

# The ants (Hymenoptera: Formicidae) of Saba (Netherlands Antilles)

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## INTRODUCTION

Saba is one of the smallest islands in the Caribbean at around 13 km<sup>2</sup> and the smallest of all Leeward islands (Table 1). The closest islands from Saba are 34 km (Sint Eustatius), 48 km (Sint Maarten) and 49 km (Saint-Barthélemy). The highest peak of the island is a dead volcano named Mount Scenery and is 870 m high, higher than that of the surrounding islands: Sint Eustatius 601 m, Sint Maarten 411 m and Saint-Barthélemy 286 m. The occurrence of various landscape types on Saba is remarkable, with tropical rain forest (fig. 1) and desert (fig. 2) as extremes.

Saba is a "special" Dutch municipality. The island belongs topographically to the Leeward Islands, a group of islands located where the northeastern Caribbean Sea meets the western Atlantic Ocean. Starting with the Virgin Islands, located east of Puerto Rico, they extend southeast to Guadeloupe and its dependencies (Wikipedia).

Fig. 1 Tropical rainforest on Saba, vegetation type *Heliconia-Charianthus Mountains*.



Fig. 2 Desert like landscape on Saba, vegetation type *Aristida-Bothriochioa Mountains*



Before we started this research on Saba ants, only two ant species from the island were known. However in 1937, 1949 and 1963 P. Wagenaar Hummelinck collected ant samples on Saba. P. H. Cobben did the same in 1956.

In March 2018, an ant focused inventory was made by the first author. This paper focusses superficially on the differences between the ants of Saba and other Leeward islands. As remarkably little is known about the ant fauna of these islands (table 1), such a comparison makes little sense,. Only for the relatively large island Guadeloupe much is known about the ant fauna. The same applies to the even larger island of Puerto Rico (8870 km<sup>2</sup>), the closest large island, with 91 ant species.

Table 1. Leeward Islands (sorted in order from northwest to southeast), their surface and their number of ants according to specification of AntWiki (April 2019) and the number of ant species which are only mentioned from this (group of) island(s) of the Leeward Islands (unique).

\* The number of ant species of Saba is presented here for the first time.

() between brackets: Sint Eustatius is a provisional counting from us (paper in preparation), also that of Saint Martin/Sint Maarten (French and Dutch part).

<b>Leeward Islands</b>	<b>Surface (km<sup>2</sup>)</b>	<b>Species</b>	<b>Unique</b>
<i>US Virgin Islands</i>	346	7	1
<i>British Virgin Islands</i>	151	9	3
<i>Anguilla</i>	91	10	0
<i>St Maarten/Martin</i>	87	(24)	(0)
<i>St Barthelemy</i>	21	0	-
<i>Saba</i>	13	42*	4*
<i>St Eustatius</i>	21	(56)	(6)
<i>St Kitts &amp; Nevis</i>	267	2	0
<i>Antigua &amp; Barbuda</i>	442	6	0
<i>Montserrat</i>	102	2	0
<i>Guadeloupe</i>	1705	89	51
<b>Total</b>	<b>3246</b>	<b>121</b>	<b>65</b>

## METHODS

In 1937, 1949 and 1963 P. Wagenaar Hummelinck collected vertebrates with some co-operators. The ants of these expeditions were selected and stored (in alcohol) in the collection of Naturalis Biodiversity Center Leiden Netherland (RMNH). Collecting was done by handpicking, using a knife, forceps, a beetle-sieve and a fine meshed dip-net (Wagenaar Hummelinck 1970) on 30 sites, where on 17 sites ants were found (fig. 4). Sites are distributed over the whole island and where (re)visited during different years. We sorted the ants by species and the final identification was done by P. Boer. Between 7 and 17 March 2018 P. Boer collected ants on Saba. All routes were covered on foot. In the first place, foraging ants were actively looked for, stones were turned, vegetation was scraped off, litter was blown out, plants and trees were searched and tube traps (fig. 3) with attractants were used. These tube traps were filled with liqueur (Leroux Triple Sec Liqueur 15%; Natural Fruit Flavor). The chance to spot ants was not optimal, since it had hardly rained after hurricane Irma (September 2017). It was therefore very dry, which meant that certain species of ants sheltered deep into the earth and thus hide from sight. In addition, many trees had fallen during the recent hurricane, which hindered access here and there and caused local damage to nature. We know for sure that a number of species were not found, which had to be present on Saba.

Fig. 3. Tube trap in carton nest of termites.



With the help of vegetation maps (Freitas, et al., 2016) a route with interesting sites was mapped out, so that the most important vegetation types could be visited. Habitat data were noted. All collected material was stored in labeled tubes and preserved in 70% ethanol. Some of the material is set on pin, some as glass preparations and the rest of the material is kept in ethanol, so that DNA extraction remain possible. All material is kept in the collection of Naturalis Biodiversity Center Leiden Netherlands.

Sample sites are shown in fig. 4.

Identification of the ants was not simple, because there are no identification keys with regard to the Caribbean. First of all, we examined which ant species were found in the Caribbean, using [www.antweb.org](http://www.antweb.org) (hereinafter referred to as AntWeb) and [www.antwiki.org](http://www.antwiki.org) (AntWiki). Subsequently identification keys were made. Here, we faced many problems, for example because species descriptions are regularly organized in such a way that comparisons are often impossible. For example, the setosity of one species are treated and nothing is said about the structure of the pronotum, whereas with a similar species it is exactly the opposite. The photo archive of AntWeb has proven to be a useful tool in finding (not yet) clearly described features. Yet we also encountered

problems there. We found specimen photos on AntWeb appearing to be different from other imaged specimens of the same species. These types of images were not taken into consideration. Photographed type specimens were used as much as possible. Some of the most helpful publications that helped us identify and create keys are Deyrup (2017); Fisher & Cover (2007); Wilson (2003); Snelling & Torres (1998), Kallal & LaPolla (2012) and the many keys published on AntWiki. See also the literature list.

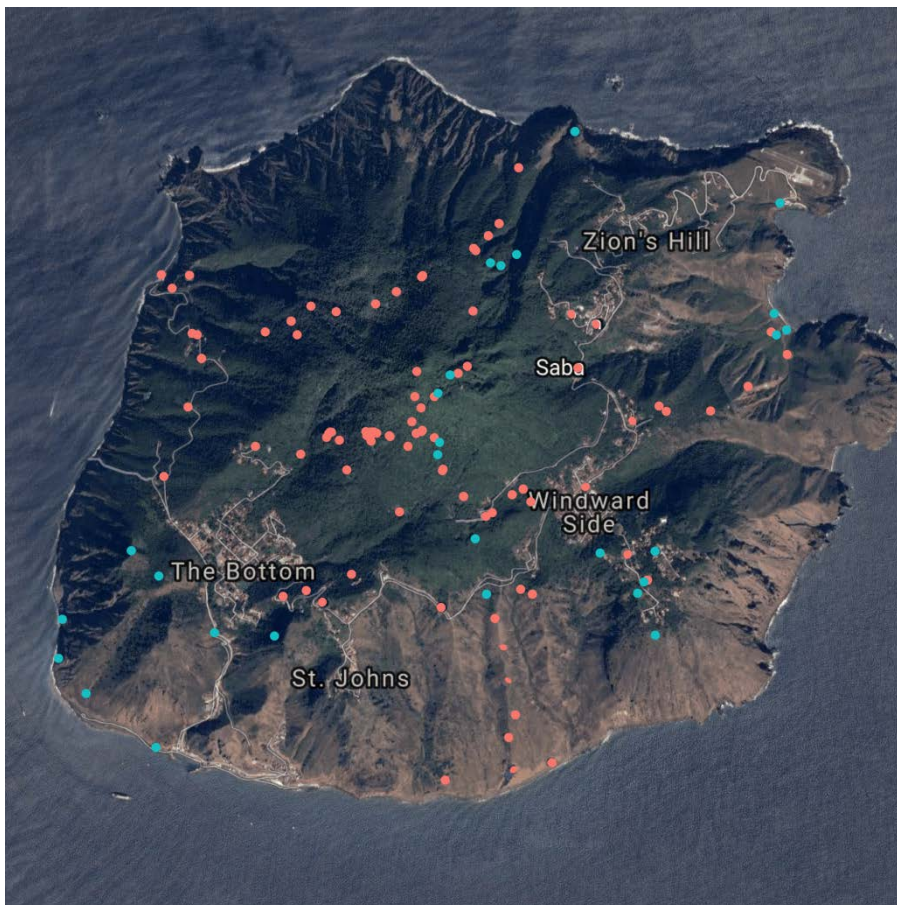
Abbreviations for the vegetation types on Saba (Freitas et al 2016):

- C cliffs, coast
- U Urbanized areas
- M1 Heliconia-Charianthus Mountains
- M2 Philodendron-Marcgravia Mountains
- M3 Philodendron-Inga Mountains
- M4 Swietenia Mountains
- M5 Cocoloba-Wedelia Mountains
- M6 Cocoloba-Inga Mountains
- M7 Aristida-Bothriochioa Mountains

Numeric characters

- CL Maximum cephalic length in median line
- CW Maximum cephalic width, across eyes
- SL Maximum straight line scape length excluding articular condyle

Fig. 4. Collection sites by Wagenaar Hummelinck (1937, 1949 and 1963; blue dots) and Boer (2018; red dots).



## THE SPECIES

One or more worker characteristics of each genus and species are mentioned. It is given whether the species is "native" or "invasive".

It is always stated how many genera and/or species are known in the Caribbean, based on AntWeb and AntWiki. However, regarding this number, we found that AntWeb and also AntWiki are not entirely up to date. These numbers must therefore be interpreted as "at least". We also looked at how many species of ants are assumed to be present on the Leeward Islands (table 1). AntWiki (April 2019) was used as the source for this. Because a lot of goods and food from Puerto Rico are imported to Saba, it is likely that ants from this island can enter Saba, therefore it is also reported whether the species discussed occurs in Puerto Rico (according to AntWiki, mainly based on the paper of Smith 1937). Puerto Rico is directly adjacent to the Leeward Islands in the north.

### DOLICHODERINAE

Of the seven genera of this subfamily known from the Caribbean, only the genera *Azteca* and *Tapinoma* occur on Saba.

#### The genus *Azteca*

Diagnostic remarks: The worker caste can generally be recognized in the field by its cordate-shaped head; vertex concave; petiolar scale strongly inclined anteriorly with a distinct ventral node; metanotal groove forming a distinct angle between the mesonotum and propodeum.

The genus counts five Caribbean species. Only *Azteca delpini* was found on Saba.

#### ***Azteca delpini***

Is differing from the other four Caribbean species by the stronger setosity on all body parts. *Azteca delpini* is very similar to *A. velox*, a species living on the mainland of Central and South America, in areas bordering the Caribbean. We could not find any difference between the workers of the taxa *A. delpini* Emery, 1893 (with subspecies *antillana* and *trinidadensis*) on the one hand and *A. velox* Forel, 1899 on the other. *Azteca delpini* should be more slender, less dimorphic, shinier than *A. velox* with a little bent thorax and almost no mesosomal grooves. But between all nest samples we have seen from Saba, St Martin, St Eustatius, Bonaire, Aruba, Curacao and some other Caribbean Islands, we see these differences in size, shine, depth of the mesosomal grooves (and so the hump of the mesosoma) and even in colour. 3-4 mm.

It is a native species in the Caribbean, including the Leeward islands, but not on Puerto Rico.

This arboreal species could be seen everywhere, crisscrossing the entire tree. Nesting in dead parts of living trees (a.o. *Cecropia*) or in cavities in that trees. Once under a stone, the other observations on trees, including *Cecropia*. The nests were mostly in dead wood from living trees. Carton nests were also observed (fig. 5).



Fig. 5. Carton nest of *Azteca delpini* in a *Cecropia*.



#### The genus *Tapinoma*

Diagnostic remarks: Petiolar node in dorsal view not visible; without erected setae on the mesosoma. The genus counts five Caribbean species. Only *T. melanocephalum* was found on Saba.

***Tapinoma melanocephalum*** differs from the other species because the gaster is lighter than the head and the gaster is without standing setae; 1.5 – 2 mm.

An invasive species in the Caribbean, including the Leeward Islands and Puerto Rico.

Not collected in the 20th century. Six out of seven times collected in tube traps with hundreds of specimens; tube traps were placed in different trees, between stones, and in litter.

Specimen of the subspecies ***T. melanocephalum coronatum*** were collected in 1949.

#### **FORMICINAE**

Of the eight genera of this subfamily known from the Caribbean, four genera occur on Saba: *Brachymyrmex*, *Camponotus*, *Nylanderia* and *Paratrechina*.

#### The genus *Brachymyrmex*

Diagnostic remarks: Nine-segmented antennae; in dorsal view the petiolar node is not visible; 1.5-2.5 mm.

The Caribbean counts eight *Brachymyrmex* species, namely *B. flavidulus* (known from Cuba), *B. australis*, *B. pictus* (both known from Jamaica), *B. heeri*, *B. cordemoyi* (known from Guadeloupe), *B. minutus*, *B. patagonicus* and *B. obscurior*. A lot about *Brachymyrmex* taxonomy is unclear, so a revision of this genus is necessary. We noticed that the eye diameter and the number of mandibular teeth do not seem to be good distinguishing features.

Three species are found on Saba: *B. minutus*, *B. patagonicus* and *B. obscurior*.

#### ***Brachymyrmex minutus***

Different from the other *Brachymyrmex* species by the colour (yellow), sparse pubescence on the first gastertergite and a clear metanotal groove.

It is a native species in the Caribbean. First observation for the Leeward Islands.

Is found on Saba under stones (2x), in the humus mass in the armpit of trees (2x) and in litter (1x).

Fig. 6. Nest of *Brachymyrmex minutus*, under a piece of concrete.



#### ***Brachymyrmex patagonicus***

Is differing from the other *Brachymyrmex* species by its dark pigmentation, a sparse pubescence on the first gastertergite and without a clear metanotal groove.

It is an invasive species in the Caribbean. First observation for the Leeward Islands.

Is found on Saba under and between stones (2x) and in dead mass of bromeliads (2x),

#### ***Brachymyrmex obscurior***

Is differing from the other *Brachymyrmex* species because of its dense, appressed pubescence, especially on the gaster; yellowish brown to brown.

This species is very similar to *B. cordemoyi* which is mentioned for Guadeloupe (AntWiki). Given the distribution of this species and the fact that *B. obscurior* is not mentioned for Guadeloupe, it is probably an incorrect identification.

*Brachymyrmex obscurior* is native to the Caribbean, including the Leeward Islands and Puerto Rico.

Occurs throughout Saba. Is found under and between whether or not overgrown stones (14 x), in litter (2x), in bare soil (2x) and in a carton nest of termites (1 x).

#### **The genus *Camponotus***

Diagnostic remarks: Antennal insertion is well above the clypeus; large differences in length between the smallest and largest workers.

43 species are known from the Caribbean. Only four of them are found on Saba: *C. claviscapus*, *C. kaura*, *C. pittieri* and *C. sexguttatus*.

#### ***Camponotus claviscapus***

Most notable features are: sparsely setosity; yellowish brown; femur of the first leg extra wide, apex of the scapus swollen.

It is a native species in the Caribbean. First observation for the Leeward Islands.

Once collected in Windwardside, 27 VII 1949, an alate queen and eight males.

### ***Camponotus kaura***

Most notable features are: sparsely setosity; yellowish brown; femur of the first leg extra wide, apex of the scapus not swollen.

It is a native species in the Caribbean, previously only known from Puerto Rico (AntWeb). First observation for the Leeward Islands.

Carton nest found in a hollow tree (1x) (fig. 7) and in a dead branch on the ground.

Fig. 7. Carton nest of *Camponotus kaura*



Fig. 8. Carton nest of *Camponotus pittieri*



### ***Camponotus pittieri***

Most notable features are: many setae covering the entire body, pubescence hairs relatively long and abundant. More or less concolorous, head slightly lighter, sometimes reddish.

It is a native species in the Caribbean, including the Leeward Islands. According to AntWeb this is a relatively uncommon species.

A nest was found on Saba in dead wood on a living tree (fig. 8).

### ***Camponotus sexguttatus***

Most notable features are: Mesosoma strongly notched, usually with variable pale spots on the gaster; often black, head and legs often lighter.

Note that Wheeler (1923) described some varieties of the species, which are now mentioned as subspecies. The most features for these are the colour and the presence or absence of light coloured spots on the gaster. However, this species is quite variable in colour. We found entire yellow workers and monochromatic brownish specimens. So colour and light spots on the gaster are not valid characteristics for distinguishing subspecies in this species.

It is a native species in the Caribbean, widely distributed, including the Leeward Islands and Puerto Rico.

Is found on Saba in dead wood, in bromeliads (till a height of 190 cm), in vegetation against boulders, in a garden and at the top of a tree in a large carton nest of termites.

Fig. 9. Habitat and nest (arrow) of *Camponotus sexguttatus*.



Fig. 10. Detail.



### The genus *Nylanderia*

Diagnostic remarks: Long, coarse setae in conspicuous pairs on the mesosomal dorsum; 2-3 mm. The genus counts nine species in the Caribbean. Only *N. steinheili* is known from Saba.

### ***Nylanderia steinheili***

Two Caribbean *Nylanderia* species, i.e. *N. guatemalensis* and *N. steinheili*, are characterized by the following: mesonotum with pubescence and mesopleuron not entirely covered with pubescence. Also like *N. bruesii*, found in Florida (according to AntWeb, but not mentioned in the Ants or Florida (Deyrup 2017)). If we follow Kallal & LaPolla (2012), the differences between these three species are only related to the size of the head and the color. Two questionable methods of distinguishing ant species. Starting with the head width, our Saba specimens have a CW of 0,47 – 0,56 mm (n=10). we can now exclude *N. bruesii*, because it has a CW of > 0,59 mm (Kallal & LaPolla 2012). If we follow Trager (1984) than there is no difference between the head width and length, the length of the scape and indices between *N. steinheili* and *N. guatemalensis*. Than the color. Kallal & LaPolla (2012): *N. steinheili* is brown and *N. guatemalensis* is yellow, according to Trager (1984) respectively blackish/dark brown and yellow-brown. If we look to the images on AntWeb, then all five photographed specimens of *N. steinheili* are dark brown. Out of the six specimens photographed of *N. guatemalensis*, two specimens are yellow, one is brown and the other three are brown or dark brown. Trager (1984) also mentions the light coxae of the middle and hind leg, in both species. But that also appears to be variable. Very light coxae occur in our Saba specimens, but non-contrastingly colored coxae as well. It is clear that further taxonomic research on both species is necessary. For the time being, in regard of the color of our specimens, the majority of the Saba workers are brown or dark brown, so we are dealing with *N. steinheili* here.

Besides, *N. guatemalensis* is not known from one of the Leeward Islands, while *N. steinheili* is.

Finally, the outer genital valve of two males, do not match the drawings of those of *N. guatemalensis* in Wheeler (1905).

Saba workers (n=10): CL 0,56 – 0,66; CW 0,47 – 0,56; SL 0,68 – 0,78; CL/CW 114-127; SL/CL 111-125. Workers on Saba were observed under stones in a grassy vegetation, between grasses on a wall and on a footpath.

### The genus *Paratrechina*

Diagnostic remarks: Extremely long legs and antennae; 2.5 – 3 mm.

The genus counts one species in the Caribbean, including the Leeward Islands and Puerto Rico: *Paratrechina longicornis*.

### ***Paratrechina longicornis***

It is a pantropical tramp species, so an invasive species on Saba.

In the 20th century only observed in urban areas. In 2018 observations of hundreds of specimens, of which an important part in tube traps. Between, on and under stones, in litter, in trees. Among others in areas that are strongly grazed by goats (M7) and along roads. Many workers were observed simultaneously.

### **MYRMICINAE**

Of the 32 genera of this subfamily known from the Caribbean, nine genera occur on Saba:

*Cardiocondyla*, *Cyphomyrmex*, *Monomorium*, *Mycocepurus*, *Pheidole*, *Solenopsis*, *Strumigenys*, *Tetramorium* and *Wasmannia*.

#### The genus *Cardiocondyla*

Diagnostic remarks: Postpetiolus (in dorsal view) subcircular, much wider than the petiole; approximately 2 mm.

The genus counts four species in the Caribbean. Two of them are observed on Saba.

### ***Cardiocondyla obscurior***

Is differing from the other *Cardiocondyla* species by the prominent anterolateral corners of its postpetiolar sternite.

This species is found worldwide, and probably native to the (sub)tropical part of America, including the Leeward Islands.

Foraging on nectar and extrafloral nectaries (Boer et al 2018).

Two observations in 2018 in a tube trap under a stone and in 1949.

### ***Cardiocondyla mauritanica***

It is an invasive species in the Caribbean, including Puerto Rico.

This species is mentioned for Saba by Wetterer (2012), but not for any other Leeward Island.

#### The genus *Cyphomyrmex*

Diagnostic remarks: Workers and females are easily recognized by the frontal carinae, as they form a shield on the dorsum of the head, which covers most of the head; < 3.5 mm.

*Cyphomyrmex* species use insect droppings and other animal and plant debris as a substrate for their yeast-like fungus cultures (Fisher & Cover 2007).

The genus counts five species in the Caribbean, two of which are observed on Saba: *C. minutus* and *C. rimosus*.

### ***Cyphomyrmex minutus***

The differences between *C. minutus* and the other Saba species *C. rimosus* are marginal. For us the most important characteristic is the median basal groove of the first gastral tergite, which is short and usually indistinct in *C. minutus* and distinct and more than twice as long as wide in *C. rimosus*. It is a native and common species in the Caribbean, including Puerto Rico. First observation for the Leeward Islands.

Nests are usually in small chambers in the ground, under objects, or in rotten wood (Longino 2004 in AntWiki 2019). On Saba in 2018 in clay-like style verge (hollow road idea), among plants on a wall, on a footpath, in soil and once in litter in a tree.

### ***Cyphomyrmex rimosus***

It is a native species in the Caribbean, including the Leeward Islands, excluding Puerto Rico.

Only one observation in 1963.

#### The genus *Monomorium*

Diagnostic remarks: Three segmented antennal club and the lack of spines on the terminal side of the propodeum; approximately 2 mm.

This genus counts four species in the Caribbean. Two of them are observed on Saba: *M. ebeninum* and *M. floricola*.

#### ***Monomorium ebeninum***

Most notable features are: Nearly black and shiny.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

Only one observation from the 20<sup>th</sup> century. In 2018 found in a cottage (2x), in gardens on different plant species (5x), in litter (3x) and on stone walls (3x).

#### ***Monomorium floricola***

Most notable features: bicolored.

It is an invasive species in the Caribbean, including the Leeward Islands and Puerto Rico.

Nests in all kind of (tiniest) cavities. In 2018 found on trees (4x), in a bromeliad (1x), under stones (3x).

#### The genus *Mycocepurus*

Diagnostic remarks: Numerous spines on most body surfaces, including a pair of occipital spines, and usually 2 to 3 pairs on the pronotum, 5 to 6 pairs on the mesonotum and 2 pairs on the propodeum, with the last pair being the most developed; the dorsum of the petiole has 2 pairs of spines (Mackay et al., 2004); approximately 3 mm.

The genus *Mycocepurus* uses a variety of organic matter as a substrate for their fungal gardens, ranging from dry leaves and caterpillar dung to fruit matter on the seeds of *Hymenaea courbaril* (Caesalpiniaceae), which facilitates germination of the plant (Kempf 1963).

The genus counts one species in the Caribbean: *M. smithii*.

#### ***Mycocepurus smithii***

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

Nests only in the soil (Torres 1989 in: AntWiki 2019).

Not collected in the 20th century. Seven times found on a footpath.

#### The genus *Pheidole*

Diagnostic remarks: Antenna with 3-segmented apical club; propodeum notably depressed below level of promesonotum (= pronotum + mesonotum); worker caste dimorphic.

For identification it is usually necessary to see the major workers. Unfortunately, these are often far in the minority or absent (in the samples), so that a confident determination often has to be omitted.

For example in the case of *P. exigua* and *P. sculptior*.

The genus counts 47 species in the Caribbean. Six of them are found on Saba: *P. exigua*, *P. fallax*, *P. jelskii*, *P. sculptior*, *P. geminata* and *P. susannae*.

#### ***Pheidole exigua***

Most notable features: see *P. sculptior*.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

Only one observation in dead wood.

### ***Pheidole fallax***

Most notable features: Three species *P. susannae*, *P. jelskii* and *P. fallax* have very long scapes and legs, have two remarkably clear constrictions in the mesosoma, the head of the minor workers is mainly smooth. *P. jelskii* and *P. fallax* differs from *P. susannae* by relative short scapes (in major workers). The major worker of *P. fallax* has a high petiolus in lateral view. The minor workers have prominent propodeal spines and the dorsal side of the pronotum is partly foveolate and have some transverse rugulae.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico. Only one observation under the bark of a tree.

### ***Pheidole jelskii***

Most notable features: Three species *P. susannae*, *P. jelskii* and *P. fallax* have very long scapes and legs, have two remarkably clear constrictions in the mesosoma and the head of the minor workers is mainly smooth. *P. jelskii* and *P. fallax* differs from *P. susannae* by relative short scapes (in major workers), minor workers have two small propodeal spines and the dorsal side of the pronotum is without transverse rugulae. The propodeal spines are in the minor worker of *P. jelskii* more dentiform, very short and the pronotal dorsum is smooth. The major worker has (in lateral view) a low petiole.

It is a native species in the Caribbean. This is the first observation for the Leeward Islands. On Saba found in dead wood, between divot on a xerothermic slope in partial shade and on an overgrown stone wall.

### ***Pheidole megacephala***

Most notable features: The ventral margin of the postpetiole is bulging in a conspicuous convexity. *Pheidole megacephala* is an invasive species in the Caribbean, including on the Leeward Islands and Puerto Rico.

Unlike most species, this species was observed more in the 20th century than in 2018. The three 2018 observation came all from under stones.

### ***Pheidole sculptior***

Most notable features: The body of the little *P. sculptior* is total foveolate except the gaster. The major workers with carinulae on the frontal side of the head. This species resembles *P. exigua* very much. The latter has some transverse striae on the dorsal side of the pronotum, *P. sculptior* has none. *Pheidole sculptior* is native in the Caribbean, including the Leeward Islands and Puerto Rico.

On Saba found in dead wood, in moles in the armpit of branches, on plants, in litter, between and under stones.

### ***Pheidole susannae***

Most notable features: Three species *P. susannae*, *P. jelskii* and *P. fallax* have very long scapes and legs, have two remarkably clear constrictions in the mesosoma and the head of the minor workers is mainly smooth. *P. susannae* differs from the other two by a relative long scape (in major workers), and minor workers have two small propodeal spines and the dorsal side of the pronotum is without transverse rugulae.

It is a native species in the Caribbean, including Puerto Rico. This is the first observation for the Leeward Islands.

Not collected in the 20<sup>th</sup> century, but now a common species. Most observation from litter and footpaths.

### **The genus *Solenopsis***

Diagnostic remarks: Two segmented antennal club and the lack of spines on the terminal side of the propodeum. The identifications of our pigmy *Solenopsis* species (most of them) are based on Pacheco & Mackay (2013). We looked carefully to the images on AntWeb of *Solenopsis* species of the

American continent, especially the Caribbean specimens. Even though, it was not a simple task. The images of AntWeb were not always identical to the drawings of Pacheco & Mackay (2013). And vice versa: the descriptions with respect to striations and punctations were not always visible in the photographs. In addition, the differences in dimensions of e.g. head length, head width, scapus length and the ratios between these units are relatively large, so that morphometry does not always provide conclusive identifications.

The genus counts sixteen species in the Caribbean. Seven species are found on Saba: *S. azteca*, *S. castor*, *S. desecheoensis*, *S. geminata*, *S. pollux*, *S. pygmaea* and *S. zeteki*.

#### ***Solenopsis azteca***

Most notable features: Shiny maroon, legs and antennae somewhat lighter; in lateral view: petiolus thick with a big ventrally belly, higher than postpetiolus; legs and antenna contrasting lighter as the rest of the body; groove between the antennal insertion quite wide, slightly divergent, clypeus without lateral teeth, 4 ommatidia.

Saba workers: CL/CW: 109-123 (mean: 117; n=7); SL/CL: 53-56 (mean: 55; n=7).

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

Found in dead wood, on a plant and in a hollow twig.

#### ***Solenopsis castor***

Most notable features: in lateral view petiolus thick pyramid-shaped with round top, petiolus narrower than postpetiolus; scape longer than in the other species. Clypeus with two prominent teeth, on the place of the lateral teeth an angled edge. 3-5 ommatidia.

It is a native species in the Caribbean. This is the first observation for the Leeward Islands.

Saba: CL/CW: 123, SL/CL: 68 (n=1)

One worker is collected (2018) from a hollow twig.

#### ***Solenopsis desecheoensis***

Most notable features: belongs to the globularia species complex. These species have a greatly dilated postpetiole (seen from above). Three species with that same character are known from the Caribbean. *Solenopsis desecheoensis* is the only species of this complex which is concolorous dark brown. Another character is the smooth dorsal side of the propodeum. According to Pacheco & Mackay the number of ommatidia is approximately 25 (22-25), but the numbers we found was 12-25 (mean 17; n=20).

It is a native species in the Caribbean, including Puerto Rico. This is the first observation for the Leeward Islands.

Not collected in 2018.

#### ***Solenopsis geminata***

Most notable features: on average significantly larger than the other here observed *Solenopsis* species; polymorph; eyes with more than 25 ommatidia.

*Solenopsis geminata* is an invasive species in the Caribbean, including the Leeward Islands and Puerto Rico.

After *Wasmannia auropunctata* the most seen and collected ant species on Saba in 2018. Dozens of nests, always in the soil, often under stones; foraging overall in the vegetation, also in trees.



Fig. 11. Nest of *Solenopsis geminata*.



Fig. 12. Effects of the bites of *Solenopsis geminata*.



### ***Solenopsis pollux***

Most notable features: Concolorous pale yellow, petiolus with ventral little lobe, petiolus slightly higher than postpetiolus and narrower; petiolus in lateral view thicker than postpetiolus; propodeum in lateral view gradually descending; 3-5 ommatidia. Edge of clypeus with four teeth (two little lateral).

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico. On Saba found in litter.

### ***Solenopsis pygmaea***

Most notable features: Concolorous pale yellow, In lateral view petiolus thick with broad rounded top, propodeum in lateral view more or less quadrate. 1-3 ommatidia. Clypeus with rounded angled edges located at the lateral teeth.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico. Not collected in 2018.

### ***Solenopsis zeteki***

Most notable features: Yellow, long, fine hairs on the head emerge from almost invisible punctures, long, sparse hairs on mesosoma, eyes usually slightly elongated; 3-5 ommatidia, clypeus without lateral teeth.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico. Saba: CL/CW: 117, SL/CL 71 (n=1). Not collected in 2018.

### **The genus *Strumigenys***

Diagnostic remarks: Four to six segmented antennae, 2-segmented antennal club; approximately 2 mm.

*Strumigenys* species hunt on small invertebrates that live in leaf litter (Deyrup, 2017).

The genus counts 25 species in the Caribbean. Three of them are found on Saba: *S. gundlachi*, *S. margaritae* and *S. rogeri*.

### ***Strumigenys gundlachi***

Most notable features: mandible with several short preapical teeth.

It is a native species in the Caribbean, including Puerto Rico. This is the first observation for the Leeward Islands.

Only collected in 1949 in the rainforest.

### ***Strumigenys margaritae***

Most notable features: mandibles of *S. margaritae* and the close related common Caribbean species *S. emmae* are short, six segmented antennae, *S. emmae* four segmented.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

This species is mentioned for Saba by Wetterer (2013).

### ***Strumigenys rogeri***

Most notable features: *Strumigenys rogeri* and the close related Caribbean species *S. eggersi* have slender elongated mandibles; in *S. eggersi* the metanotal groove is superficial, but in *S. rogeri* obvious; mandibles without intercalary teeth or denticles arising between apicodorsal and apicoventral teeth of apical fork, or from dorsal base of apicoventral tooth.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

Only collected in 1949 in the rainforest.

### The genus *Tetramorium*

Diagnostic remarks: Antennal club 3-segmented; between the mandibles and the antennal sockets a rising ridge.

This genus counts six or seven (if the *T. guineense* on Puerto Rico (Smith 1937) is a correct identification) species in the Caribbean. We observed only one species on Saba: *T. lucayanum*.

### ***Tetramorium lucayanum***

Most notable features: Brown black with prominent propodeal spines, other *Tetramorium* species from the Leeward Islands are red-brown; approximately 3 mm.

It is an invasive species in the Caribbean, including Puerto Rico. This is the first observation for the Leeward Islands.

All observations on Saba concerned xerothermal conditions: bone-dry dead wood, in litter, in dead wood in a living tree, under a stone in a dry habitat, in a dead bromeliad (80 workers) lying on the ground.

### The genus *Wasmannia*

Diagnostic remarks: Antennal club 2-segmented; clear antennal scrobes, propodeum with long spines; approximately 2 mm.

The genus counts two species in the Caribbean, on Saba only *W. auropunctata*.

### ***Wamannia auropunctata***

Most notable features: Petiole flattened; the petiole of the other Caribbean species *W. sigmoidea* is more rounded.

It is a worldwide invasive species, just like in the Caribbean, including the Leeward Islands and Puerto Rico.

It is the most seen and collected ant species on Saba, found in all kinds of habitat, from under stones in the soil, till high in trees in bromeliads.

## PONERINAE

Of the eleven genera of this subfamily known from the Caribbean, four genera occur on Saba: *Anochetus*, *Hypoponera*, *Odontomachus* and *Platythyrea*.

### The genus *Anochetus*

Diagnostic remarks: long and straight mandibles; petiole with tooth on each lateral corner; approximately 4 mm.

The genus counts seven species in the Caribbean. We found one species on Saba: *A. mayri*.

### ***Anochetus mayri***

Most notable features: *Anochetus mayri* and the closely related species *A. inermis* are distinguished from the rest of the Caribbean *Anochetus* species by shorter scapes, which do not protrude above the occiput. *Anochetus mayri* differs from *A. inermis* by the smaller eyes and a denser hairy gaster.

It is a ground dwelling species. Colonies are small, often with a few workers (AntWiki, 2019).

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

In 2018 once found under a stone. Seven times collected in 1949 and 1963.

### The genus *Hypoponera*

Diagnostic remarks: Constriction between the gaster segments 1 and 2; inner tip of hind tibia with a single, large, pectinate spur; 2-3 mm.

The genus counts five species in the Caribbean. Three of them are known from Saba: *H. ergatandria*, *H. opaciceps* and *H. opacior*.

### ***Hypoponera ergatandria***

Most notable features: The scapes do not reach the occiput, unlike that of *H. opacior* and *H. opaciceps* whose scapes reach the edge of the occiput.

It is a worldwide invasive species (often erroneously known under the name *H. punctatissima*), so in the Caribbean, inclusive the Leeward Islands and Puerto Rico (under the name *H. punctatissima*). Not collected in 2018.

### ***Hypoponera opacior***

Most notable features: The scapes reach the occiput; the petiole of the worker in lateral view is narrower dorsally than ventrally, the anterior and posterior faces are not parallel as is with *H. opacior*.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

Tens to prefer higher, drier plant associations, with nests in the surface stratum with debris, in rotten stumps, grass sods or beneath stones (AntWiki 2019).

Once collected in 1949.

### ***Hypoponera opaciceps***

Most notable features: The scapes reach the occiput; the anterior and posterior faces of the petiole (in lateral view) are parallel, in contrary with *H. opacior*.

It is a native species in the Caribbean, including Puerto Rico. This is the first observation for the Leeward Islands.

Six times collected from bromeliads, once in dead organic material on a palm tree and once in dead wood on the ground.

Fig. 13. Habitat of *Hypoponera opaciceps*.



### The genus *Odontomachus*

Diagnostic remarks: Looks like *Anochetus*, but the workers are greater (> 9 mm) and the petiolar node has one prominent vertical spine.

The genus counts six species in the Caribbean. We observed on Saba only *O. ruginodis*.

### ***Odontomachus ruginodis***

Most notable features: Side of the petiolus with clear rugulae, pronotum and mesonotum have tight rugulae, metasternum with two nodules instead of spines (as in *O. haematodes*) and smaller than *O. mayri*; the most clear difference with *O. bauri* is that the inner side of the hind femur at base is virtually glabrous, in *O. bauri* with pubescence.

It is native species in the Caribbean, including the Leeward Islands and Puerto Rico.

In 2018 found under stones (4x), in an overgrown stone wall (1x), in mould in the armpit of a tree (1x), in a bromeliad, between the roots of a fern.

The genus *Platythyrea*

Diagnostic remarks: *Platythyrea* species are relative large (6 mm) with widely separated frontal lobes; all body parts are deep and wide punctuated.

The genus counts three species in the Caribbean. We observed one: *P. punctata*.

***Platythyrea punctata***

Most notable features: CL >0.90 mm; petiolar node < 0.85 mm long, about as long as broad or slightly longer than broad.

It is a native species in the Caribbean, including the Leeward Islands and Puerto Rico.

Nests in rotten logs and stumps (Smith 1937). On Saba only once observed in the 20<sup>th</sup> century. In 2018 often observed singly foraging workers on footpaths, also seen in bromeliads (3x).

## ANTS AND VEGETATION TYPES

Information on Saba regarding the occurrence of certain ant species in certain vegetation types is limited. A vegetation type is a certain part of a piece of landscape with a more or less uniform plant composition. However, in a well-defined vegetation type there are certain elements that do not always "fit" into that type, as footpaths, roads, open spaces, habitation, and suchlike. Certainly ants are masters in finding certain elements in a landscape to found their colony there, for example a specific tree, under a stone on a bare plain or a sparse overgrown slope. All those elements can occur in multiple vegetation types. Partly as a result of this, the overview in table 2 provides only a few concrete results. Yet there are some cases that stand out:

Two species occur in all vegetation types *Wasmannia auropunctata* and *Solenopsis geminata*, both invasive species.

Three species are found exclusively in the small area of tropical rain forest (M1): *Solenopsis castor*, *Strumigenys gundlachi* and *S. rogeri*. *Platythyrea punctata* is only found in the more wet vegetations (M2 and M3).

In the dry vegetation types M4 - M7 we see *Anochetus mayri*, *Cardiocondyla obscurior*, *Paratrechina longicornis*, *Pheidole jelskii*, *Solenopsis desecheoensis*, *S. pygmaea*, *S. zeteki*, *Tapinoma melanocephalum* and *Tetramorium lucayanum*.

Table 2. Number of times that a species was found in a certain vegetation. Note: It was not possible to determine a vegetation type for all samples.

<i>species</i>	urban	coast	M1	M2	M3	M4	M5	M6	M7
<i>Anochetus mayri</i>		2					1	3	1
<i>Azteca delpini</i>		1			1		1	5	2
<i>Brachymyrmex minutus</i>			1	2	1			2	1
<i>Brachymyrmex obscurior</i>	2	2		4	4	1		6	7
<i>Brachymyrmex patagonicus</i>	1	1		2				3	1
<i>Camponotus claviscapus</i>	1								
<i>Camponotus kaura</i>				1	1				
<i>Camponotus pittieri</i>					3	1	1		
<i>Camponotus sexguttatus</i>	2				6	1		5	
<i>Cardiocondyla obscurior</i>								1	1
<i>Cyphomyrmex minutus</i>	2				3		1	6	2
<i>Cyphomyrmex rimosus</i>								1	
<i>Hypoponera ergatandria</i>								1	
<i>Hypoponera opaciceps</i>				5	2				1
<i>Hypoponera opacior</i>	1								
<i>Monomorium ebeninum</i>	5			1	1			2	4
<i>Monomorium floricola</i>	1					2	1	3	4
<i>Mycocepurus smithii</i>	1	1		3	2				
<i>Nylanderia guatemalensis</i>	1			2				3	1
<i>Odontomachus ruginodis</i>		2		4	3	1			1
<i>Paratrechina longicornis</i>	1								11
<i>Pheidole exigua</i>					1				
<i>Pheidole fallax</i>					1				
<i>Pheidole jelskii</i>						1		2	
<i>Pheidole megacephala</i>		1		1				4	4
<i>Pheidole sculptior</i>	2			2	5	1		8	2
<i>Pheidole susannae</i>				1	8		2	4	5
<i>Platythyrea punctata</i>				5	3				
<i>Solenopsis azteca</i>			1		2			2	1
<i>Solenopsis castor</i>			1						
<i>Solenopsis desecheoensis</i>								3	2
<i>Solenopsis geminata</i>	2	1	3	9	7	4	1	7	8
<i>Solenopsis pollux</i>					1			2	
<i>Solenopsis pygmaea</i>									2
<i>Solenopsis zeteki</i>									1
<i>Strumigenys gundlachi</i>			1						
<i>Strumigenys rogeri</i>			1						
<i>Tapinoma melanocephalum</i>								2	5
<i>Tetramorium lucayanum</i>							1		5
<i>Wasmannia auropunctata</i>	2		8	11	12	2	2	13	6
<b>TOTAL</b>	<b>24</b>	<b>11</b>	<b>16</b>	<b>53</b>	<b>67</b>	<b>14</b>	<b>9</b>	<b>88</b>	<b>78</b>

## DISCUSSION

42 ants species are now known from Saba, 13 of them are mentioned for the first time for the Leeward Islands, and 4 species of the latter are only known from Saba.

No ants (except *Wasmannia auropunctata*) were observed in the bromeliads in the tropical rainforest on Mt Scenery (M1). This is in contrast to the bromeliads in other places. The M1 bromeliads may have been too wet for the ants.

Remarkable is the lack of some invasive species in this study, which are known to occur in the Leeward Islands: *Monomorium pharaonis*, *Tetramorium simillimum* and *T. bicarinatum*. The absence of these species may be accounted to the fact that urban areas were under sampled.

By making use of tube traps clearly more samples were taken for *Tapinoma melanocephalum* and *Monomorium ebeninum*.

Most species like *Pheidole sculptior*, *Wasmannia auropunctata*, *Camponotus sexguttatus*, *Nylanderia steinheili*, the three *Brachymyrmex* species and *Azteca delpini* were observed in 2018 about as many times as in the period 1937-1963.

Significantly more observed in 2018 than in the period 1937-1963 are: *Hypoponera opaciceps* (8 to 1), *Monomorium ebeninum* (12 to 1), *Odontomachus ruginodis* (10 to 3), *Platythyrea punctata* (> 7 to 1), *Tetramorium lucayanum* (6 to 2).

Clearly less observed is *Anochetus mayri* (1 to 6). In the period 1937-1963 one or two observations were made of some species that were not observed in 2018. These species are the small *Solenopsis* species (with the exception of *Solenopsis azteca*) and the equally small *Strumigenys* species. In contrast, some larger species were not observed at all in the 20th century, such as some *Camponotus* species.

*Pheidole susannae* was not collected in the period 1937-1963, against 20 observations in 2018. In (neo-) tropical America it is a common species that is found in many habitats, including disturbed habitats (AntWeb). It is possible that this species is a newcomer to Saba and has expanded considerably there, in fact acting as an invasive species.

We see a similar case at the aggressive and invasive *Solenopsis geminata*. In the period 1937-1963 this species was collected ten times, against 37 times in 2018.

The invasive species *Paratrechina longicornis* was also found more often in 2018 (13 versus 3 times in the period 1937-1963). Another invasive newcomer in 2018 is *Tapinoma melanocephalum*.

Almost the opposite occurs with the well-known invasive species *Pheidole megacephala*. This species was observed only three times in 2018, compared to eleven times in the period 1937-1963.

In summary, it seems strongly that invasive species, excluding *Pheidole megacephala*, have increased over the last 50 years.

We will soon investigate whether the same trend is occurring on St. Eustatius.

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### **Authors' contributions**

PB coordinated the study, did the final identifications and wrote the manuscript with input from MB as co-author and maker of the datasets. All images were made by PB.