

THE FRESHWATER SHRIMPS OF CURAÇAO, WEST INDIES (DECAPODA, CARIDEA)

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ABSTRACT

On the basis of a field survey and review of existing records I here report on the occurrence of ten freshwater shrimp species in Curaçao. Four species constitute new and/or previously unpublished records for the island. Existing records for the neighbouring islands of Bonaire and Aruba are reviewed.

The most common species are *Macrobrachium carcinus*, *M. crenulatum*, and *Xiphocaris elongata*. *Macrobrachium heterochirus*, *Micratya poeyi*, and *Atya scabra* appear to be quite rare, while *M. lucifugum* and *Typhlatya monae* are limited to karst waters. Survey results for Curaçao reflect the detrimental effects of excessive damming, which blocks surface water flows and thereby prevents lifecycle migration of amphidromous species.

RÉSUMÉ

A partir d'une étude sur le terrain et des données existantes, dix espèces de crevettes d'eaux douces ont été identifiées de Curaçao et font l'objet de ce travail. La présence de quatre de ces espèces constitue des résultats nouveaux ou non encore publiés pour cette île. Les données existantes pour les îles voisines de Bonaire et Aruba sont examinées.

Les espèces les plus communes sont *Macrobrachium carcinus*, *M. crenulatum* et *Xiphocaris elongata*. *Macrobrachium heterochirus*, *Micratya poeyi* et *Atya scabra* apparaissent comme rares, tandis que *M. lucifugum* et *Typhlatya monae* sont limitées aux eaux karstiques. Les résultats des prospections sur le terrain à Curaçao reflètent les effets préjudiciables des barrages en excès, qui bloquent l'écoulement de l'eau de surface et empêchent ainsi la migration nécessaire des espèces amphidromes.

INTRODUCTION

While much information is already available on the rich endemic fauna of hypogean fresh- and brackish water microcrustaceans of Curaçao in general (e.g., Kensley, 1981; Stock, 1976a, 1977b, c, 1979, 1980; Stork, 1940; Wägele, 1982), little is known about the freshwater shrimps.

Since the review of the decapods published by Chace & Holthuis (1948), which documented three species of shrimp, three new species records have been published (Holthuis, 1977; Hobbs & Hart, 1982). As yet, nothing has been done that could be characterized as a truly extensive survey.

To obtain greater insight into the occurrence and present status of shrimp species in freshwater habitats of Curaçao, I conducted a 17-site island survey. Fishes and freshwater sponges were also collected but are reported on separately (Debrot & Van Soest, 2001; Debrot, in press). This report concerns the shrimps collected, and also provides a review of earlier records, several of which have remained unpublished until now. Descriptions of the species mentioned are not provided here, but can be found elsewhere (Chace & Hobbs, 1969; also partly in Hobbs & Hart, 1982; Hobbs et al., 1977).

STUDY AREA AND METHODS

Curaçao lies in the southern Caribbean, approximately 70 km from the coast of Venezuela. Total surface area is approximately 444 km² and the highest point is 375 m above sea level. Annual mean temperature is 27.5°C and annual rainfall averages 566 mm. The vegetation is principally xerophytic. Approximately 50% of the annual rainfall occurs in October-December. Record levels of rainfall occurred during the 1999 rainy season, particularly in December, when rainfall was about 248% higher than normal. Continued high levels of rainfall in the first quarter of the new year meant that many streams and dams retained water well into June of 2000.

The island is traversed by a large number of seasonal streams. In addition, a large number of agricultural water catchment dams, most of which were constructed by man during the colonial era, continue to be maintained. I selected ten dams, six streams ("rooi"), and one livestock watering hole ("pos") as principal sampling sites for a reasonable distribution across the island (sites 1-17, fig. 1). All principal sites were extensively sampled for crustaceans and fishes during a single daytime visit using a combination of fine mesh (4 mm) cast nets and dipnets (June-July 2000). Voucher specimens of all shrimp are deposited in the collections of the National Museum of Natural History, Leiden (RMNH).

I further report observations and/or specimens collected from six supplementary sites that were only studied incidentally (sites a-f, fig. 1), and three sites which were not visited during this study (sites g-i). At all principal sites and several supplementary sites, salinity and conductivity were measured to the nearest 2‰ and 0.5‰, respectively, using a YSI Inc. Model 30 salinity and conductivity meter, while pH was measured to the nearest 0.02 unit using a Fisher Accumet Model 230 pH meter. For each site, altitude above sea level (a.s.l.) is reported to the nearest 5 m.

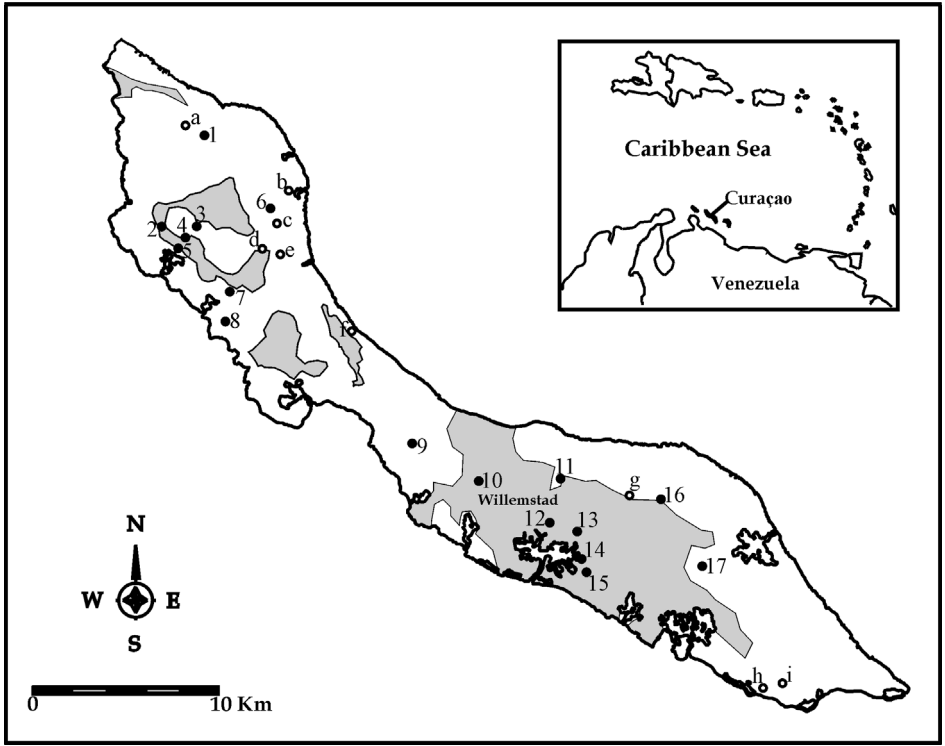


Fig. 1. Map of Curaçao showing principal (1-17) and supplementary (a-f) collection sites, as well as other sites (g-i) referred to in the text but not visited. Shading indicates populated areas.

Table I provides a brief overview of some habitat characteristics of the study sites for which measurements were available. Ranges for water parameter measurements for the 17 principal epigean study sites were as follows; pH: 7.15-9.15, conductivity: 1201-8780 μS ; salinity: 0.6-4.8 ppt.

All freshwater shrimp species known for Curaçao are listed below, along with the study sites at which each was documented. Brief notes are provided on each species.

SPECIES ACCOUNTS

ATYIDAE

Atya innocuous (Herbst, 1792)

Sites. — 1, 2, a.

Remarks. — Prior published records for Curaçao are for Santa Cruz, 1970 (det. L. B. Holthuis) by Kristensen, (1971, 1993), and for Santa Cruz and Hato by Hobbs

TABLE I

Habitat characteristics, as available, for principal and supplementary freshwater fauna sampling sites in Curaçao, on dates indicated

Site #	Location	Altitude a.s.l. (m)	Habitat type	Max. depth (cm)	pH	Conduct- ivity (μ S)	Salinity (ppt)	Date (2000/01)
Principal sites								
1	Rooi Baki, Savonet	20	stream	20	8.00	1449	0.7	5/vi/00
2	Rooi, Santa Cruz	20	stream	30	8.18	1201	0.5	5/vi/00
3	Dam, Hofi Hooi	10	dam	> 100	8.30	1772	0.9	6/vi/00
4	Rooi, Hanchi Buriku	5	stream	40	8.30	1725	0.9	6/vi/00
5	Rooi, Hofi Klein St. Martha	5	stream	40	7.15	2030	1.0	5/vi/00
6	Dam, Huish. Sch., Barber	20	dam	80	8.80	1843	1.0	5/vi/00
7	Dam di Rio Magdalena	30	dam	> 200	9.00	1260	0.6	6/vi/00
8	Pos di pia di Dr. Maal	10	water hole	> 500	7.90	2411	1.2	5/vi/00
9	Dam, Malpais	5	dam	> 200	8.05	2074	0.9	5/vi/00
10	Dam, Soltuna	15	dam	50	8.25	4092	2.2	4/vi/00
11	Dam di Muizenberg	20	dam	> 100	8.35	4499	2.4	6/vi/00
12	Rooi, Rio Canario	10	stream	50	8.45	2781	1.6	6/vi/00
13	Dam, Kabouterbos	10	dam	50	8.75	4466	2.4	2/vi/00
14*	Rooi, Bloempot	5	stream	50	8.05- 8.25	1916- 5100	1- 2.7	2/vi/00
15	Dam (pos SHERA) Girouette	10	dam	> 150	7.90	2166	1.1	2/vi/00
16	Dam, Hofi Ronde Klip	30	dam	> 100	9.15	8780	4.8	6/vi/00
17	Dam Pretu, Gr. St. Joris	15	dam	> 100	8.10	4037	2.1	5/vi/00
Supplementary sites								
a	Pos Shimaron, Savonet	50	spring	50	7.71	5630	3.3	6/vii/00
b	Playa Grandi, Wacao	0	salina	> 100	8.15	62900	40.7	13/vii/00
c	Rooi, Misa Barber	20	stream	—	—	—	—	—
d	Dokterstuin	40	dam	—	—	—	—	—
e	Pos Ariba, Dokterstuin	30	water hole	> 100	7.65	2479	1.3	17/vii/00
f	Kueba Shingot	5	cavern	> 500	7.14	7590	4.5	13/vi/01
g	Hofi Brievengat	20	stream	—	—	—	—	—
h	Spelonk di Fuik	5	cavern	—	—	—	—	—
i	Dam Koko	5	dam	—	—	—	—	—

* Site was almost at sea level and showed large differences in parameters over a short distance.

& Hart (1982). This species is found from Nicaragua to Panama and throughout the Greater and Lesser Antilles, south to Trinidad (Hobbs & Hart, 1982).

Atya scabra (Leach, 1815)

Sites. — Not collected in present survey.

Remarks. — This was one of only two species of shrimp recorded in the past, which was not collected in this study. The species is reported for Curaçao by Hobbs

& Hart (1982) based on two specimens collected by L. B. Holthuis at Santa Cruz in 1957. *Atya scabra* appears to be uncommon in Curaçao. It is a wide ranging species found from Argentina to Mexico, throughout the Caribbean and east to the west coast of Africa (Hobbs & Hart, 1982).

Micratya poeyi (Guérin-Méneville, 1855)

Sites. — Not collected in present survey.

Remarks. — Holthuis (1977: 272) mentioned this species from Cuba, Grenada, Barbados, and Curaçao. In the collections of the RMNH two samples from Curaçao are present, both involving 1 spm. and both originating from Santa Cruz. One sample was collected by L. B. Holthuis (4 January 1957), the other by A. C. J. Burgers and I. J. Hermans on 8 May 1957. Both specimens are adult.

Typhlatya monae Chace, 1954

Sites. — f.

Remarks. — The presence of the genus *Typhlatya* in cavern waters of Curaçao, Bonaire, and Aruba had been reported numerous times before (Stock, 1977a; Wagenaar-Hummelinck, 1979; Botosaneanu & Stock, 1979, 1982; Stock, 1982) and was identified for Bonaire by Stock as *Typhlatya monae*, but not published (Florijn & Visser, unpubl.). In this survey, *T. monae* was collected in 2 m of water in the cave of Shingot, Curaçao (1 spm., 13 June, 2001, RMNH D 48698, det. L. B. Holthuis). The species was also abundantly present in the brackish water cavern Spelonk di Fuik (site h) at salinities of 11 ppt, in March 1992 (Pors & Debrot, in prep.). This distinctively small, yellowish-orange species is common in cavern waters of Bonaire, where it is most abundant below the halocline and in oxygen-depleted waters (Florijn & Visser, unpubl.). *T. monae* is rapidly consumed in the presence of *Macrobrachium*. While both species prefer fresh water, *T. monae* only occurs in the vicinity of the latter species in caverns with stratified waters, where it apparently can escape predation by retreating to the deeper-lying salty and oxygen-depleted waters (Florijn & Visser, unpubl.). These records for the southern Caribbean (Curaçao and Bonaire) represent a large range extension for the species, heretofore only reported from Puerto Rico, Mona Island, the Dominican Republic, and Barbuda in the Lesser Antilles (Hobbs et al., 1977). The species is listed by the IUCN as “vulnerable”, and is characterized by populations being “small or restricted” (category VU-D2) (Hilton-Taylor, 2000).

XIPHOCARIDIDAE

Xiphocaris elongata (Guérin-Ménéville, 1856)

Sites. — 2, 3, 4, 5, 10.

Remarks. — The only prior record of this species from Curaçao is for Santa Cruz and dates from 1970 (det. L. B. Holthuis) (Kristensen, 1971, 1993). During this survey, the species was found at five sampling stations, making it the third most common species encountered. As reported by others, the species was particularly apt at evading capture by skipping across the surface of the water. The species is reported throughout the Greater and Lesser Antilles (Chace & Hobbs, 1969).

PALAEMONIDAE

Macrobrachium carcinus (Linnaeus, 1758)

Sites. — 1, 2, 3, 4, 5, 8, 10, 14, a.

Remarks. — Previous records for Curaçao, as well as for Aruba and Bonaire, are by Chace & Holthuis (1948; as *M. jamaicense*) and by Chace & Hobbs (1969). Kristensen (1971, 1993) makes additional mention of this species for Santa Cruz, Curaçao. Available records for Bonaire are limited to the south-central section of the island (Punt Vierkant, Kralendijk, Lac) (Chace & Holthuis, 1948; Florijn & Visser, unpubl.; Kristensen, 1975). This species is the largest native freshwater shrimp of Curaçao, often reaching sizes in excess of 43 mm CL. It was abundantly harvested by the inhabitants of the island, principally during May 2000, from streams and behind dams on the western half of the island and represents a valuable freshwater fishery resource.

The species is widely distributed and found from Florida, throughout the Greater and Lesser Antilles, south wards to Brazil (Chace & Hobbs, 1969). More detailed life history information on this species is provided by Lewis et al. (1966) and Choudhury (1971), while recent larval culture trials are reported by Herman et al. (1999).

Macrobrachium crenulatum Holthuis, 1950

Sites. — 1, 3, 4, 8, 14, a.

Remarks. — No prior published or unpublished records of this species for Curaçao could be found. However, *M. crenulatum* was the second most common species among the shrimps harvested by island inhabitants from streams and along dams in May 2000. Sizes were commonly in excess of 25 mm CL.

The species is widely distributed throughout the Greater and Lesser Antilles and has also been found from Panama to Venezuela (Chace & Hobbs, 1969).

Macrobrachium faustinum (De Saussure, 1857)

Sites. — 1, 4, 14.

Remarks. — Prior records for Curaçao and Bonaire are by Rathbun (in: Boeke, 1919: 324, as *M. olfersii*, cf. Holthuis, 1952: 93), Chace & Holthuis (1948), and Chace & Hobbs (1969). Kristensen (1971, 1993) reports additional records for Santa Cruz, Curaçao, while Florijn & Visser (unpubl.) provide unpublished records for many sites on Bonaire.

This species is found from the Bahamas throughout the Greater and Lesser Antilles (Chace & Hobbs, 1969), including Venezuela (Pereira, 1991). Hunte (1980) provides information on the rearing of larvae of this species in the laboratory.

Macrobrachium heterochirus (Wiegmann, 1836)

Sites. — c.

Remarks. — The only prior mention of this species for Curaçao is by Kristensen (1971, 1993) (det. L. B. Holthuis). This species was collected at only one site during this survey (supplementary site c) and appears to be uncommon.

The species has been reported from Mexico to Brazil and throughout the Greater and Lesser Antilles (Chace & Hobbs, 1969). Ching & Velez (1985) provide additional information on mating, incubation, and fecundity.

Macrobrachium lucifugum Holthuis, 1974

Sites. — f.

Remarks. — Prior records for this species for Curaçao and Bonaire are by Chace & Holthuis (1948) (as *Macrobrachium* sp.) and Holthuis (1974) (as a new subspecies, *M. faustinum lucifugum*). Additional unpublished records are provided for Bonaire by Florijn & Visser (unpubl.). In 1975, Chace described this as a new species, *M. crybelum*, while today it is known simply as *M. lucifugum* (cf. Hobbs, 1994). Two specimens were collected in surface waters (4.5 ppt.) from the cave of Shingot, Curaçao on 13 June 2001 (RMNH D 48699). The species is troglitic and was not found at the 17 main epigeic study sites.

It appears to be widely distributed in the West Indies and has also been reported from Cuba, the Dominican Republic, Puerto Rico, Jamaica, and Bonaire (Hobbs, 1994).

DISCUSSION

This paper presents four new and/or previously unpublished records of shrimp species for the island of Curaçao (*Typhlatya monae*, *Xiphocaris elongata*, *Macrobrachium crenulatum*, and *M. heterochirus*). The known freshwater shrimp fauna

of the island now amounts to ten species. This is considerably less than on a number of other Lesser Antillean islands, such as St. Lucia and Guadeloupe (Barnish, 1984; Fièvet et al., 2001), but more than on the smaller and more arid neighbouring islands of Bonaire and Aruba. The scarcity of shrimp species in Curaçao is no doubt partly due to the general aridity of the island and the scarcity of fresh- and brackishwater habitats. Eight of the above ten species were found in the survey reported here. A record of *M. amazonicum* (Heller, 1862) erroneously ascribed to Curaçao by Bunkley-Williams & Williams (1998) is based on specimens reported by Nierstrasz & Brender à Brandis (1925) for Surinam (L. B. Holthuis, pers. comm.). Therefore, no records for this species exist for Curaçao.

The most common shrimps in epigean waters were *M. carcinus*, documented from eight of the 17 sites, *M. crenulatum* and *X. elongata* (respectively, at six and five of 17 sites). Epigean shrimp assemblages were clearly dominated by predatory palaemonids (*Macrobrachium*). The two known cavernicolous species (*T. monae* and *M. lucifugum*) were not collected at any of the 17 main epigean collection sites but were exclusively found at the only cavern water site visited (site f). Such sites (e.g., also site h) are relatively rare on Curaçao, in contrast to Bonaire, where they are numerous (Florijn & Visser, unpubl.).

In Curaçao, epigean freshwater shrimps are typically considered a phenomenon of the central-western sections of the island, where rainfall is somewhat higher (Meteorological Service, 1982) and nature is less disturbed. In this survey, few sites on the eastern part of the island were studied. However, earlier in the season unidentified shrimp were reported to have been abundantly harvested in a seasonal stream at Brievengat (site g). Also, Mr. G. Doran reports to have harvested large numbers of shrimp from Dam Koko (site i) in the past. Thus, while epigean freshwater shrimp indeed appear to be most common in the central-western sections of the island, they certainly also occur in the eastern regions.

There is a growing body of recent literature on various aspects of the ecology of West Indian freshwater shrimps (e.g., Benstead et al., 2000; Covich, 1988; Covich et al., 1996; Covich et al., 1998; Covich et al., in press; Fièvet et al., 2001; Holmquist et al., 1998; Pringle et al., 1993). Nevertheless, relatively little is known about the potential lifecycle mechanisms that would permit these species to maintain themselves on arid islands such as Curaçao.

Due to the low amount as well as the highly seasonal nature of annual rainfall in Curaçao, the freshwater epigean stream habitat, which most of the species prefer, is only available for a short period each year. During the dry season, usually lasting anywhere from 8 to 10 months annually, fresh water is extremely scarce and the question is how the shrimp fauna is able to survive that dry season. Several species are long-lived (Covich et al., in press; *M. faustinum* > 6 yrs in the author's garden fish basin) and most species can tolerate a range of salinities ranging from fresh to

brackish conditions (Ching & Velez, 1985; Lewis et al., 1966). Therefore, possible habitats for dry season survival include (1) estuarine areas, (2) accessible pools and/or wells along the drainage areas, (3) rare feeder springs, or (4) subterranean karst waters. With respect to this latter issue, Hobbs (1994) lists four of the seven epigeal species found in Curaçao as having been found in subterranean waters elsewhere, while Florijn & Visser (unpubl.) document both of the epigeal species known from Bonaire, in cavern waters on that island. Certain species appear able to survive early moults under near-seawater salinities (e.g., *M. carcinus*, cf. Choudhury, 1971). Therefore, some species might not even survive from year to year as adults but, circumstances permitting, (5) recruit from pelagic larvae originating from elsewhere. Any or several of these mechanisms may be used opportunistically, but which, if any, predominate for any given species requires further study.

As full larval development requires access to brackish conditions (e.g., Benstead et al., 2000), the freshwater shrimp fauna of the Caribbean is characterized by amphidromy, whereby up- or downstream migration of one or more life stages is required. High dams, which eliminate surface water flow, therefore, also eliminate the native fauna (e.g., Holmquist et al., 1998). No shrimps were found at nine of the seventeen principal sites and three of the six supplementary sites. Three of the nine principal sites that had no shrimps present were isolated by high dams, which totally cut off surface flows (sites 7, 9, 17), while four others were dam pools isolated from marine linkage due to a combination of other dams and channelization (sites 11, 13, 15, 16). For the remaining two sites (one dam pool and one stream, respectively, sites 6 and 12), the absence of shrimps could not readily be accounted for.

Since colonization by western man, the hydrology of Curaçao has been severely altered through massive deforestation and desertification, as well as water extraction, impoundment, channelization, and contamination. The status of all freshwater shrimp species in Curaçao is precarious at best, not only because of the natural scarcity of the freshwater habitat but also because of its increasing vulnerability to anthropogenic impacts.

ACKNOWLEDGMENTS

I thank Brian Leysner, Oscar Frans, and Frank Isabella for field assistance, Klaas Dekker for the water quality measurements, and Leon Pors for drawing the map. I further thank Noris and Glen Doran for bringing me their initial specimens, which inspired this study. I am grateful to Dr. Lipke Holthuis for identifying all shrimps and for providing much additional information. Drs. Leopoldo Miranda-Castro,

Bert Williams, Alan Covich as well as Krista Jones, Eric Newton, Tom Gilleland, and Tineke Prins are thanked for help in locating literature. This work was made possible by the Island Government of Curaçao and the Central Government of the Netherlands Antilles by means of their annual subsidy to the CARMABI Foundation.

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