium voor Entomologie, Wageningen, for drawing the habit figures 1, 3, 6, 10, 13–15. The remaining figures, of genital and other structures, have been drawn by the author, who would like to emphasize that all structures illustrated relate only to the specimens mentioned in the text, and not to type specimens or specimens from type localities.

Accurate descriptions, classifications and analyses of the water of habitats on the Netherlands Antillean islands have been given by WAGENAAR HUMMELINCK in the first, fourth and seventeenth papers of these *Studies*, and in the first one of his 'Zoologische Ergebnisse einer Reise nach Bonaire, Curaçao und Aruba im Jahre 1930' (*Zool. Jahrb. Syst.* 64, 1933, p. 289–326). Since most of the water striders occur in every reasonably suitable place, I have designated only a few of my own localities by the station numbers used by HUMMELINCK. For instance, the statement that *Mesovelia mulsanti* and *Microvelia pulchella* are found "on fresh and brackish, stagnant or slowly flowing water, with a light to moderately dense, floating vegetation, in unsheltered or only slightly sheltered localities" means, that both species appeared to occur together in all habitats corresponding to this description. When, for example, the locality Rooi Tamboe, Aruba, is added to such a statement, it means that both species have been found in that gully, which is some hundreds of metres long, wherever the substratum offered the good conditions of life mentioned.

The small extent of the islands (approximate total area 980 sq. km), and their xerophytic character, made it possible to obtain a fairly complete picture of the water strider fauna.

In cases in which the number of captured specimens has not been given after the localities, the number collected was large.

Specimens from the different islands have been compared with each other, but no differences could be observed on the subspecies level. A report will be given later regarding the intraspecific vari-

ation of some species and the allometry of *Microvelia longipes*. A study of the larval stages will also follow.

I have pleasure in recording my indebtedness to Professor C. J. DRAKE for his help in identification, and for valuable information.

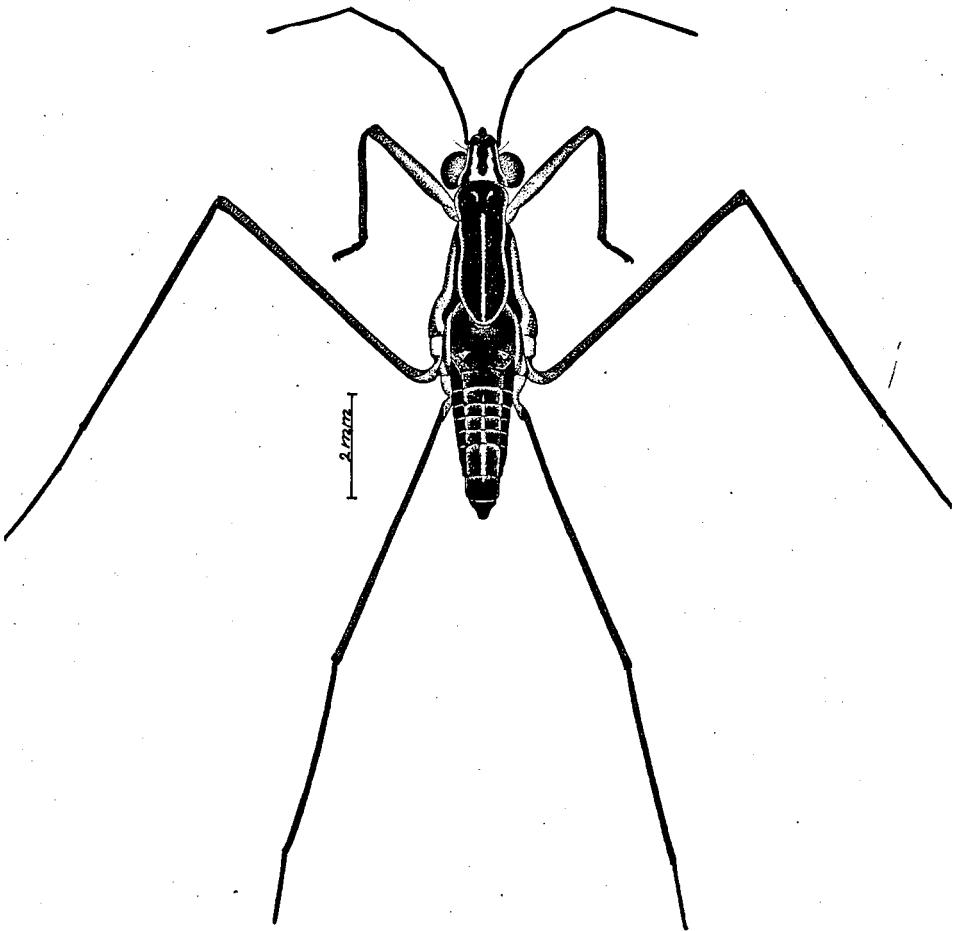


Fig. 1. *Limnogonus guerini* (Lethierry & Severin), apterous male, from Curaçao, Hofje Groot St. Joris.

## GERRIDAE

*Limnogonus guerini* (Lethierry & Severin) 1896

(Fig. 1, 2 a-e)

Very common and widely distributed in the West Indies, Central America, and Mexico, extending north into the southern parts of Texas and California (DRAKE & HARRIS 1934).

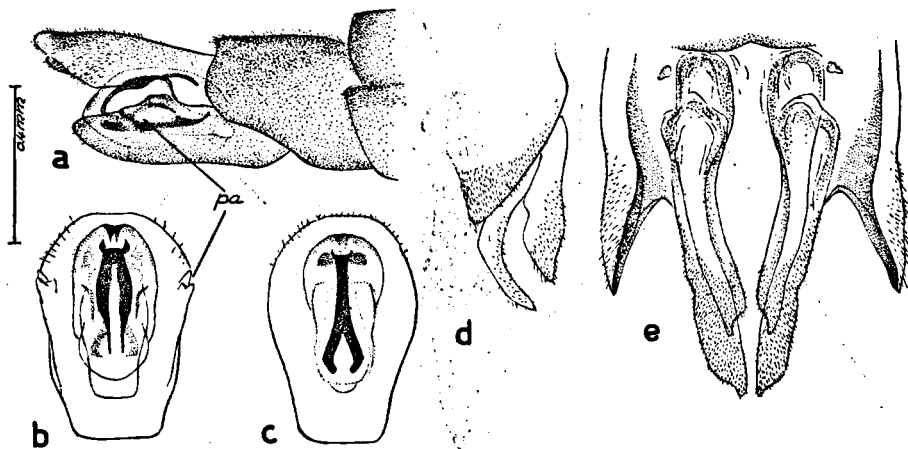


Fig. 2. *Limnogonus guerini*, from Curaçao. — a, last abdominal segments of male, lateral view; pa, paramere. b, dorsal view of genital segment of male; anal tube removed. c, ventral view of genital segment of male. d, end of abdomen of female, lateral view. e, end of abdomen of female, dorsal view; tergite and anal tube removed.

ARUBA: Rooi Tamboe, 9.IV.1957 (1 ♀ macr.).

CURAÇAO: Hofje Groot St. Joris, 19.X.1956 (6 ♀ apt., 6 ♀ macr., 9 ♂ apt., 3 ♂ macr., larvae). Marchena, Otrabanda, Willemstad, 10.XI.1956 (2 ♀ apt.). Rio Canario, rivulet near golf-links, 17.XI.1956 (4 ♀ apt.). Westpunt near light-house, 31.I.1957 (4 ♀ macr., 4 ♂ macr.). Klein St. Martha, 1.II.1957 (2 ♂ apt.); 2.III.1957 (8 ♀ apt., 2 ♀ macr., 6 ♂ apt., 1 ♂ macr.). Plantage Noordkant, 27.III.1957 (1 ♀ apt.).

BONAIRE: Dos Pos, 16.V.1957 (34 ♀ apt., 17 ♀ macr., 26 ♂ apt., 30 ♂ macr.). Hofje Fontein, 21.V.1957 (10 ♀ apt., 3 ♂ apt.). Rooi Americano, Washington, 31.V.1957 (4 ♀ apt., 2 ♂ apt., 1 ♂ macr.).

ST. MARTIN: Slob of Proeftuin St. Peter, Cul de Sac, Sta. 537, 24.V. 1949 (1 ♀ apt., 1 ♂ apt.; WH). Devil's Hole Swamp, Sta. (542), 27.XI.1956 (4 ♀ apt., 2 ♀ macr., 2 ♂ apt.).

Summarizing, the ratio of apterous to macropterous specimens is 74 : 32 for females, and 50 : 39 for males. With the exception of Devil's Hole Swamp, St. Martin, all localities are in fresh-water habitats. *L. guerini* lives on stagnant or running water, mostly in permanent ponds with some algal vegetation.

***Trepobates taylori* (Kirkaldy) 1899**

(Fig. 3, 4 a-f, 5)

West Indies, Central America, Colombia, Venezuela, and Mexico, extending north into Texas and Arizona (DRAKE & CHAPMAN 1953).

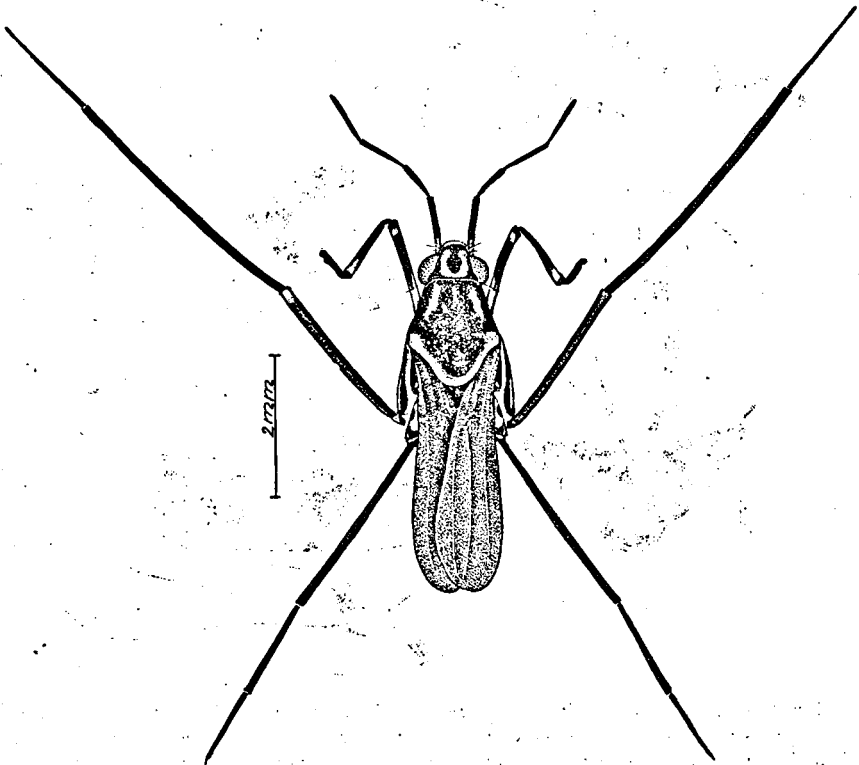


Fig. 3. *Trepobates taylori* (Kirkaldy), macropterous female, from Bonaire, Roost Americano.

On Aruba, Curaçao and Bonaire, when not otherwise indicated, always numerous and in the apterous form.

ARUBA: Hofje Fontein, 29.VI–5.VII.1930 (MG); Sta. 93a, 2.VII.1930 (WH); Sta. 93, 23.XII.1936 (WH); Sta. 93 Aa, 30.XII.1948 (WH); Sta. 93b, 30.XII.1948 (1 ♂ macr.; WH); Sta. 93c, 2.VIII.1955 (WH); 10.IV.1957.

CURAÇAO: Tanki Mamaja, Hato, Sta. 75, 6.X.1936 (WH). Tanki Koenekoe Hatoen, Hato, Sta. 70, 15.X.1936 (numerous, all apt., larvae, first stage; WH). Bak di Hofje Groot St. Joris, Sta. 67, 20.X.1936 (larval stages; WH); Sta. 67a, 9.IV.1949 (larval stages; WH). Pos Ariba, Dokterstuin, Sta. 83, 27.X.1936 (larval stages; WH). Tanki di Hofje Savonet, Sta. 89, 29.X.1936 (WH). Bak di Hofje Groot St. Joris, 19.X.1956. Hofje Knip, 3.XI.1956. Pos Cajoea, Hofje Santa Barbara, 13.I.1957. Klein St. Martha, pond along main road,

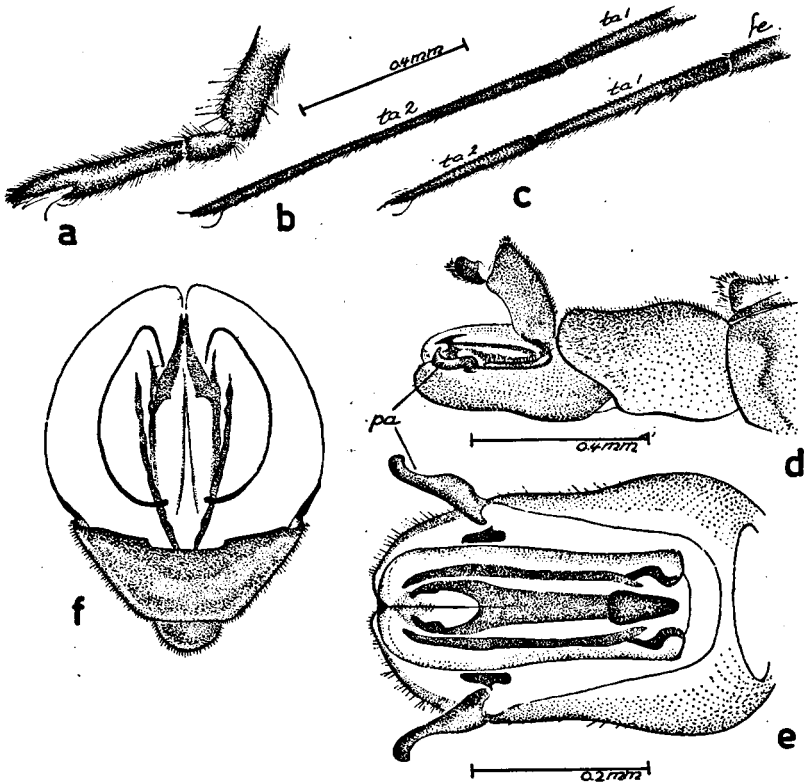


Fig. 4. *Trepobates taylora*, from Bonaire. — a, foot structure of left foreleg of female. b, foot structure of middle leg of male. c, foot structure of hindleg of male. d, last abdominal segments of male, lateral view; pa, paramere. e, dorsal view of genital segment of male; anal tube removed. f, end of abdomen of female, dorsal view; tergites partly removed.

1.II.1957 (1 ♀ macr., 1 ♀ apt., 1 ♂ macr.). Klein St. Martha, large pond with open surface and bordered by Nymphaea, 1.III.1957 (enormous numbers, concentrated in shoals, all apt.). Plantage Noordkant, 27.III; 26.VI.1957. Piscadera, near stone quarry, 12.VI.1957.

BONAIRE: Rooi Americano, Washington, rivulet, 26.V.1957 (numerous apt., 3 ♀ macr., 2 ♂ macr., larvae). Pos Mangel, Washington, 30.V.1957 (numerous apt., 2 ♀ macr.). Tankis around Rincón, 31.V.1957.

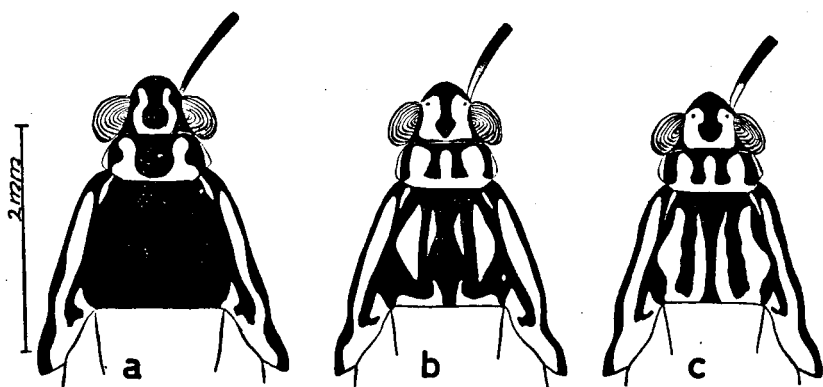


Fig. 5. *Trepobates taylori*, females, eunomy of dark pigment on head and thorax. — a, Curaçao, Klein St. Martha. b, Curaçao, Piscadera innerbay. c, Paraguaná (Venezuela), Estanque de Santa Ana.

From these data it follows that the long-winged form is rather rare, and that its occurrence is, generally speaking, sporadic. *T. taylori* has been found together with *Limnogonus* in some localities, but it prefers areas of more open water than does the latter. *T. taylori* is the water strider which first colonizes the temporary fresh-water ponds that originate in the rainy season. The black body-marking is subject to variation which, however, follows a eunomic line (Fig. 5 a-c). It is possible that environmental factors influence the advance of the black pattern, the specimens from one habitat being rather homogenous.

## VELIIDAE

***Trochopus plumbea* (Uhler) 1894**

(Fig. 6, 7 a-h, 8 a-d, 9)

Widely distributed in the Caribbean region: Grenada, St. Vincent, Virgin Islands, Jamaica, Grand Cayman, Honduras, and Florida.

On Aruba, Curaçao and Bonaire all captures relate to the apterous form.

ARUBA: Lagoon of Boekoeti, east of harbour entrance of Oranjestad, 25.VI. 1930 (2 ♀, 2 ♂; MG). Plaja Master, near Savaneta, Sta. 1009, among *Avicennia*, 2.I.1949 (numerous adults; WH); Sta. 1009A, among *Rhizophora*, 2.I.1949 (numerous adults; WH). Savaneta, in creeks of open lagoon, 25.IV.1957 (numerous).

CURAÇAO: Kabrietenbaai of Spaanse Water, Sta. 1035, near *Rhizophora*, 9.XII. 1930 (2 pairs in copula, 2 larvae; WH). Swimming pool of Piscadera Baai, Sta.

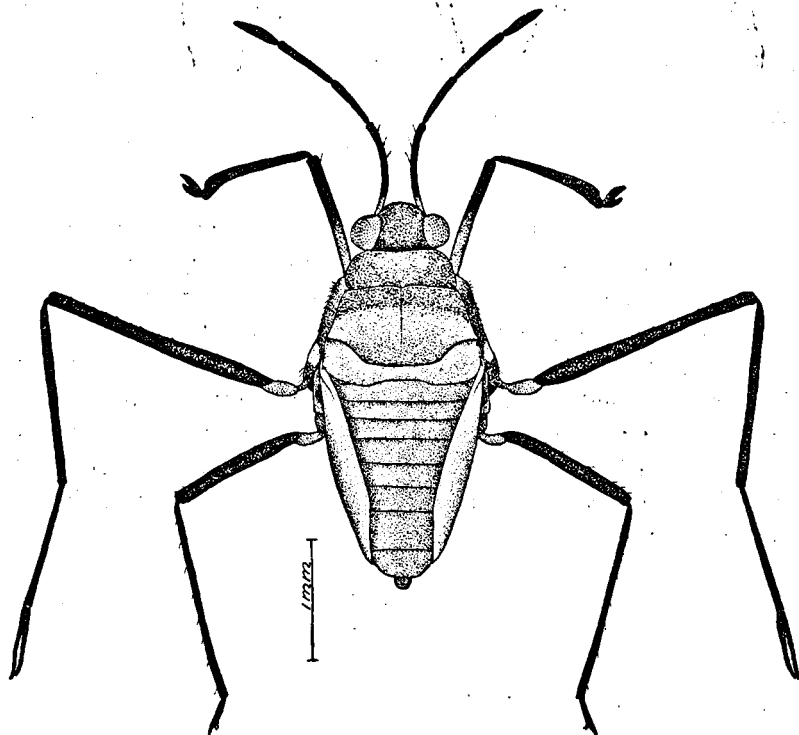


Fig. 6. *Trochopus plumbea* (Uhler), apterous female, from Curaçao, Piscadera.



1029, among limestone rocks, 29.I.1949 (numerous, mostly young larvae; WH). Plaja Hoeloc, south of St. Kruis, Sta. 1023A, among limestone rocks, 19.III. 1949 (large numbers with larvae; WH). Fuikbaai, 6.IV.1949 (leg. A. D. Ringma). Spaanse Water, 18.XI.1956 (1 ♀; leg. L. B. Holthuis). Piscadera, seashore, in dense shoals on the surface of the water near the limestone cliff, I-III. 1957 (numerous copulating pairs, last larval stages). Piscadera Baai, lagoon, scattered along the north and east zones under the lee of *Rhizophora* and *Conocarpus*, I-III.1957.

BONAIRE: Lagoen, Sta. 1070A, among *Rhizophora*, 2.XI.1930 (4 pairs in copula; WH). Southwestern part of Lac, shallow part of lagoon, XI-XII. 1930 (2 larvae; WH).

In their key to the *Veliidae* CHINA & USINGER (1949, p. 351) distinguish the genus *Trochopus* Carpenter (1898) from the genus *Rhagovelia* Mayr (1865) on the grounds that the former has 2-segmented, the latter 3-segmented hind tarsi. However, BACON (1956, p. 733-735) places *plumbea* in *Rhagovelia*, and gives detailed bibliography and morphological description of this species. In his revision of *Rhagovelia* of the Western Hemisphere he classifies the 78 species in nine groups, and places *plumbea* in the *angustipes* group. MATSUDA (1956, p. 931) gives a supplementary description of the thoracic parts. The latter author splits the genus into two subgenera, viz. *Rhagovelia* s. str. and *Neorhagovelia*, to the latter of which *plumbea* should be allocated. This remarkable blue-greyish species, the long-winged form of which has not yet been seen, has been found only on salt waters along the sheltered south coast of the three Netherlands Antillean islands north of the Venezuelan mainland. It inhabits open sea close to the shore, open bays and open lagoons.

Nothing is known about its biology. The surface of the sea near Piscadera and Savaneta on which *Trochopus plumbea* has been found, is entirely free from deposition and seaweed. It is obvious that, if there is oviposition in this habitat, it can only take place against the steep limestone cliff. In the inner bays the species occurs along the mangrove border. Here the *Rhizophora* trunks at water level probably function as a substratum for the eggs. Such oviposition implies that the eggs must be proof against regular wetting with sea water; in fact, it is possible that the embryo develops beneath the surface of the water. The biology of the marine veliid *Halovelia marianarum* Usinger, known to be distributed throughout

a wide range in the Pacific Ocean, has been studied by KELLEN (1959). As this species shows some resemblance to *T. plumbea* as regards both habit and habitat and behaviour, part of the abstract of KELLEN's paper is quoted here: "*H. marianarum* lives in Samoa

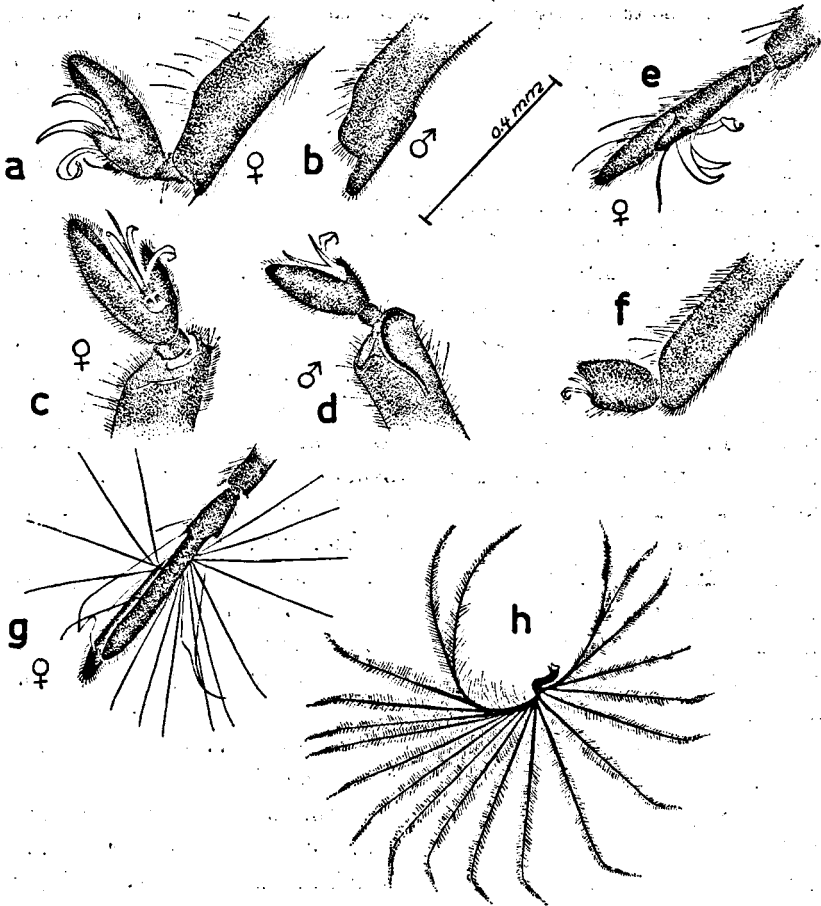


Fig. 7. *Trochopus plumbea*, from Curaçao, foot structures. — *a*, left foreleg of female, hind view. *b*, left foreleg of male, apex of tibia. *c*, left foreleg of female, inner view. *d*, left foreleg of male, inner view; notice the special structure on the apex of tibia for getting attached to the second coxa of the female during the copulation act. *e*, hindleg of female, hind view. *f*, left foreleg of male larva V, hind view. *g*, right middle leg of female, front view. *h*, the complex of fringed hairs, prepared out of the cleft last tarsal segment of the middle leg.

along the edges of a shallow lagoon and is closely associated with volcanic rocks which occur in the intertidal zone. The veliids are active at mean tide, and hide in holes in the rocks at low and high tide. They have several different patterns of swimming on the water, and are able to run rapidly over rocks. In the field they feed mainly on tendipedid midges and Collembola." KELLEN succeeded in rearing the species under laboratory conditions; the eggs were deposited singly in small holes in the rocks, usually about half an inch above the surface of the water. It is interesting to note that *T. plumbea* occurred scattered on the quiet water bordering the *Rhizophora* forests in the inland bay of Piscadera. (March 1957), whilst at the same time it has been found on the open sea, but in separate closed populations of adults (copulations!) and older larvae. There the bugs skate out of the wind along and under the excavated limestone

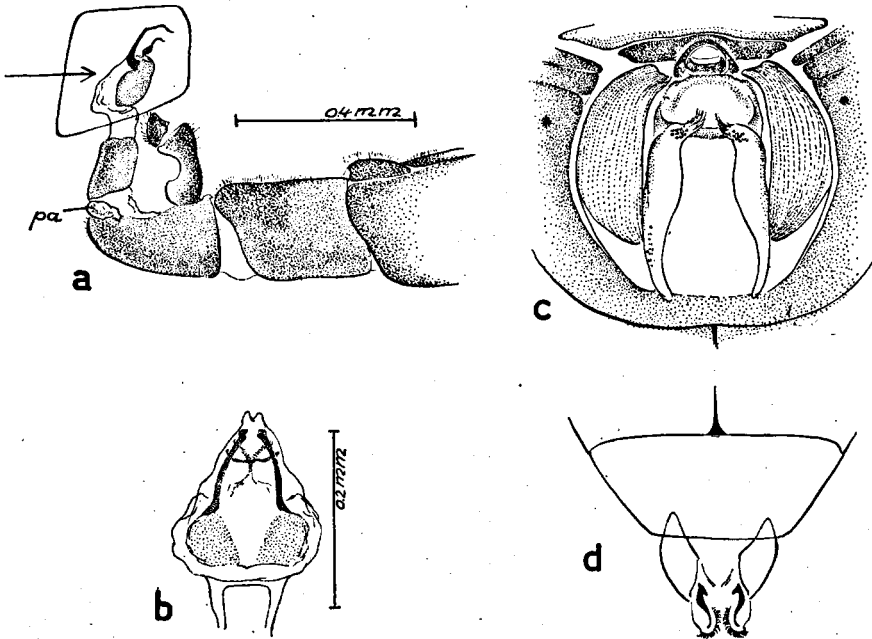


Fig. 8. *Trochopus plumbea*, from Curaçao. — *a*, erected last abdominal segments of male, lateral view. *b*, the framed part of *a*, seen in the direction of the arrow. *c*, apex of abdomen of female, hind view. *d*, apex of the somewhat extracted abdomen of female, ventral view.

coast. In spite of the intense surf and movement of the waves, which glide along the coast to the west but do not wholly break, the striders stay together at a distance of one or two metres offshore. It should be worthwhile investigating whether there is a migration

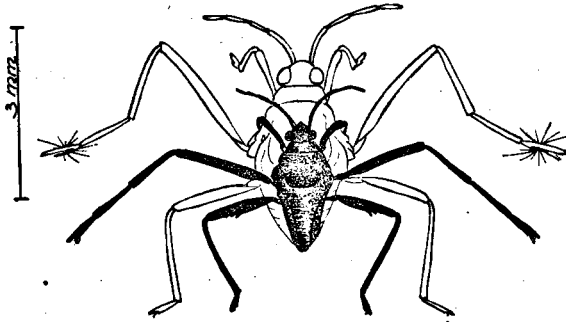


Fig. 9. *Trochopus plumbea*, copulating pair, from Curaçao.

from the sea through the open water connection into the inland bay, and whether the insects go in search of the mangrove zones to find their prey, i.e. dead or half dead arthropods, or to find suitable places for oviposition.

### ***Microvelia pulchella* Westwood, 1834**

(Fig. 10a-c, 11 a-e)

Neotropical region, Florida, Texas and Arizona.

ARUBA: Pos di Noord, Sta. (102Aa), 26.V.1930 (WH). Rooi Prins, Sta. 104Ba, 4.VII.1930 (WH). Rooi Tamboe, 9.IV.1957. Picarón, 17.IV.1957.

CURAÇAO: Hofje Ariba, Fuik, Sta. 65, 9.IX.1936 (WH). Tanki di Hofje Savonet, Sta. 89, 29.X.1936 (WH). Tanki Grandi, Steenen Koraal, Sta. 392, 17.IV.1949 (WH). Museum garden pool at Willemstad, Sta. 390, 25.IV.1949 (WH). Seroe Christoffel - Savonet, 21.X.1956. Hofje Knip, 3.XI.1956. Piscadera Baai, 14.XI.1956; II-IV.1957. Pos Cajoeda, Hofje of Santa Barbara, 13.I.1957. Westpunt near lighthouse, 31.I.1957. Plantage Noordkant, 26.VI.1957.

KLEIN CURAÇAO: Pos north of lighthouse, Sta. 64, 29.VIII.1936 (WH). Another well north of lighthouse, Sta. 387, 1.X.1948 (WH).

KLEIN BONAIRE: Pos Calbas, Sta. 63b, 9.VI.1930 (WH); 27.XI.1930 (WH). Djompie, 17.X.1930 (WH). Pos Blauwduif, 17.X.1930 (WH). Pos di Cas, 17.X.1930 (WH); 27.XI.1930 (WH); Sta. 61b, 7.IX.1948 (WH); 6.V.1957.

BONAIRE: Pos Baca, south of Kralendijk, Sta. 53b, 17.V.1930 (WH); Sta. 53c, 16.IX.1948 (WH); Sta. 53d, 21.II.1949 (WH). Spring of Fontein, Sta. 48b,

21.V.1930 (WH); 21.V.1957. Pos Letín, west of Boca Onima, Sta. 47a, 29.V.1930 (WH). Pos Bronswinkel, Sta. 44a, 31.V.1930 (WH). Pos Guajaká Chikito, Lima, 29.VIII.1930 (WH). Pos Baca Grandi, Sta. 379, 2.IX.1948 (WH); Sta. 379a, 16.IX.1948 (WH); Sta. 379b, 27.XII.1948 (WH); Sta. 379d, 2.IX.1949 (WH). Pos Ichi, south of Kralendijk, Sta. 52e, 21.II.1949 (WH). Dos Pos, 16.V.1957. Hofje Fontein, 21.V.1957. Pos Onima, 21.V.1957. Rooi Hoeba, north of Goto, 22.V.1957. Rooi Americano, Washington, 26.V.1957.

SABA: Upper Mountain water hole, west of Hellsgate, Sta. 438, 25.VII.1949 (WH). Booby Hill cistern, Sta. 520, 25.VII.1949 (WH).

St. MARTIN: Crab Hole cistern, Sta. 530, 18.V.1949 (WH). Puddle in Rambeau Valley, Sta. 532, 20.V.1949 (WH). Puddle in Rolands Canal Upstreet, Sta. 531, 25.V.1949 (WH). Cul de Sac, 28.XI.1956. Ponds near Bellevue and Oysterpond, XI.1956.

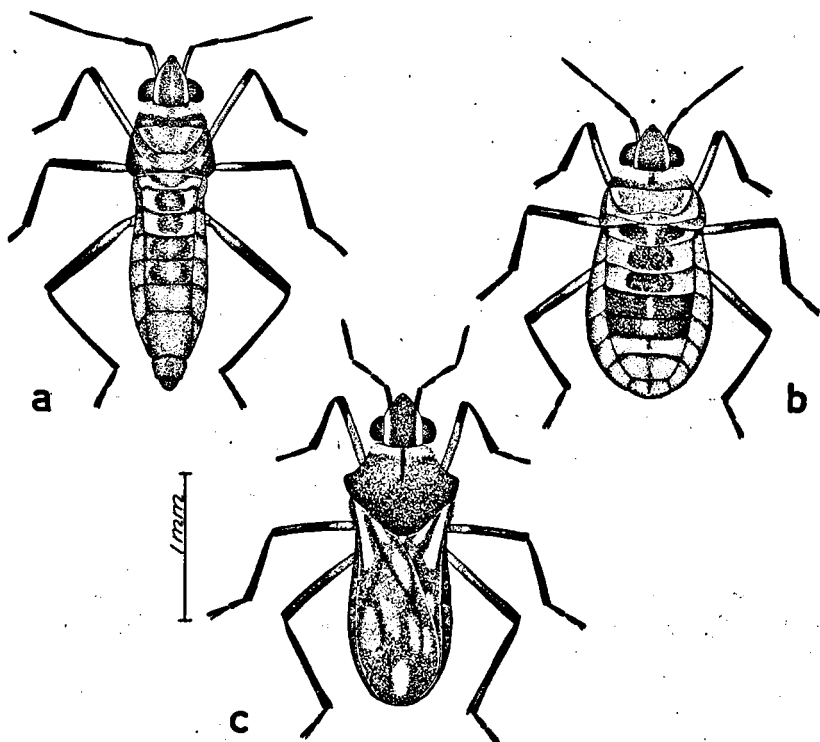


Fig. 10. *Microvelia pulchella* Westwood, from Bonaire, Dos Pos. — a, apterous male. b, apterous female. c, macropterous female.

This widespread species is the most common water strider on the islands. It inhabits both brackish and fresh, stagnant and slowly

running, overgrown and unovergrown water, with a preference for sheltered water's edges.

For data on synonymy and variability see DRAKE & HUSSEY (1955, p. 102–106). The macropterous form, and especially that of the male, is in the minority. In the Rooi Amerikano, Bonaire (26.V. 1957), *Microvelia pulchella* has been found in enormous quantities in a drying-up puddle, especially the long-winged form. The pattern of light and dark colouring, and the body length of this species, are very variable. For instance, the length of 14 unselected apterous males from Hofje Fontein, Bonaire, varied from 1.66 mm to 2.42 mm.

DRAKE & HUSSEY (1955, p. 104) consider *Microvelia incerta* (Kirby) as a subspecies of *pulchella*. However, on p. 105 they state: "Except for its distinctly smaller average size, *M. p. incerta* does not seem to differ from typical *M. pulchella* in any essential way, and cannot be regarded as specifically distinct from it. Although *M. incerta* is treated here as a subspecies of *M. pulchella*, this is not done in the sense that the two represent geographically isolated and distinguishable forms. *M. p. incerta* ranges northward in the nearctic region far beyond the limits of typical *pulchella*, yet in the

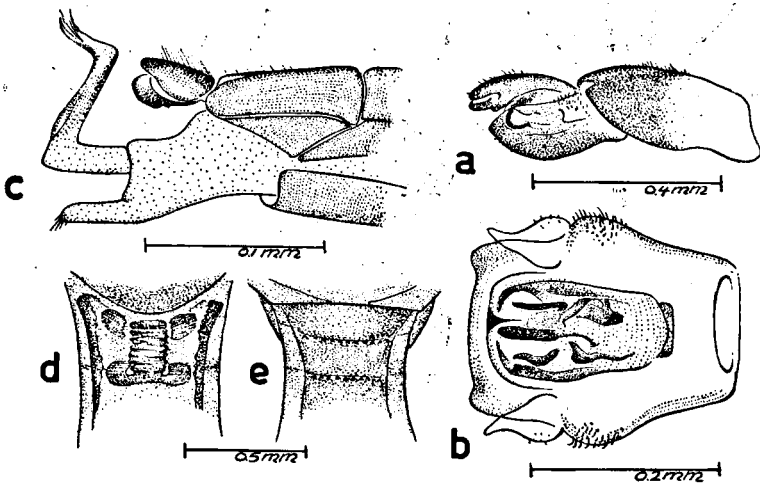


Fig. 11. *Microvelia pulchella*, from Bonaire. — a, last abdominal segments of male, lateral view. b, genital segment of male, dorsal view; anal tube removed. c, last abdominal segments of female, somewhat extracted, lateral view. d, base of abdomen of macropterous male. e, base of abdomen of brachypterous male.

neotropical region the distribution of the two forms is the same. Indeed, specimens from a given locality, or even from a single school or swarm, sometimes show perfect intergradation between the smaller *incerta* and the larger *pulchella*, and this is true for males and females alike and for winged and wingless individuals. In general, specimens from northern localities are a little smaller than those from tropical or subtropical places." USINGER (1956), in his book on the water insects of California, treated *incerta* as a synonym of *pulchella*, whereas WILSON (1958) reported *incerta* from the Mississippi as a subspecies of *pulchella*.

On the Netherlands Antillean islands, too, the two forms were found mixed in the same localities and same populations. Professor DRAKE informed me that the biology of *Microvelia capitata* of FRICK (1949) actually refers to that of *M. pulchella* and *incerta*. It seems that in the past great confusion prevailed regarding the conception of this and other American species. Consequently, the relevant literature up to 1919-1920 is unreliable.

### ***Microvelia longipes* Uhler 1894**

(Fig. 12a-d, 13a-b)

Originally described from Grenada, this species is now known from the greater part of the West Indian islands, and from Venezuela, British Guiana, Brazil, Colombia, Ecuador, Peru, Bolivia, Paraguay and Argentina.

ARUBA: Picaron, natural well, 17.IV.1957.

CURAÇAO: Pos Cajoea, Knip, Sta. 399, 17.VIII.1948 (numerous macr., apt. and larvae; WH). Pos Europa, Dokterstuijn, Sta. 82a, 11.II.1949 (1 ♀ macr., 1 larva; WH). Hofje Groot Piscadera, in well, X.1956. Hofje Knip, sheltered fresh-water puddles and wells, 3.XI.1956. Plantage Noordkant, 27.III.1957; 26.VI.1957.

BONAIRE: Pos Chikitoe, near Goto, 26.V.1930 (♂ and ♀, apt.; WH). Pos Hoebe, north of Goto, Sta. 65, 26.V.1930; 16.X.1930 (numerous ♂, ♀, apt. and macr., larvae; WH). Pos Bronswinkel, Sta. 44a, 31.V.1930 (♂, ♀, apt.; WH). Pos Mangel, 31.V.1957.

ST. EUSTATIUS: Manahega cistern, Downtown, Sta. 505, 7.VII. 1949 (WH). Manahega Well, Sta. 506, 7.VII.1949 (WH). Twin Cisterns, Downtown, Sta. 507, 7.VII.1949 (WH). New Well, Downtown, Sta. 508, 7.VII.1949 (♂, ♀, all apt., larvae; WH). Venusbaai well, 29.XII.1956.

ST. MARTIN: Doctor's Well, Rockland, Sta. 538, 24.V.1949 (some apt. ♀, larvae; WH). Koolbaai, fresh-water puddle, 22.XI.1956; cement water-trough, 5.XII.1956 (large quantities). North of Agr. Exp. Sta. St. Peter, Cul de Sac, 24.XI.1956; ponds near Bellevue and Oysterpond, XI.1956.

On these islands, this striking dimorphic species is exclusively a denizen of stagnant fresh water with an open and sheltered surface. In consequence it is only found on small concealed puddles and in cisterns. On St. Eustatius it has been found even in small paved wells with the surface of the water about 3 m below ground level. The locality Koolbaai, St. Martin, shows that the species eschews direct sunlight. This is the lonely place where *M. longipes* was found on a puddle without any shelter-giving vegetation. The puddle is, however, divided by a cement wall about one metre high, which trends east-west, as shown in Fig. 16. An enormous number of *M. longipes* were living in the north half of the puddle, along the wall, but not a single specimen in the south half. Almost the only species regularly accompanying it is the second *Microvelia*, viz. *pulchella*. There is apparently a great variation in the extremely long hind legs of the male, but this length is obviously correlated with the

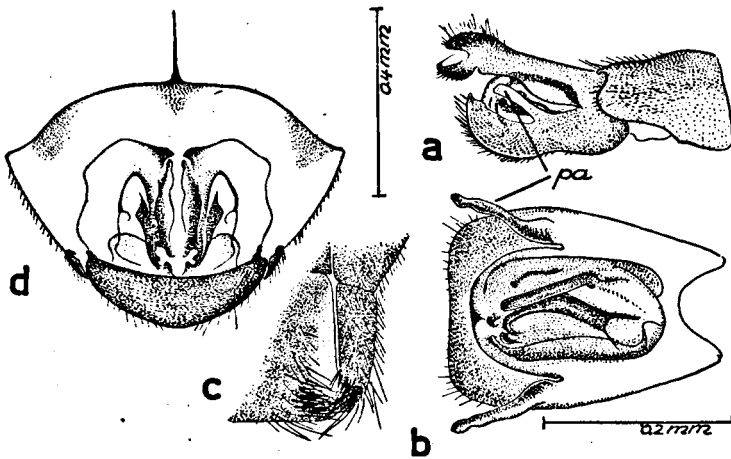


Fig. 12. *Microvelia longipes* Uhler, from St. Martin, Koolbaai. — *a*, last abdominal segments of macropterous male, lateral view. *b*, genital segment of male, dorsal view. *c*, peculiar structure of last connexival part of male. *d*, last abdominal segments of female, dorsal view; tergites partly removed.



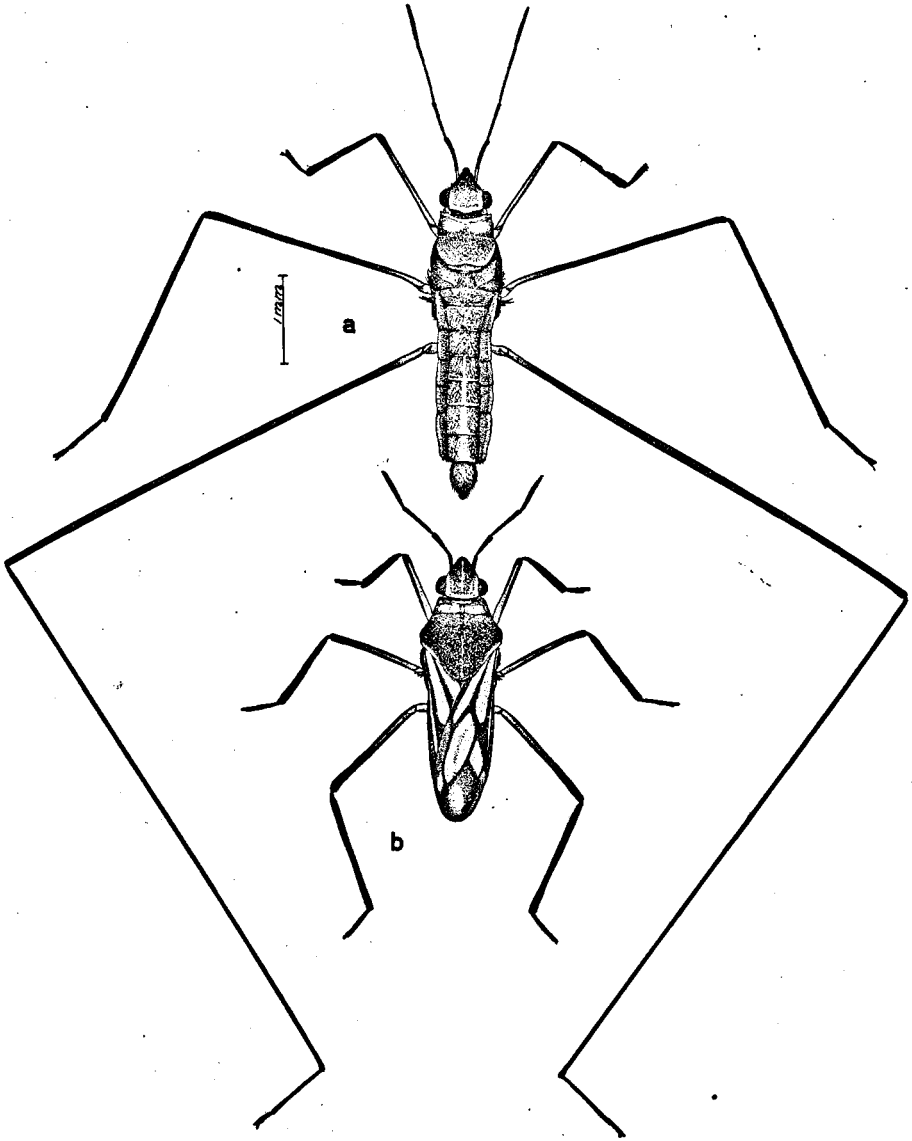


Fig. 13. *Microvelia longipes*, from St. Martin, Koolbaai. — *a*, apterous male. *b*, macropterous female.

total body length, which is variable, as in *M. pulchella*. An allometric study of this species will follow later.

Both males and females normally occur in the apterous form, but in large populations the macropterous form can be present in considerable numbers in both sexes. The long-winged females have been described by UHLER in 1894 as *M. modesta* (cf. DRAKE 1952).

## MESOVELIIDAE

### *Mesovelia mulsanti* White 1879

(Fig. 14, 17a-c, 18a-d)

Distributed over almost all of the Western Hemisphere, from across southern Canada, Central America and the West Indies deep into northern Argentina.

ARUBA: Hofje Fontein, 29.VI-5.VII.1930 (MG); Sta. 93c, 2.VIII.1955 (1 ♂; WH). Spaans Lagoen, 5.IV.1957. Rooi Tamboe, 9.IV.1957. Picaron - Hofje Fontein, 28.IV.1957.

CURAÇAO: Tanki di Hofje Savonet, Sta. 89, 29.X.1936 (WH). St. Martha, salt and fresh water ponds, 13.X.1956; 1.II.1957; 2.III.1957. Seroe Christoffel - Savonet, small stream in Rooi Beroe, 21.X.1956. Hofje Knip, 3.XI.1956. Rio Canario, near golf links, 17.XI.1956. Malpais, XI.1956. Pos Cajoeda, Hofje Santa Barbara, 13.I.1957. Westpunt, tanki near lighthouse, 31.I.1957. Pannekoek, III.1957. Piscadera Baai, northern border, X-XI. 1956; II-IV. 1957. Plantage Noordkant, 6.VI.1957.

KLEIN CURAÇAO: Pos north of lighthouse, only in the pool containing *Ruppia*, 23.VI.1957.

BONAIRE: Pos Baca, Sta. 53d, 21.II.1949 (WH). Pos Bronswinkel, Sta. 44b, 23.VIII.1955 (16 ♂ apt., 1 ♂ macr., 8 ♀ apt.; WH). Playa Grandi, 4.V.1957. Dos Pos, 16.V.1957. Hofje Fontein, 21.V.1957. Rooi Hoeba, 22.V.1957. Rooi Americano, 26.V.1957. Pos Bronswinkel, 31.V.1957.

ST. MARTIN: Crab Hole Cistern, Sta. 530, 18.V.1949 (WH). Slob of Agr. Exp. Sta. St. Peter, Cul de Sac, Sta. 537, 24.V.1949 (WH). Puddle near Doctor's Well, Sta. 539a, 29.VI.1955 (WH). Cul de Sac, 28.XI.1956.

This widespread species occurs all over the Dutch Antillean islands wherever the habitats are suitable, i.e. on stagnant or slowly running, fresh and brackish water with a slightly to moderately dense vegetation of algae, *Ruppia*, *Chara*, *Nymphaea*, or other floating or partially submerged material. It is most numerous on

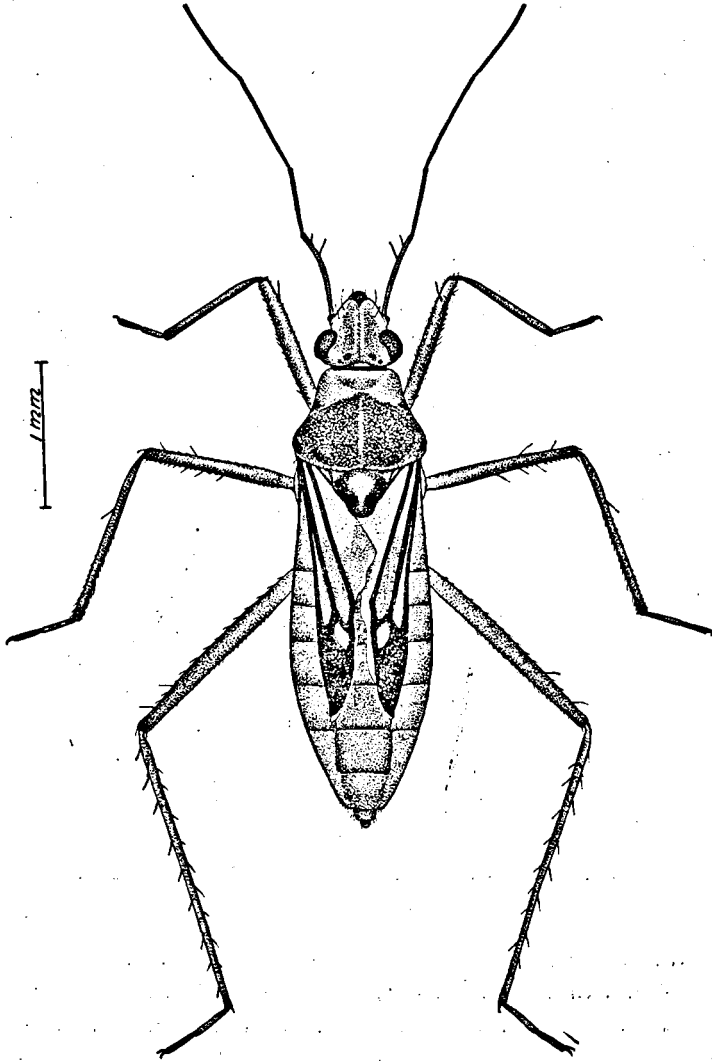


Fig. 14. *Mesovelia mulsanti* White, macropterous female, from Curaçao, Savonnet (notice the autotomy of membrane).

unsheltered areas, where the macropterous form is not rare. Accompanying species are *Microvelia pulchella* (in nearly all cases) and *Merragata hebroides*, on which it preys (WILLIAMS 1944). In denser grass or *Juncus* vegetation its place is taken by *Mesovelia amoena* (Curaçao: Piscadera inner bay; Bonaire: Goto and Bronswinkel). On the more open surfaces its biotope borders on that of *Limnogonus guerini*.

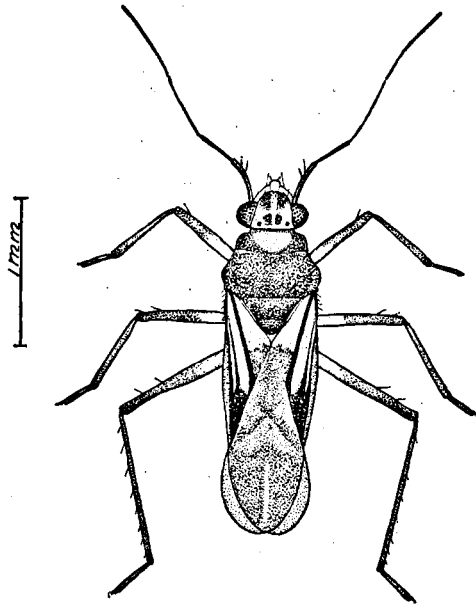


Fig. 15. *Mesovelia amoena* Uhler, macropterous female, from Bonaire, Pos Bronswinkel.

HUNGERFORD (1920, p. 99–106) and HOFFMAN (1932, p. 90–94, 113–115) give detailed information regarding the biology of *M. mulsanti*. The species is very variable in the male hair tufts and parameres, and in the prongs and lobes of the apex of the female abdomen. On these differences, JACZEWSKI (1930) based four subspecies. However, NEERING (1954) studied the three characters concerned in over 1700 ♂ and 2100 ♀ from the whole geographical range of the species and could not find a correlation between the characters, or between the variation and the differences in habitats. She concludes

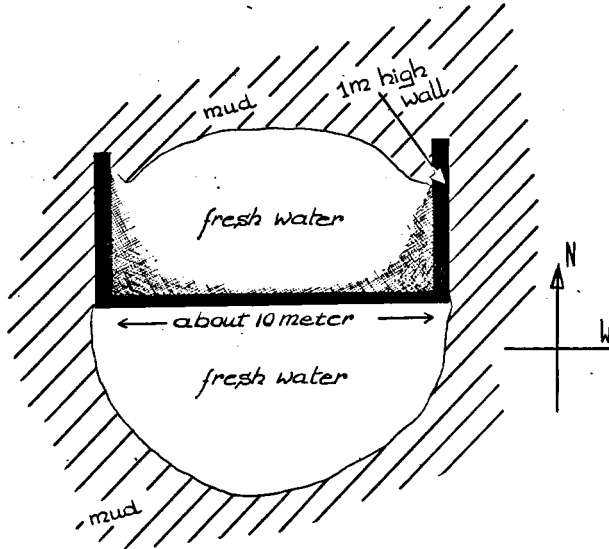


Fig. 16. Habitat of *Microvelia longipes* (shaded) at St. Martin, Koolbaai (see text)

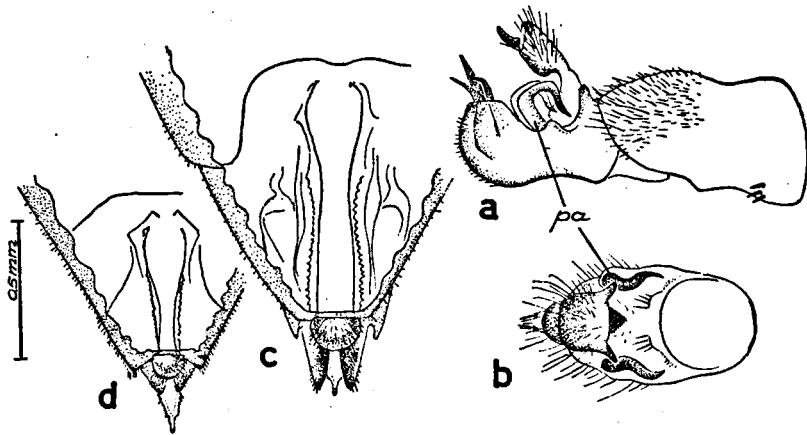


Fig. 17a-c. *Mesovelina mulsanti*, from Curaçao. — a, last abdominal segments of male, lateral view. b, genital segment of male, dorsal view. c, abdominal segments of female, dorsal view; tergites partly removed. 17d. *Mesovelina amoena*, from Bonaire, last abdominal segments of female, dorsal view; tergites partly removed.

that the morphological differences are of no taxonomic importance. Another varying feature is the number of strong hairs on femur 2 in the males. In most specimens from Curaçao and Bonaire these hairs are situated behind only, in the apical part. In the other specimens the row of hairs continues to the base of the femur (Fig. 18a). The latter form, which is very often correlated with a strong darkening and enlargement of the median headspots (Fig. 18c) and

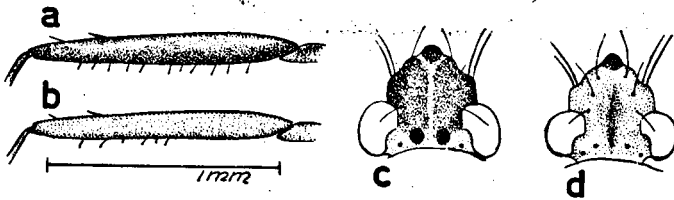


Fig. 18. *Mesovelia mulsanti*. — a-b, femur of middle leg. c-d, head, dorsal view. a and c, dark specimens from Bonaire, Dos Pos (see text).

a darkening of the whole body, has been found especially in sheltered habitats. It occurred extremely markedly in all the 12 specimens from Dos Pos (Bonaire). These were captured in a sunken, well sheltered, fresh-water puddle without green water vegetation, in which the present author had not expected *Mesovelia*. It is also the only locality in which it occurred together with *Microvelia longipes*.

Our captures included several long-winged specimens with completely broken membranes. The possible meaning of this form of autotomy, which is caused by the action of the hind tibia, is discussed by JORDAN (1951).

### ***Mesovelia amoena* Uhler 1894**

(Fig. 15, 17d)

Southern states of North America, Panama, and Brazil; Jamaica, Puerto Rico and Grenada.

CURAÇAO: Bron di San Pedro, southern spring in Hofje, Sta. 395, 13.II.1949 (1 ♀ apt.; WH). Piscadera Baai, among a sort of *Juncus* and *Sporobolus*, on brackish water, X-XI.1956 (all ♀, mostly apt.).

BONAIRE: Pos Ichi, Sta. 52e, 21.II.1949 (1 ♀ apt.; WH). Goto, entrance from the Dos Pos side, among *Sporobolus virginicus*, around central puddle, 19.V.

1957 (numerous ♀, apt.); same dried up puddle, 30.V.1957 (only 1 ♀). Pos Bronswinkel, among *Eleocharis mutata* and grasses, 31.V.1957 (numerous ♀, apt. and macr.).

ST. EUSTATIUS: Manahega Cistern, Sta. 505, 7.VII.1949 (2 ♀ apt.; WH).

Up till now only females have been found in the Netherlands Antilles. The species prefers a more densely grown habitat than *M. mulsanti*. At Piscadera Baai, Goto and Bronswinkel, both species occurred separately, *M. amoena* between the grasses growing in water, *M. mulsanti* on the more open water areas around the same vegetation. A high percentage of autotomy is also found in this species.

#### GENERAL REMARKS

The occurrence or absence of certain species is determined more by the physical condition of the substratum than by the chemical constitution of the water. On the one hand, this is a consequence of the uniformly insectivorous life-habits of the Amphibicorisae, on the other, it has been brought about by their special foot structures, which are morphologically and functionally adapted to locomotion on a swampy substratum on the borderline between soil or plant and water, or on the naked surface of the water, whether moving or stagnant, salty or fresh. All water striders are moderately predatory in their habits, with a preference for dead or half-dead arthropods, and hence there is only a limited and indirect correlation with a distinct type of vegetation. As specialization in the predatism of the water striders has never been demonstrated, it is to be expected that any bigger species will prey on any smaller ones when they occur together, but that, in its turn, the adult stage of a smaller species may also prey on the eggs or younger larvae of a larger species. Thus, for instance, *Mesovelia mulsanti* is a well-known predator on *Merragata* (WILLIAMS 1944); but the former will also prey on *Microvelia pulchella*, just as *Microvelia longipes* likewise preys on *M. pulchella* when both species come together on sheltered, stagnant fresh waters. *Mesovelia mulsanti*, on the other hand, runs the risk of being taken by surprise by *Limnogonus guerinii*.

TABLE 1.

Habitat  Species	moving water		slightly flowing or stagnant		stagnant		
	salt		brackish or fresh		fresh		
	open water surface		increasing floating, lower and higher vegetation		open water surface, naturally or artificially sheltered		
	sea, lagoon, landlocked bay	tanks, ponds, rivulets	algal growth of open water, directly bordering the zone with floating and higher vegetation	algae growth of Juncus, Sparganium, etc., in water	muddy water-land zone	on salty or brackish mudflats between halophilous plants and leaf decay	swampy places at the foot of weeds and in leaf decay
<i>Rhagovelia plumbea</i>							
<i>Tropobates taylori</i>							
<i>Limnognathus guerini</i>							
<i>Mesovelia mulsanti</i>							
<i>Mesovelia amoena</i>							
<i>Microvelia pulchella</i>							
<i>Merragata hebraeides</i>							
<i>Hebrus elimatus</i>							
<i>Microvelia longipes</i>							

ECOLOGICAL DIFFERENTIATION OF THE WATER STRIDERS IN THE NETHERLANDS ANTILLES.

*Hebrus concinnus* and *H. consolidus* have been omitted because only one capture was made of each of these species. The arrows show the mutual predatory possibilities.



It is a striking fact that nearly all the species occurring in the Netherlands Antilles have an extensive geographical distribution. An explanation for this can perhaps be found in the steppe type of climate of the islands of the Leeward Group. The temperature is rather constant, around 27.5° C, and fluctuates by only a few degrees. The annual precipitation of about 450–550 mm falls for the most part in the period October–January. With the exception of some natural wells, the brackish waters and the few fresh-water pools dry up in periods of extreme drought. Whether, and, if so, in what stage these semi-aquatic Heteroptera remain dormant there in such periods is not known, but it is obvious that those species with modest ecological claims and ample possibilities of distribution will be best fitted to survive these unfavourable episodes, or to repopulate the habitats, after the return of more favourable conditions, via migration from other territories.

Representatives have been found of all the known families of water striders except the *Hydrometridae*. Hydrometrids might perhaps still be encountered in such apparently favourably situated habitats, as the overgrown borders of rivulets, for example the temporarily stream flowing from the Christoffel-mountain to Savonet on Curaçao, or Pos Bronswinkel or Rooi Americano on Bonaire.

The ecological differentiation of the water striders met with in the Netherlands Antilles is summarized in Table 1.

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