

## THE DUTCH CARIBBEAN

## The stoneworts of Bonaire and Curaçao in 2023

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## Key words

Bonaire  
Curaçao  
Antilles  
*Chara*  
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stonewort  
distribution

**Abstract** – Very little research has been done on the stoneworts (Characeae) of the Caribbean islands. This also applies to the stoneworts of the Dutch Caribbean islands Bonaire and Curaçao (Leeward Antilles). Hitherto, only stoneworts which happened to be collected between 1930 and 1959 during studies of other groups of organisms formed the basis of our knowledge. Eight taxa are known from Bonaire and Curaçao.

Early 2023, the first author made a targeted survey for stoneworts on Bonaire and Curaçao. His survey had the great advantage that the rainy season prior to the survey was extremely wet, which resulted in much more fresh water on the surface of the islands than during the wet seasons in previous years. Nevertheless, only three taxa were found: *Chara armata*, *C. leptosperma*, and *C. zeylanica* f. *elegans*. The latter taxon appeared to be quite common on both islands, sometimes filling entire water bodies, while *Chara armata* was only found in a single location on Curaçao. *Chara leptosperma* is new for Bonaire and Curaçao. The cause of the possible decline in the number of stonewort species is not quite clear.

**Samenvatting** – Er is nog slechts heel weinig onderzoek gedaan naar kranswieren op de Caribische eilanden. Dat geldt ook voor Bonaire en Curaçao (Benedenwindse Eilanden, Nederlandse Caribische eilanden). Alleen kranswieren die tussen 1930 en 1959 verzameld zijn tijdens onderzoek naar andere groepen organismen vormen de basis van onze kennis over kranswieren op deze eilanden. Van Bonaire en Curaçao zijn acht taxa bekend.

Begin 2023 heeft de eerste auteur Bonaire en Curaçao gericht geïnventariseerd op het voorkomen van kranswieren. Het onderzoek werd bevorderd door een extreem nat regenseizoen voorafgaand aan de inventarisatie, waardoor aan het oppervlak veel meer zoet water aanwezig was op de eilanden dan tijdens de natte seizoenen in eerdere jaren. Desondanks zijn slechts drie taxa aangetroffen: *Chara armata*, *C. leptosperma*, en *C. zeylanica* f. *elegans*. Het laatstgenoemde taxon bleek vrij algemeen op beide eilanden en vult soms zelfs hele waterlichamen op, terwijl *Chara armata* slechts op één locatie op Curaçao gevonden is. *Chara leptosperma* is nieuw voor Bonaire en Curaçao. De oorzaak voor de mogelijke achteruitgang van het aantal soorten is niet geheel duidelijk.

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## INTRODUCTION

Bonaire and Curaçao are dry islands in the tropical Caribbean with a rainfall of 400–600 mm per year. Precipitation mainly falls in the rainy season (October–December), in the dry season it can be dry for a long time. Therefore permanent fresh water is scarce. Nevertheless, several species of Characeae are known from Bonaire and Curaçao. During an inventory by

the first author in January and February 2023 an attempt was made to map the present occurrence of Characeae.

As fresh water is a necessity for people and animals, during a long time efforts have been made to detain the fresh water on the islands and to create places with permanent fresh water. Several types of fresh water localities can be distinguished:

1. Freshwater springs. – There are a few natural freshwater springs on both islands. On Bonaire, Put Bronswinkel and

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Pos Mangel in National Park Washington Slagbaai are well-known springs; on Curaçao this applies to the freshwater spring Roi Rincon near the Hato airport. In the past, these springs were mainly located in open areas, but nowadays these springs are surrounded by increasingly dense forests. As a result, their character has changed considerably. There are no significant flowing streams on these islands.

- 2. Man made wells. – Dozens of wells have been dug on both islands. In the past, they were essential for obtaining fresh water, but due to the production of drinking water from sea-water nowadays, many wells fell into disuse and do not contain water any longer. Moreover, they are frequently located in private gardens and not easy accessible for our research.
- 3. Freshwater ponds behind dams. – Especially at the beginning of the 20<sup>th</sup> century many dams were constructed to create freshwater ponds or lakes. These reservoirs can be very large, such as Muizenberg on Curaçao. Dam Grandi is a well-known dam with a fresh water lake on Bonaire. Some of these lakes still contain fresh water more or less permanently, but only in the wettest years, although dams are more and more actively maintained.
- 4. Temporary puddles and pools. – During periods of heavy precipitation, temporary pools can form, e.g., on the limestone plateaus but also elsewhere.

Finally, it should be mentioned that in a karst landscape there is much more fresh water underground, accessible via caves. These locations were not included in the study as they lack daylight and therefore aquatic plants are not able to grow there.

Previous research into stoneworts on Bonaire and Curaçao

To our knowledge, no specific research has ever been conducted into the occurrence of stoneworts on the two islands. However, P. Wagenaar Hummelinck did extensive fieldwork in the period 1930–1973 in many locations with fresh or brackish water, mainly into the occurrence of mollusks, but he also collected and carefully preserved many other organisms. The first taxonomic study

of Characeae on the islands based on this material is by Zaneveld (1942), followed by more extensive research by van den Hoek (1959). Various other researchers reported the occurrence of stoneworts in fresh water, but only as part of the description of a location for other purposes, often based on the material of Wagenaar Hummelinck (e.g., de Ridder 1977, Koster 1960). Van den Hoek (1959) presents an overview of many types of seaweeds in fresh and brackish water on the islands of Curaçao, Bonaire, and Aruba and he also mentions the occurrence of five taxa of stoneworts on Bonaire and Curaçao (Table 1). Van den Hoek separately mentions the taxa found on Klein Bonaire. Klein Bonaire is an almost completely flat island located near Bonaire. Currently it is not permanently inhabited and freshwater locations are nearly absent.

Guerlesquin (1985) presented an overview of the Characeae of the Caribbean islands and reported three taxa for the Dutch Caribbean islands Bonaire and Curaçao in addition to the taxa also mentioned by van den Hoek (1959). It is, however, unclear when Guerlesquin’s three taxa were found and whether their discovery is the result of her own field research.

MATERIAL AND METHODS

The first author participated in a large-scale study into biodiversity on Bonaire organized by Naturalis Biodiversity Center in Leiden, the Netherlands. In the context of this study, he made a targeted survey for stoneworts on Bonaire in January and February 2023. For this, he examined most locations with fresh surface water which are present on Bonaire, including Klein Bonaire. Afterwards he visited Curaçao and investigated again as many water bodies as possible to collect stoneworts. The found stoneworts were preserved in alcohol, there is no dried material.

The last standard review of stoneworts in the world dates from 1964 and 1965 (Wood & Imahori 1964, 1965). It is confusing that, also by Wood & Imahori, many stonewort taxa have been classified as a variety or form of *Chara zeylanica* J.G.Klein ex Willd.

Table 1. The Characeae reported from Bonaire and Curaçao (Guerlesquin 1985, van den Hoek 1959). The nomenclature follows AlgaeBase (Guiry & Guiry 2024).

\* It is unclear which (infraspecific) taxon Guerlesquin (1985) had in mind when citing this name.  
\*\* All new names given and new combinations made by van Raam (2010) are unfortunately invalid.

Source	Scientific name	Bonaire	Klein Bonaire	Curaçao
van den Hoek (1959)	<i>Chara armata</i> Meyen ex Kütz. (syn. <i>Chara zeylanica</i> Willd. f. <i>armata</i> (Meyen ex Kütz.) Zaneveld)		X	
van den Hoek (1959)	<i>Chara guatemalensis</i> (Nordst.) C.B.Rob. (syn. <i>Chara zeylanica</i> J.G.Klein ex Willd. f. <i>guatemalensis</i> (Nordst.) Zaneveld)			X
van den Hoek (1959)	<i>Chara hornemanii</i> Wallman (syn. <i>Lamprothamnium hornemannii</i> (Wallman) F.K.Daily)	X		
Guerlesquin (1985)	<i>Chara inconstans</i> A.Braun ex Kütz. var. <i>oerstediana</i> A.Braun (syn. <i>Chara zeylanica</i> J.G.Klein ex Willd. f. <i>oerstediana</i> (A.Braun) R.D.Wood)			X
Guerlesquin (1985)	<i>Chara zeylanica</i> J.G.Klein ex Willd. *	X	X	X
Guerlesquin (1985)	<i>Chara zeylanica</i> J.G.Klein ex Willd. f. <i>elegans</i> (A.Braun ex T.F.Allen) H.&J.Groves (syn. <i>C. zeylanica</i> J.G.Klein ex Willd. var. <i>elegans</i> (A.Braun ex T.F.Allen) Raam, nom. inval.) **		X	X
van den Hoek (1959)	<i>Chara zeylanica</i> J.G.Klein ex Willd. f. <i>michauxii</i> (A.Braun) H.&J.Groves (syn. <i>Chara foliolosa</i> Muhl. ex Willd. var. <i>michauxii</i> (A.Braun ex Kütz.) Raam, nom. inval.) **			X
van den Hoek (1959)	<i>Chara zeylanica</i> J.G.Klein ex Willd. f. <i>trichacantha</i> (A.Braun) H.&J.Groves	X	X	



Fig. 1. Locations with stoneworts on Bonaire: 1. Pos Gurubu (two ponds); 2. Two ponds near Kaya Gavilan in Kralendijk; 3. Ditch along Kaya Hulanda in Kralendijk. Source background map: [www.openstreetmap.org](http://www.openstreetmap.org).

Nevertheless, we decided to use Wood & Imahori (1964, 1965) for the identification of our specimens, because it is still the best work available for Bonaire and Curaçao.

The nomenclature follows AlgaeBase ([www.algaebase.org](http://www.algaebase.org); Guiry & Guiry 2024). The alcohol material of the specimens collected by the first author will be preserved in the herbarium of Naturalis Biodiversity Center (L) in Leiden, the Netherlands.

## RESULTS

The rainy season of 2022–2023 in the Leeward Antilles was extremely wet, implicating there was much more fresh water present on Bonaire and Curaçao during the survey in January and February 2023 than in previous years. However, this extra availability of water had little or no positive influence on the occurrence of stoneworts, they being absent in most ponds and puddles.

In total, stoneworts were found at three locations on Bonaire (Fig. 1) and five locations on Curaçao (Fig. 2). These stoneworts belong to three taxa: *Chara armata* Meyen ex Kütz., *C. leptosperma* A.Braun, and *C. zeylanica* f. *elegans* (A.Braun ex T.F.Allen) H.&J.Groves (*C. zeylanica* var. *elegans* (A.Braun ex T.F.Allen) Raam, nom. inval.).

All three taxa were found on Curaçao, while two of them were found on Bonaire as well: *Chara leptosperma* and *C. zeylanica*

f. *elegans* (Table 2). *Chara zeylanica* f. *elegans* (Fig. 3) was already known from Curaçao and Bonaire (Table 1). *Chara zeylanica* is a widespread species in North, Central, and South America (Wood & Imahori 1965), although on their website AlgaeBase Guiry & Guiry (2024) suggest a distribution that is limited to South-West Asia. This illustrates the still confusing taxonomy of this species. *Chara leptosperma* (Fig. 4) has a widespread distribution in large parts of the world (Wood & Imahori 1965, as. *C. globularis* var. *leptosperma* (A.Braun) R.D.Wood), although Guerlesquin (1985) does not report this species from the Caribbean. In any case, *Chara leptosperma* is a new record for both Bonaire and Curaçao.

The richest stonewort locations were two small lakes near Soto on Curaçao (Fig. 5). These lakes were (almost) completely filled with *Chara zeylanica* f. *elegans*, which covered an area of more than one hectare, virtually without any other aquatic species. *Chara zeylanica* f. *elegans* is also the most common species on Bonaire and Curaçao. On Curaçao it abundantly occurred in Malpais Estate and on Bonaire it was present in several ponds of Pos Gurubu and in ditches and ponds in Kralendijk (Table 2). All these waters are generally clear and most of them contain no or only few other aquatic plants, e.g., *Echinodorus berteroi* (Spreng.) Fassett. In 2023, *Chara zeylanica* f. *elegans* was also found on Aruba by J. Janssen (pers. comm., identification by E. Nat).

Despite the earlier records of stoneworts of Klein Bonaire (e.g., van den Hoek 1959), stoneworts were completely absent from

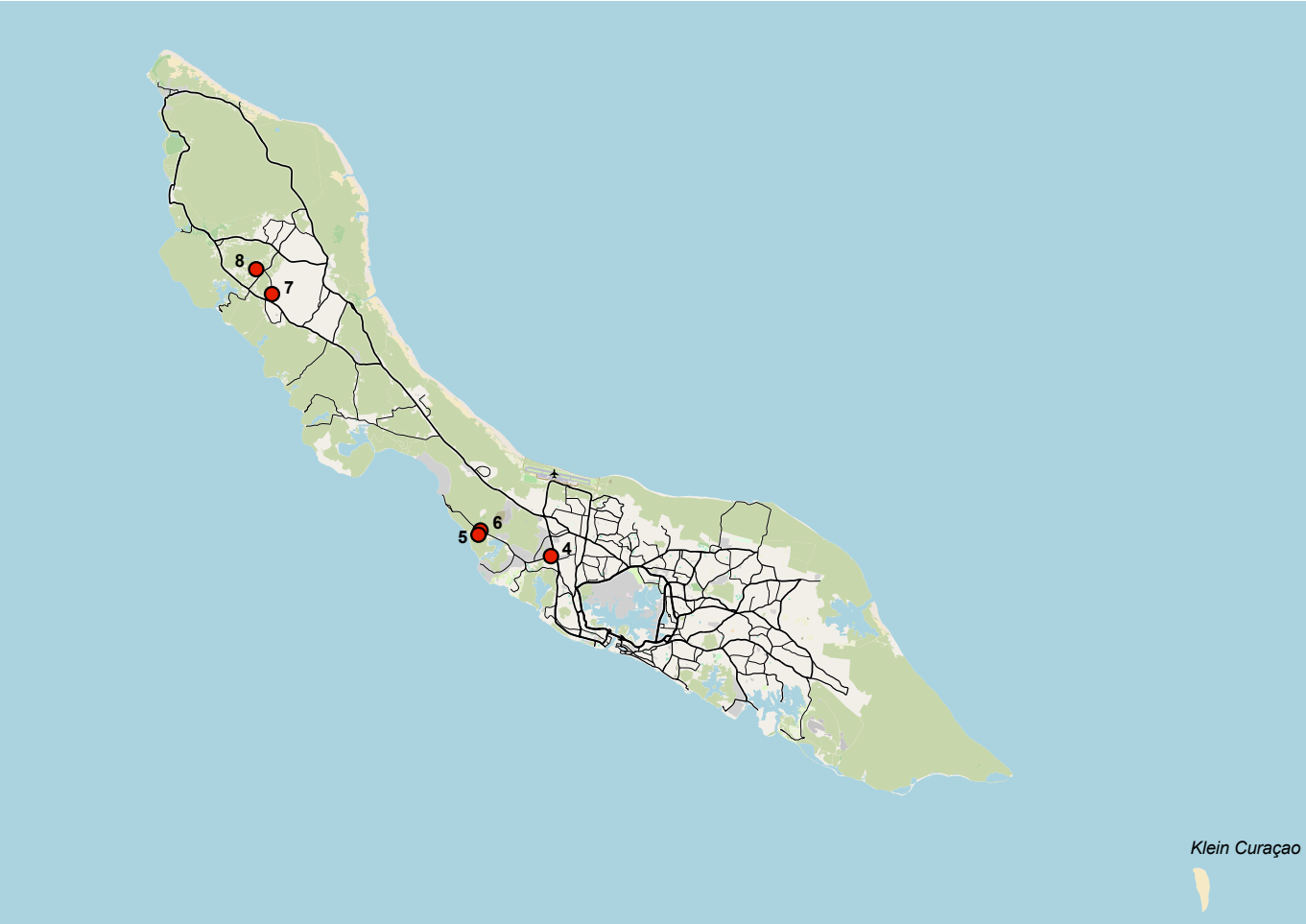


Fig. 2. Locations with stoneworts on Curaçao: 4. Pond opposite supermarket along the start of the Weg naar de Bullenbaai (road to the Bullenbaai) in Willemstad; 5. Malpais Estate in dried up lake north of the main road; 6. Malpais Estate, in two ponds south of the main road; 7. Small pond east of Soto; 8. Small pond north of Soto. The little island of Klein Curaçao was not surveyed. Source background map: [www.openstreetmap.org](https://www.openstreetmap.org).

Table 2. The stonewort species (*Chara spec.*) found during the targeted survey for stoneworts on Bonaire and Curaçao in 2023.

Species	Island	Location	Coordinates
<i>Chara armata</i> Meyen ex Kütz.	Curaçao	Malpais Estate in a dried up pond north of the Weg naar de Bullenbaai	N 12.161600 W -68.997900
<i>Chara leptosperma</i> A.Braun	Curaçao	Willemstad, pond opposite the supermarket in the corner of the Weg naar de Bullenbaai and the Rondeweg	N 12.149200 W -68.964300
	Bonaire	Pos Gurubu	N 12.193136 W -68.262766
	Bonaire	Ponds along Kaya Gavilan in Kralendijk	N 12.155919 W -68.268280
<i>Chara zeylanica</i> J.G.Klein ex Willd. f. <i>elegans</i> (A.Braun ex T.F.Allen) H.&J.Groves	Curaçao	Near Malpais Estate south of the Weg naar de Bullenbaai	N 12.161100 W -68.997300
	Curaçao	Pond north of Soto	N 12.287300 W -68.108900
	Curaçao	Pond east of Soto	N 12.274700 W -68.100900
	Bonaire	Pos Gurubu	N 12.193136 W -68.262766
	Bonaire	Ponds along Kaya Gavilan in Kralendijk	N 12.155919 W -68.268280
	Bonaire	Ditch along Kaya Hulanda in Kralendijk	N 12.146714 W -68.273129

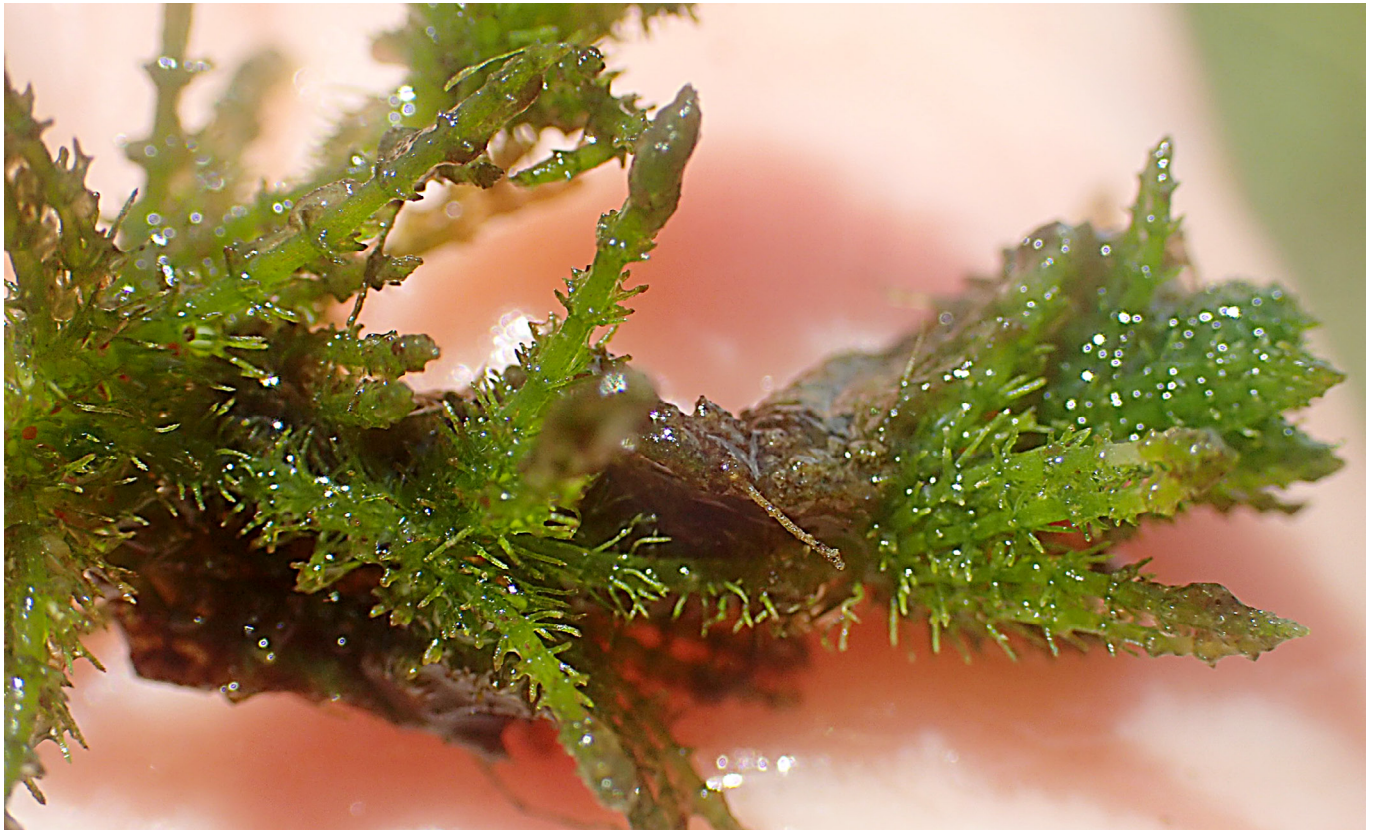


Fig. 3. *Chara zeylanica* Willd. f. *elegans* (A.Braun ex T.F.Allen) H.&J.Groves in a pond near Malpais Estate south of the Weg naar de Bullenbaai, Curaçao. Photo: Sylvia van Leeuwen.

this little island due to the lack of suitable habitats, at least on January 25, 2023. This, of course, also applies to *Chara armata*, which has been previously reported from Klein Bonaire (van den Hoek 1959), but is apparently not known from any other Caribbean island (Guerlesquin 1985). Wood & Imahori (1965) as well as AlgaeBase (Guiry & Guiry 2024) suggest a Pacific distribution for the species (Sherwood 2004, van Raam 2010), but give no further information about its occurrence in the Caribbean region. We saw, however, a new population of *C. armata* at a single location in Curaçao, although it was only represented by a small amount of drying material in a dried up puddle on the grounds of the Malpais country house (landhuis Malpais). Despite the small quantity of material, this find represents not only the first record of *Chara armata* for Curaçao, but also the first record of this species on another Caribbean island than Klein Bonaire.

#### COMPARISON OF THE THREE STONEWORT TAXA

*Chara leptosperma* closely resembles *C. globularis* Thuill. and has actually been described as a variety of the latter by Wood (1962: 10). Both taxa are triplostichous. Their main axes are slender, the spine-cells are small (papillose), and the branchlets are corticated over nearly their entire length. A significant difference is, however, that the stipulodes of *C. globularis* are small, whereas they are well developed in both rows of stipulodes in *C. leptosperma*. *Chara armata* and *C. zeylanica* f. *elegans* also resemble *C. globularis*, but in these species the part of the main axes just over the branchlet whorl is ecorticate. Furthermore, *C. zeylanica* f. *elegans* is characterised by having relatively long bracteoles and long stipulodes, which are longer than the width of the main axes when at maximum length. Our specimens of

this taxon show much morphological variability, but all of them have branchlets (laterals) which are short in comparison with the branchlets of *C. leptosperma*. *Chara zeylanica* f. *elegans* was raised to variety level by van Raam (2010), but since this CD-ROM does not constitute effective publication within the meaning of the Code (Turland et al. 2018; Art. 29, Art. 30), the combination *Chara zeylanica* var. *elegans* (A.Braun ex T.F.Allen) Raam is invalid. Hence we use the name *Chara zeylanica* f. *elegans* for this taxon. We would like to make clear that it is beyond the scope of this study to make further investigations to determine the taxon's infraspecific rank.

*Chara armata* is treated by Wood & Imahori (1964, 1965) as part of the *C. zeylanica*-complex. The species is characterised by the irregular number of corticated branchlet segments in a whorl, usually being 4 or more.

Elaborate descriptions and illustrations of the three taxa are given by Wood & Imahori (1964, 1965).

#### DISCUSSION

Despite the fact that our study focusing on stoneworts was conducted after an extremely wet rainy season and the first author visited most publicly accessible waters on Bonaire and Curaçao, only three stonewort taxa were found, where eight taxa are known from these islands (Table 1). An explanation for this difference is, of course, that our research was only conducted over a short period of time, while the previous finds were made over a much longer period. Another, perhaps unlikely, reason for the difference might be that the considerable amount of morphological variation within *Chara zeylanica* f. *elegans*



Fig. 4. *Chara leptosperma* A. Braun in a pond along Kaya Gavilan in Kralendijk, Bonaire. Photo: Sylvia van Leeuwen.

– like we observed in our own material – has been overlooked as morphological plasticity, which in previous studies may have led to misidentifications of apparently different specimens; we have, however, no evidence for this. A more plausible explanation for the higher number of previously reported taxa is that Wagenaar Hummelinck visited many wells dug during the period 1930–1973, which may have regularly contained stoneworts. Many of these wells have now fallen into disuse and dried up. It is possible that there are nowadays still wells with fresh water and stoneworts on private land, but in any case far fewer than before. Janssen (pers. comm., January 2024), who conducted an extensive study about aquatic vegetations on Bonaire in 2023–2024, reported two additional stonewort locations: an additional location near near Pos Gurubu and on the Amboina section of the agricultural organization Landbouw, Veeteelt & Visserij (LVV.) Unfortunately, no material was collected safely and the identity of the stoneworts on these two locations is not known.

Many freshwater ponds behind dams were either dry for many years before containing water again in 2023 or only contained water for very short periods in the rainy season. However, it is unlikely that the previous periods of desiccation explains the

absence of stoneworts during our survey, because stonewort spores can remain dormant in the soil for a long time and before germinating under favourable conditions (e.g., [Arbeitsgruppe Characeen Deutschlands 2016](#), [Moore 1986](#); an extreme example is given by [Stobbe et al. 2014](#)). In 2023, the first author observed seedlings and juvenile plants of several species of flowering plants on the banks of several ponds, indicating the presence of a viable seed bank, which might be an indication for a viable spore bank as well.

In 2023, the stoneworts occurred mainly in ponds with deep waters, which probably only dry up in very dry years or only during short periods of the dry seasons. Even in these more or less permanent ponds there were often only a few other aquatic plants present, for example some *Lemna aequinoctialis* Welw. An exception was a ditch on Bonaire with an abundant aquatic plant vegetation, which included, e.g., *Typha domingensis* Pers., *Najas marina* L., and *Eichhornia crassipes* (Mart.) Solms.

In conclusion, the number of stonewort taxa currently present on Bonaire and Curaçao showed significant decrease compared to the situation 50–80 years ago and it seems that they have completely disappeared from Klein Bonaire.



Fig. 5. A small lake east of Soto, Curaçao, completely filled with *Chara zeylanica* Willd. f. *elegans* (A.Braun ex T.F.Allen) H.&J.Groves. Photo: Bart van Tooren.

Hopefully, there will be more attention for stoneworts occurring on Aruba, Bonaire, and Curaçao in the near future and we hope this will give us better insight in the stonewort diversity of these islands.

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