THE MAMMALS OF ARUBA

(Mammalia: Chiroptera, Rodentia, Lagomorpha)

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Foreword

During a three years stay on Aruba (Dutch Caribbean) I got the opportunity to study the mammals (and other creatures as well) on this tropical island. In this paper the results are given of investigations made from November 1992 till November 1995.

Aruba harbours different ecotypes: marine, coastal and terrestrial. For practical and logistical reasons the marine area is excluded from this study. Therefore whales (Cetacea) and dolphins, although regularly spotted, even in the coastal waters were not included. The same holds for donkeys, goats, cats and dogs, although a great number of them are becoming feral. During some weeks in the summer of 1995 a squirrel (*Sciuris gratanensis*?) was noticed on the Marinierskazerne Savaneta (pers. report H. Koevermans). Since this species is not recognised as belonging to the fauna of Aruba, this record is for the time supposed to be from a casual visitor.

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Paula Berkemeyer provided a sketch of 'Kees', one of the first captured specimens of *Calomys hummelincki*; as an icone it is on top of each page.

With Angela Martino I share the special interest in *Calomys hummelincki*; I want to thank her for her help in finding recent literature on this subject as well as her enthousiastic (e-mail) discussions.

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Abstract

The results are given of the study of the mammals on Aruba (Dutch Caribbean) performed during a stay from November 1992 till November 1995. During this period several methods of mammal species recordings were used. The number of investigated square kilometre blocks is 237, the number of the bat trappings is 356. In total 187 mammals were caught in 4381trapping-nights with live-traps (4.3%). Overviews are given of the most important roosts of bats, of trapping results and observations.

Three new bat species for Aruba were detected and captured: *Pteronotus davyi davyi*, *Natalus tumidorostris tumidirostris* and *Molossus molossus*; of the latter a roost of 36 specimens was found.

Measurements of the forearm in *Mormoops megalophylla intermedia* shows a wide variety in lengths in males as well as in females; a sexual dimorphism in forearm length being 53.7 (on average) in both sexes, could not be demonstrated. *M. m. intermedia* is restricted to the Dutch Caribbean. The results shown in this study make a definite difference in forearm length in this subspecies not marked.

In *Glossophaga longirostris elongata* a wide variety is found in forearm lengths in males (39.16, on average) as well as in females (39.57, on average). No sexual dimorphism exists in forearm length in this species. *G. l. elongata* is often silent while flying around (whispering bats); on the batdetector (74 kHz) sometimes a short rattle is heard.

In *Leptonycteris curasoae* no sexual dimorphism in forearm length was found: being on average 54.16 in males and 54.3 in females. Analysis of droppings showed that the main part of the food consisted of cactusfruit and pollen. The population size on Aruba exists of approximately 900 to 1200 individuals, almost always staying in one colony at Wela quarry or at the Tunnel of Love. This species is often silent while flying around; on the batdetector (70 kHz) sometimes a short and very fast rattle is heard, without tune quality.

The exterior of *Calomys hummelincki* is discussed profoundly. The distribution on Aruba is almost restricted to a continuous belt alongside the Northcoast. The habitat is positively associated with grass and with flat area while the texture is loam and gravel. A population study has been performed at Rincon. The population structure is described according sex ratio, signs of sexual activity, changes of body weight and displacement of individuals based on the capture-mark-recapture method. During the population study the results of this study indicates that sex ratios mostly are in favour of males. Home ranges were computed as 4100 m^2 for an adult male and 1175 m^2 for a juvenile female. The displacement figures indicate a greater spatial activity of males. During the study period two periods of reproduction were revealed.

In *Rattus rattus* the fur on the venter is dark grey or white; in 30 of examined specimens 25 have a white venter. The molar abrasion pattern shows no difference in abrasion according to the substrates quarts-diorite and limestone. The habitat is positively associated with undulating terrain while a strong one is found for trees.

A female (lactating) specimen of *Rattus norvegicus* was found as a traffic victim. Around Santa Cruz a small cluster of the species was present and besides that there was a single case near Brasil. With these findings the occurence on Aruba has been established.

In general *Mus musculus* can be recognised at the notch in the upper incisors, however this is not a consistent character: observation showed only in 27% a clear notch in both and in 36% not even a trace of a notch was present. The molar abrasion pattern was observed and no difference was found according to the substrate quarts-diorite and limestone. The habitat of *M. musculus* has a strong positive association with herbs and grass and a positive association with limestone (and sands).

Sylvilagus floridanus nigronuchalis occurs almost all over the island. The habitat is positively associated with quarts diorite soils and negative with limestone soils. A positive association according to the vegetation is found with succulents and melon cactus and a negative association with grass. Regarding to landscape elements a positive correlation shows up with trancheru's (cactus hedge) and green isles.

All bats on Aruba can be regarded as critical or endangered and therefore should be included in the Red List of

Mammals of Aruba. Primary need is to gain control of important breeding caves and the secondary need is to protect and restore foraging habitat. A routine program to monitor population numbers is needed to measure the effectiveness of the protective efforts. It is indicated to protect *C. hummelincki* on a population level. The optimal habitat of this species is known to exist of loamy sandy soils (alongside the north coast). Therefore the status of *C. hummelincki* is classified as 'vulnerable'. The distribution of *S. f. nigronuchalis* shows that the species is present in almost the half (47.7%) of the square kilometre blocks. A considerable decline (>75%) could not be demonstrated. Therefore the status of *S. f. nigronuchalis* is classified as 'low risk'. Proposals for conservation are given for the different mammal species.

Resúmen

E rapport aki ta duna e resultadonan di e estudio encuanto mammífero na Aruba, ehecutá durante un estadia di tres aña di November 1992 te November 1995. Durante e periodo aki diferente metodo di determina sortonan di mammífero, a wordo usá. Den e estudio, 237 areanan di un kilometer quadra a wordo investigá, cu 356 serie di trampa pa raton di anochi. En total 187 mammífero atrapá den anochi, hasiendo uso di 4381 trampa cu live-traps(4.3%). E rapport ta duna un vista di e mas importante lugarnan di drumi di e raton di anochi, cu e resultadonan di captura y di observacion.

Tres sorto nobo di raton di anochi a wordo capturá y detectá: *Pteronotus davyi davyi*, *Natalus tumidorostris tumidirostris* y *Molossus molossus*. Di *M. molossus*, a wordo descubri un lugar di drumi cu 36 ehemplar.
Medida di e brasa anterior di *M. m. intermedia* ta mustra un variedad grandi den largura tanto serca e machonan como e hembranan: no tawata posibel di demonstra un diferencia di largura entre e dos sexonan. Presencia di *M. m. intermedia* ta limitá na Antillas Hulandes y Aruba. E resultadonan di e estudio aki no ta demonstra un diferencia cla den medida di brasa anterior den e subspecie aki.

Den e especie *Glossophaga longirostris*, nos a topa cu un variedad grandi den medida di e brasa anterior tanto den e machonan (39.16) como e hembranan (39.57). No tin diferencia den medida di brasa anterior entre macho y hembra. E sorto aki frequentemente ta silencioso durante su vuelo (whispering bats) ; tin biaha por wordo scuchá un sonido corto manera un maraca cu e 'bat-detector'.

No tin diferencia den medida di brasa anterior entre macho y hembra den e especie *Leptonycteris curasoae*. E promedio di largura di e machonan tawata 54.16 y di e hembranan tawata 54.3. E analisis di sushi ta mustra cu e mayoria di e cuminda ta consisti di fruta di cadushi y pollen. E populacion na Aruba ta consistí di 900 te 1200 individuo, casi semper presente na un colonia na Wela o na Tunnel of Love. Mayoria di biaha e sorto ta silencioso durante vuelo: e « batdetector » ta laga nos scucha un sonido monotono y rapido.

Tin discucion profundo tocante e descripcion di *Calomys hummelincki*. E distribucion na Aruba ta casi limita na un « faha » continuo serca e costa norte. Su habitat ta terreno plat cu lodo, santo y yerba. Un estudio sobre e populacion a wordo ehecutá na Rincon. E structura di e populacion ta describi percentahe di macho y hembra, actividad sexual, cambionan di peso y migracion di individuonan basá riba e método di « capture-mark-recapture » . E resultadonan di e estudio aki ta mustra cu tin mas macho cu hembra durante un aña. Ta wordo calcula cu un macho adulto ta usa un espacio di 4100 meter quadra, mientras cu un hembra juvenil ta usa un espacio di 1175 meter quadra. Segun e datonan di migracion, e machonan ta mustra un actividad mas grandi den movecion. Durante e periodo di estudio a presentá dos temporada di reproduccion.

Di e djaka *Rattus rattus* e lana na e barica ta gris scur o blanco. 25 di e 30 ehemplarnan investigá tin barica blanco. No tin un diferencia den gastamento di muela enter animalnan cu ta biba riba suelo di quarts-dioriet y animalnan cu ta biba riba calichi. E djaka ta prefera terreno cu subida y bahada y principalmente cu palonan.

Un hembra di e djaka *Rattus norvegicus* ta hayá victima di tráfico. Ront di Santa Cruz un grupo chiquito ta presente cu un solo caso na Brasil. Cu e resultadonan aki e presencia na Aruba di e sorto aki ta determiná.

Generalmente e raton *Mus musculus* por ta conoci dor e buraco den e djente superior, pero esaki no ta un caracteristico consistente. Observacion ta mustra den solamente 27 % un buraco na tur dos djente y den 36 % ni un buraco tawata presente. No tin un diferencia den gastamento di muela enter animalnan cu ta biba riba suelo di quarts-dioriet y animalnan riba calichi. E ratón ta prefera terreno cu yerba y frequentemente calichi cu santo.

E coneu *Sylvilagus floridanus nigronuchalis* ta presente na casi tur lugar di e isla. E coneu ta biba principalmente riba suelo di quarts-dioriet, y poco riba calichi. E ta prefera vegetacion cu cuquisa y bushi y no ta frequenta

vegetacion cu yerba. E ta prefera un paisahe cu tranquera y gruponan di mata.

Tur sortonan di raton di anochi na Aruba por ta considerá na peliger di extinccion y mester ta incluí den e lista di mammiferonan cu mester di proteccion. E mas importante ta e control di e cuebanan cu ta importante pa brui y despues protehá y drecha e areanan unda e raton di anochi ta haya su cuminda. Mester mesuranan regular di e grandura di e populacion pa determina e effectividad di e esfuerzonan di proteccion. E ta sigi di protehá C. hummelincki na e nivel di e populacion henter. E ta conocí cu e habitat optimal di e sorto aki ta consistí di terreno lodoso y santoso (banda di e costa di nort). P'esei e status di *C. hummelincki* ta classificá como 'vulnerable'. E distribucion di S. f. nigronuchalis ta mustra cu e sorto ta presente na casi e mitá (47%) di e areanan di kilometer quadra. No ta mustra un bahada importante (>75%). P'esei e status di *S. f. nigronuchalis* ta classificá como 'baha riesgo'. E rapport ta duna propositonan pa conservacion e diferente sortonan di mammifero.

Samenvatting

De resultaten worden gegeven van een onderzoek naar zoogdieren op Aruba (Nederlands Caraïbisch Gebied), verricht gedurende een verblijf van november 1992 tot november 1995. Verschillende methoden van onderzoek van zoogdiersoorten werden gedurende deze periode gebruikt. Het aantal onderzochte kilometerhokken was 237 terwijl het aantal vleermuisvangsten 356 bedroeg. In totaal werden 187 zoogdieren gevangen gedurende 4381 valnachten met live-traps (4,3%). Overzichten worden gegeven van de meest belangrijke vleermuisdagverblijven, vangstresultaten en waarnemingen.

Drie nieuwe vleermuissoorten voor Aruba werden ontdekt en gevangen: *Pteronotus davyi davyi, Natalus tumido-rostris tumidirostris* and *Molossus molossus;* van de laatste soort werd een dagverblijf met 36 exemplaren gevonden.

Metingen van de onderarm van *Mormoops megalophylla intermedia* toonden een grote spreiding aan in lengten bij zowel mannetjes als vrouwtjes; een sexuele dimorfie in deze lengte, zijnde 53,7 mm in beide sexen, kon niet worden vastgesteld. *M. m. intermedia* is wat zijn verspreiding betreft beperkt tot het Nederlands Caraïbisch Gebied. De resultaten die in dit onderzoek staan gepresenteerd, maken een belangrijk verschil in onderarmlengte in deze ondersoort ten opzichte van andere ondersoorten, niet afgetekend.

Bij *Glossophaga longirostris elongata* werd een grote spreiding gevonden van de onderarmlengten zowel bij mannetjes (gemiddeld 39,16) als bij vrouwtjes (gemiddeld 39,57). Er bestond geen sexuele dimorfie van de onderarm in deze soort. *G. l. elongata*. Deze soort is vaak stil bij het rondvliegen (whispering bats); soms wordt op de batdetector (74 kHz) een kort rateltje gehoord.

Bij de onderarmlengten in *Leptonycteris curasoae* bestond geen sexuele dimorfie: gemiddeld 54,16 mm bij mannetjes en 54,3 mm bij vrouwtjes. Analyse van keutels liet zien dat het belangrijkste deel van het voedsel bestond uit cactusvruchten en pollen. De grootte van de populatie op Aruba bestaat uit omstreeks 900 tot 1200 dieren die hoofdzakelijk in één groep verblijven in de mijnschacht van Wela of in de Tunnel of Love. Tijdens het rondvliegen is deze soort meestal stil; op de batdetector (70 kHz) is soms een kort en zeer snel rateltje te horen zonder toonkwaliteit.

Het uiterlijk van *Calomys hummelincki* wordt uitgebreid bediscussieerd. De verspreiding op Aruba is bijna geheel beperkt tot een continue strook langs de Noordkust. De habitat is positief geassocieerd met vlak terrein met een textuur van leem en grind en een grasvegetatie. Bij Rincon werd een populatie onderzoek verricht. De populatieopbouw is beschreven naar sexe, tekenen van sexuele activiteit, veranderingen van lichaamsgewicht en verplaatsingen van individuen met de 'capture-mark-recapture'methode. Gedurende de gehele periode van de studie (10 maanden) blijkt dat de sexe ratio's ten gunste van mannetjes uitvallen. Voor een volwassen mannetje werd een home range berekend van 4100m^2 en 1175 m^2 voor een jong vrouwtje. De verplaatsing gegevens wijzen voor het merendeel op een grotere ruimtelijke activiteit van mannetjes. Gedurende de populatie studie werden twee reproductieve perioden vastgesteld.

De vacht van *Ratts rattus* is op de buik donkergrijs of wit; van de 30 onderzochte exemplaren hadden 25 een witte buik. Het slijtpatroon van de kiezen vertoonde geen verschil bij dieren die leefden op een kwarts-dioriet bodem of een kalksteen bodem. De habitat blijkt positief geassocieerd met golvend terrein terwijl er een sterke associatie werd vastgesteld met bomen.

Een vrouwelijk (lacterend) exemplaar van *Rattus norvegicus* werd gevonden als verkeersslachtoffer. Rond Santa Cruz werd een klein cluster van de soort gevonden en daarnaast was er een enkel exemplaar bij Brasil. Met deze vondsten werd het voorkomen van deze soort op Aruba vastgesteld.

In het algemeen kan *Mus musculus* herkend worden aan de inkeping in de boven snijtanden, hoewel dit niet een constant aanwezig kenmerk is: in het onderzochte materiaal bleek dat in 27% een duidelijke inkeping in beide snijtanden aanwezig was terwijl in 36% zelfs geen spoor van een inkeping was te zien. Het slijtagepatroon van de kiezen werd beoordeeld en er werd geen verschil gevonden bij exemplaren die leefden op kwarts-dioriet of op een kalksteen bodem. De habitat van *M. musculus* was sterk positief geassocieerd met kruiden en gras wat betreft de vegetatie en er was een positieve associatie met kalksteen en zandige bodems.

Sylvilagus floridanus nigronuchalis komt bijna overal op het eiland voor. De habitat is positief geassocieerd met kwarts-dioriet bodems en negatief met kalksteen bodems. Wat betreft de vegetatie bleek er een positieve associatie te bestaan met succulenten (inclusief bolcactussen) en een negatieve associatie met gras. Met landschapselementen was er een positieve correlatie met trancheru's (cactushaag) en groeneilanden.

Alle vleermuizen van Aruba kunnen worden beschouwd als 'bedreigd' of 'ernstig bedreigd' en dienen te worden opgenomen in de Rode Lijst van Zoogdieren van Aruba. Allereerst is het noodzakelijk de belangrijke grotten met kraamkolonies in controle te krijgen en verder is het noodzakelijk het fourageer gebied te beschermen en te verbeteren. Een routine programma om populatie aantallen te monitoren is nodig om de effectiviteit van de beschermingsmaatregelen te meten. Het is noodzakelijk om *C. hummelincki* op populatie niveau te beschermen. De optimale habitat van de soort blijkt te bestaan uit lemig, zandige grondsoorten (langs de Noordkust). Daarom is de status van *C. hummelincki* geklasseerd als 'kwetsbaar'. De verspreiding van *S. f. nigronuchalis* laat zien dat de soort aanwezig is in bijna de helft (47,1%) van de kilometerhokken. Een aanzienlijke afname (> 75%) kon niet worden aangetoond. Daarom is de status van *S. f. nigronuchalis* geklasseerd als 'thans niet bedreigd'. Voorstellen om bescherming van de verschillende zoogdiersoorten worden gegeven.

1. Introduction

The first to publish a list of species from Aruba has been Wagenaar Hummelinck (1940) in a study of the species of the islands off the coast of Venezuela. Some new mammal species were included for Aruba based on the collected material during the late thirties. A more extensive study is published by Husson (1960b): 'De zoogdieren van de Nederlandse Antillen'. After that no publications of newly discovered mammals on Aruba appeared. Kristensen (1982) mentioned a 'fish-eating bat', probably *Noctilio leporinus* (L., 1758); however, more specific details are lacking, despite an interview in 1995. Genoways & Williams (1978) and Petit (1995) discovered new species on Curaçao and Bonaire respectively on Curaçao; however, their surveys did not cover Aruba.

In this publication the results are published of a study conducted from 1992 to 1995. The mammal species on Aruba could be listed as in table 1. The year in the last column indicates when the species was described for the first time for Aruba.

Table 1. Mammal-species on Aruba (* including *Mus musculus musculus* as well as *Mus musculus domesticus*).

Species	English name	Dutch name	known since
Peropteryx macrotis (Wagner, 1843)	neotropical sac-winged bat	kokerstaart vleernuis	1940
Pteronotis davyi davyi Gray, 1838	lesser nakedbacked bat	naaktrugvleermuis	1996
Mormoops megalophylla intermedia (Miller, 1900)	leaf-chinned bat	bladkinvleermuis	1940
Glossophaga longirostris elongata (Miller, 1900)	long-tongued bat	langtongvleermuis	1940
Leptonycteris curasoae (Miller, 1900)	long-nosed bat	langneusvleermuis	1940
Natalus tumidirostris tumidirostris (Miller, 1902)	funnel-eared bat	trechteroorvleermuis	1996
Molossus molossus (Pallas, 1766)	mastiff bat	varkenssnuit	1996
Calomys hummelincki (Husson, 1960)	vesper mouse	dwergwitvoetmuis	1940
Rattus rattus (L., 1758)	black rat	zwarte rat	1940
Rattus norvegicus (Berkenhout, 1769)	brown rat	bruine rat	1996
Mus musculus (L., 1758)*	house mouse	huismuis	1940
Sylvilagus floridanus nigronuchalis (Hartert, 1894)	Arubian cottontail	Arubaans katoenstaart Konijn	1894

In chapter 2. Methods a description is given of the general geographical, climatological and vegetational aspects of this island. Also the landscape types and some specific situations are described. Descriptions are given of faecal contents as well as of specific mammal measurements. The used statistical tests are mentioned. Chapter 3 Results gives an overview of the overall trapping results and observational figures. The next section deals with the species accounts while more faunistic details are given under the headings, when appropriate, Account of species, Taxonomy, Measurements and weights, Description, Areal and geographical distribution, Ecology, Reproduction, Population, Ectoparasites, Predation, Interrelation and Remarks. In chapter 4 the new mammals since 1960 are commented while at the end of this chapter Conservation proposals are given. The used literature is listed in References. In Appendix I definitions are listed of the landscape types and landscape elements. In Appendix II a description is given of the localities used in the text and referred to on a map. Appendix III comprises the correlation figures of the trapping results. In Appendix IV the Red List of Mammals on Aruba is presented. Appendix V lists a gazetteer.

2. Methods

2.1. Description of the situation

Aruba is the most western of the Dutch Leeward Islands. It lies 25 kilometre north of the coast of Venezuela and 68 kilometre west of Curaçao. The island is 31.5 kilometre long, 10 kilometre at its widest, with an area of 184 sqare kilometre. The geographical position is between 12'25" and 12'38"N and between 69'52" and 70'30"W, outside the hurricane belt. Aruba is oblong with Punta Basora in the utmost southeast point and Cudarebe in the utmost northwest.

Aruba is geologically based on four major components. The core consists of a diabase-schist-tuff formation. This formation, more or less triangular, wedges in the middle. Here the landscape is hilly and gives rise to the highest tops Jamanota (189 m) and Arikok (188 m). Furthermore a quartzdiorite batholith with its differentiates covers a great part of the island to the north-west from the core and for some parts to the south-east. In this lightly undulating landscape the differentiating hooibergite crops steeply out in hills e.g. Hooiberg (168 m), Ceru Bientu (87 m) and Ceru Warawara (90 m). The limestone formation encircles more or less the older ones and forms rather conspicuous table mountains e.g. Ceru Canashito (74 m) (Wagenaar Hummelinck, 1940). Limestone terraces form in between three major levels. The last major geological component consists of sands: beach, dune and arroyo-sands.

On a limited scale soils have been analyzed according to grain size with a set of sieves with diameters of resp. 2000 μ (gravel), 1000 μ (grove sand), 500 μ (medium grove sand), 250 μ (fine sand), 125 μ (very fine sand), 63 μ (extremely fine sand) (geological nomenclature in brackets); the residue is called loam.

The average yearly temperature is 27.8^{o} C and the trade winds blow constantly from northeast. Within the year there is little difference in the seasons: highest day (night) temperatures of 30^{o} C (26^{o} C) in August and September and coolest 28.5^{o} C (21.5^{o} C) in January and February. The annual rainfall is less than 510 mm per year, the humidity averages 76%.

The vegetation is characterised in general as xeric and consists of thorn-bushes and cacti. There is hardly any lichen or moss. A restricted number of grass species and herbs grow in the valleys and around houses. Of the cactusses the tuna *Opuntia wentiana* is most common; besides that, three species of columnar cactusses can be seen: *Lemairocereus griseus*, *Cephalocereus lanuginosus* and *Cereus repandi*. Other succulents are different species of agave and aloe (originally introduced as crop). The most famous divi-divi *Caesalpina coriaria*, however, is scanty.

Aruba harbours different types of ecolotypes, marine, coastal and terrestrial, the most striking ones are characterised here (Appendix I). In this study of the terrestrial and, to a lesser extent the coastal units, several landscape-elements are important for the outdoors of Aruba. These are sometimes natural but most of all man made. The presence of the distinct components is subject to a certain amount of variation.

Biogeographically Aruba is situated in the Neotropical region. The distribution of mammals on the island depends on the main vegetation. Depending on the availability of species the island-character determines the areal border.

2.2. Recordings

During the investigation all possible methods of mammal species recordings were used. The different methods are described briefly and, if necessarily, a short description is given of the different technicques. However, the methods of recordings were not equably distributed over the island. An overview of the different types of recording is listed in table 2.

Table 2. Recording types of mammal-observation. Pdd: *P. d. davyi*, Mmi: *M.m. intermedia*, Gle: *G. l. elongata*, Lc: *L. curasoae*, Ntt: *N. t. tumidorostris*, Mol: *M. molossus*, Ch: *C. hummelicki*, Rr: *R. rattus*, Rn: *R. norvegicus*, Mm: *M. musculus*, Sfn: *S. f. nigronuchalis*.

Recording type	Pdd	Mmi	Gle	Lc	Ntt	Mol	Ch	Rr	Rn	Mm	Sfn
Field observation	*	*	*	*		*	*	*		*	*
Bat detector		*	*	*		*					
Live-trap							*	*		*	
Hand capture	*		*	*			*				
Hoop capture	*	*	*	*							
Mist net		*	*	*		*					
Tuttle trap		*	*	*	*						
Traffic victim								*	*		*
Found dead		*	*	*				*	*		
Owl pellet							*	*		*	
Other predation							*	*		*	*
Tracks								*			*
Droppings											*

Binomial nomenclature has been followed according Mammal Species of the World (1993); according the most recent revisions the subspecies nomenclature has been adopted.

Field observations of mammals are mostly difficult since mammals are nocturnal and hide during the day. There are however some exceptions: by day bats are encountered in darker places and caves, but only a few species allow a close proximity for (provisionable) determination. Also encounters at sunrise and sunset and more rarely in daylight, with *S. f. nigronuchalis* resulted in identification of the species. Night observations with the lights of a motorcar revealed another number of *S. f. nigronuchalis*.

With a batdetector the highfrequent sounds, often species specific, are transformed in audible sounds for the human ear. In favourable conditions, such as low numbers of different species of bats and loud calls, inventarisations are possible. By night an inventarisation have been performed by driving with a fixed speed of 20 kilometres an hour over the asfalt paved roads with a SBR 1121 mounted on the car.

The harp trap is an easy bat-trapping construction, consisting of a double frame with vertical nylon threads; a canvas bag, partially lined with polyethylene, is supported beneath the frame to catch bats as they fall after having been intercepted by the trap. Harp traps are highly effective on positions where large numbers of bats are flying in a forced and predictable way. In harp traps bats can stay for a while and hide without stress. Two harp traps, measuring 1.20 m by 1.20 m were regularly used in cave and mine entrances. Mist nets may be employed successfully at almost any site where bats are expected to fly. The most successful sites are near roosts, at water holes and across trails where bats are expected to fly. When mist nets are used in openings of caves and mines, bat populations should be relatively small and the nets should be monitored constantly to avoid the capture of large number of bats at one time (Kunz & Kurta, 1988). Two mist nets, measuring 6 m by 1.50 m, were used in the neighbourhood of caves, ponds, arroyo's and in the neighbourhood of (night) flowering plants. Catching by hand or by hoop nets is another possibility for catching mammals and especially bats. This method was used only in special occasions.

An important device for trapping small mammals is the live-trap. In this study 10 Longworth live traps and another 50 wooden homemade live-traps were used. On each square kilometre of Aruba a location was chosen according best professional judgement. At that location 30-40 traps, baited with peanut butter and rolled oats, were positioned on optimum places in a line or grid with distances of five metres. Each location was searched for droppings (of *S. f. nigronuchalis*) and a survey of the soil and vegetation was made (see 2.5.: Inventarisation and habitat). Besides these small traps, four bigger traps were used, baited with eggs or fish and positioned in road tunnels.

Finding traffic victims is a product of three variables: traffic intensity, number of mammals crossing roads and the intensity of patrolling the roads. Cases in which it was impossible to conclude whether traffic, snap traps, illnesses, poisoning or predation was the cause of death were recorded as 'found dead'.

In general, owl pellets form an important source for describing the small mammal population; this also holds true for pellets of the Arubian burrowing owl *Athene cunicularia*. Van Marwijk Kooy (1991) described the analysis of pellets of the barn owl (*Tyto alba bargei*) on Curaçao and he found different species of mammals. He discriminates between *C. hummelincki* and *M. musculus* on the skull (rostrum) and the presence of notched upper incisors (in side view). However, the barn owl of Curaçao produced parts of the skull (rostrum) in the pellets while the burrowing owl *A. cunicularia* only produced mandibles and only a limited number of recognisable parts of the skull. Moreover, almost half of *M. musculus* caught on Aruba did not have notched upper incisors. Therefore the number of roots of the first lower molar was used in this paper as discrimination, being three or four in the genus *Calomys* (Hershkovitz, 1962) and two in *M. musculus* (Lange e.a. 1994). Other predation, by the American kestrel *Falco sparverius*, the Arubian rattle snake *Crotalus horridens unicolor*, dogs and house cats form a mere casual observed item and is dealt with in the species account.

Because of the hard soil on Aruba, tracks are of limited value for inventarisation purposes with exceptions: *R. rattus* on wet sand/mud or cave dust and *S. f. nigronuchalis* on sandy soil.

Droppings are very useful as signs of presence over long times due to the conservation of the, in most times, dry climate. However, in caves droppings (of bats) are concentrated and have a more or less predictable presence. The presence of cactusseeds in the droppings of *G. l. elongata* and *L. curasoae* can serve as a potential foodstore for scavenging *R. rattus*, *M. musculus* and tropical landcrabs (*Cardisoma carnifex*[?]).

Account of specimens

The 'Account of specimens' is given in three categories. In the first place for each species are given the 'Records of specimens collected' or parts of specimens; those items are legated to the Nationaal Natuurhistorisch Museum in Leiden. The 'Records of specimens examined' are those that were in hand, were determinated and of which (some) measurements or characteristics were noted. For bats those were sex, weight, length of resp. forearm, digit (including metacarpal) three and five. For *C. hummelincki*, *R. rattus*, *R. norvegicus*, *M. musculus* and *S. f. nigronuchalis* besides sex and weight, measurements were taken (if possible) of headbody, tail, ear and hindfoot. The 'Records of specimens observed' comprise those specimens that were not in hand but of which the determination of the species was beyond reasonable doubt.

The total number of the specimens is given in the headings (between brackets) and, as far as possible, place, date, number and sex were noted. The total numbers for 'Records of specimens observed' is not given in each species because some (e.g. Chiroptera) are merely estimations (minimum numbers). For the location of the places is referred to the gazetteer. In this list square kilometre blocks (see Appendix V and fig. 30) define places.

2.3. Measurements and observations

Measurements less than ca. 5 mm have been taken with an Euromex stereomicroscope with an ocular micrometer. Measurements between ca. 5 mm and ca. 5 cm have been taken with dial callipers, calibrated in twentieths of a millimetre. Both were recorded to the nearest tenth of a millimetre. Measurements over ca. 5 cm have been taken with a spring rule and recorded to the nearest mm. The most important measurements used in this study are described in Appendix II. Because of the unusual shape of the skull in some mormoopids cranial measurements employed in this study were selected according to Smith (1972). Humidity has been determined with a hair-hygrometer.

Droppings

A short description is given of available droppings. Measurements have been taken of length and diameter. Faecal analysis is a method to determine the contents of the diet of insectivore and herbivore (fruit-eating as well as grazing) mammals. The epidermis of ingested plants can often be recognised in faecal remains by its undigestible outer layer (the cuticula) carrying specific imprints of the cells underneath (De Jong, 1994).

2.4. Roosts

On Aruba bats stay in colonies of some to several thousand specimens during the day. By doing so they exhibit an outspoken clustered dispersion. These roosts are caves, quarries, abandoned buildings, or parts in buildings (lofts) that are quiet and silent; no tree-dwelling bats have been found. Characteristics of the roosts are partly or total darkness, little air-movements and, varying per species, a high humidity of the air. Of each of the most important dayroosts some measurements have been taken to give an impression of the microclimate that was used by the different species (table 3).

Table 3. Measurements of important day-roosts and nurseries of bats (Gle: *G. l. elongata*; Lc: *L. curasoae*; Mmi: *M. m. intermedia*; Ntt: *N. t. tumidorostris*; Pdd: *P. d. davyi*; Pmc: *P. macrotis*; *: only known from literature.

Name of cave / quarry	soiltype	length	lux	height	temperature	humidity (%)	Bat species present
Canashito	limestone	12					Pmc*
South			10	1.76	30.6	82	Gle
North-east			20	1.13	32.1	76	Gle/Lc/Mmi
Tunnel of Love	limestone	200					
chamber 1			70	4.92	30.2	88	Gle
chamber 2			0	4.17	29.1	92	Gle
chamber 3			0	6.77	29.0	91	Gle
chamber 4			0	3.30	30.8	90	Lc
chamber 5			5	5.48	30.3	88	Gle
Quadirikiri	limestone	150					Lc*
Kamber Grandi			500	3.36	30	72	Gle
Kamber di Bentura			500	2.94	30	71	Gle
Kamber di Leeuw			0	3.67	31	97	Mmi
Fontein	limestone	95	250	3.5	30.4	76	Gle
Lago Colony Cave 1-5	limestone	480	0	2.20	31.3	85	Gle/Mmi*
Wela quarry	slatestone	80	0	1.8	32.6	89	Pdd/Gle/Lc/Ntt
Jamanota quarry	diabase	60	n.a.	1	n.a.	n.a.	Gle/Lc

The cave of Canashito nowadays exists of two small caves the biggest of which is about 12 m deep and 2 1/2 m high. They are situated at the north side of the high terrace of the Seroe Canashito. In the rest of this hill that is remained after mining activities are some smaller caves, inaccessible for humans.

The Tunnel of Love is formed in the middle terrace that is on this very place some 40 m high. This rather dry cave exists of five chambers, connected with each other till 25 m under the terrace. The floor of this cave is irregular by the diorite underground. The length is approximately 200 m, the height of the chambers is varying from 5 to 6 m.

The Cueba di Quadirikiri is an easily accessible cave in the northwest side of the middle terrace. This cave consists of two big chambers with some openings in the ceiling (resp. the Kamber Grandi and the Kamber di Bentura). At the end of the cave is a narrow opening to a blind chamber (Kamber di Leeuw) with an extreme high air humidity. The total length of the cave is 150 m, the height of the chambers and the connecting corridors is approximately 5 m and 3 m, resp.

The cave of Fontein is named after the well of Fontein. The broad entrance disposes the first chamber with a

great number of stalactite-stalagmite pillars. The rest of the cave spirals to the right like a snail-shell and narrows at the end till approximately 3 1/2 to 2 m. At the rear end of the cave three small chambers are situated. The total length of the cave is 95 m.

The Spelonk di Seroe Cora, also known as the Lago Colony Cave, is situated in the lower middle terrace at Lago Colony. The set of corridors roughly follows the faults in the limestone plateau. This large cave shows active sintering (the only one on Aruba). The total length is 480 m; the height of the chambers varies from 4 to 7 m, that of the corridors from 2 to 3 m (Wagenaar Hummelinck, 1979).

Alongside the north coast, especially between Seroe Colorado and Boca Prins, on the edge of the middle terrace numerous small caves can be found, several of which are used as roosts by bats (especially *G. l. elongata*). Besides the natural caves in limestone and by wind carved diorite boulders, a few quarries from the time of the goldmining industry on Aruba are left. The Wela quarry turned out to be the most valuable one for bats. The length is 80 m, the height and width resp. 1.80 and 1.30 m. The quarry at Yamanota exists of a horizontal part with a hardly accessible opening and a vertical shaft of ca. 3 x 3 m and approximately 8 m deep.

2.5. Inventarisation and habitat

Trappings of mammals have been performed in each square kilometre block of Aruba. Blocks that were totally private property or that were not accessible (e.g. closed sections of the dockyards) have not been investigated. The small rif-islands at the Southcoast neither have been investigated for logistic reasons. If blocks covered only a part of land investigated, a number of traps were used proportional to the land size. Each trapping site was chosen according best professional judgement according to an optimal trapping result.

The number of bat trapping sites was rather limited. With the Tuttle trap trapping sessions were performed in the neighbourhood of flyways of bat caves. The mist nets were used on promising places near flowering plants. On the trapping site of each block a vegetational record was taken. Trapping sites were defined as the area in which the traps were placed surrounded by a rim of 100 m to each direction; distances to elements were calculated from the centre of the defined trapping site. Of each trapping site a habitat record was made; besides elements of vegetation also soiltype, texture, terrain features, specific landscapes and different landscape-elements. Besides that, the number of used traps and the results were noted.

A differentiation in soil type was made according to limestone, quartz-diorite, diabase alluvial/colluvial and other. The texture of the soil type is differentiated in: sand (≥ 50 µm, < 2 mm), gravel (≥ 2 mm, < 5 cm), stone (≥ 5 cm, < 20 cm), boulder (≥ 20 cm, < 10 m) and rock (≥ 10 m). The amount of loam was estimated by the degree of forming of so-called ‘mud-clefts’; three categories were separated: ‘absent’, ‘small’ and ‘big’. The terrain is characterised as flat (no more than 2 m level difference within the record), undulating (more than 2 m level difference within the record, not continuing outside the record), hilly (more than 2 m level difference within the record, continuing outside the record) and cliff (rocky level difference of at least 2 m and almost perpendicular over a distance of at least 10 m). Of each trapping site the height was read from a detailed map.

The vegetation was classified according the following definitions. ‘Grass’ (monocotyles) comprisedall species of grass, 'herbs' (dicotyles) all other plants with the exception of succulents. The succulents were split in 'melon-cactus', 'agaves' and 'cactusses' (cactusses and aloe plants). The woody structures were divided in 'low bushes' (wood vegetation not higher than 2 m, 'high bushes' (wood vegetation higher than 2 m and not a 'tree') and 'tree' (wood vegetation higher than 5 m or at least a free stem of 2 m).

Cover of the vegetation and leaflitter was estimated and categorised in seven classes: 0 - 6 (table 4).

Table 4. Definitions of categories of percentages cover.

Category	percentage cover
0	0%
1	> 0%, < 5%
2	≥ 5%, < 12.5 %
3	≥ 12.5%, < 25%
4	≥ 25%, < 50%
5	≥ 50%, < 75%
6	≥ 75%

Garbage was classified positive either by heaps of garbage of at least 1 x 1 m or by at least 10 items scattered over 100 square meter.

The population structure for the different species is described as far as possibly according sex-ratio, signs of sexual activity (descended and/or enlarged testicles in males and pregnancy or enlarged nipples in females), changes of body weight and displacement of individuals based on the capture-mark-recapture method.

In this study differences between groups (sexes) were compared and tested with Students' t-test. In this analysis the F-value is computed with SPSS using univariate ANOVA and compared in an F-table (< 0.05 level of significance).

3. Results

3.1. General results

The total number of investigated square kilometre blocks is 237. The results of the bat trappings are summarised in table 5; the 'other' captures were caught by hand (*P. d. davyi*) or by hoop nets (rest). Besides the bats *Hirundo rustica* (Savaneta W) resp. *A. cunicularia* (Rooi Lamoenchi) have been caught once.

Table 5. Number of bat trappings by different methods.

Bat trappings	harp trap	mist net	other
P. d. davyi			2
M. m. intermedia	49	5	1
G. l. elongata	164	26	5
L. curasoae	89	2	2
N. t. tumidorostris	2		
M. molossus		1	8
Total	304	34	18

The total amount of trapping-nights was 4381 with 187 caught mammals (4.3%) as a result: *C. hummelincki* 18 (0.4%), *R. rattus* 39 (0.8%) and *M. musculus* 130 (3%); trapping nights of population study of *C. hummelincki* are not included. Also a considerable number of catches of non-mammalian species have been made (table 6).

Table 6. Other catches by traps.

Species	number (%)
Hermit crab *Coenobita Clypeatus*	104 (2.4%)
Landcrab *Cardisoma Carnifex*	20 (0.5%)
Cockroach *Blattus* spec.	18 (0.4%)
Kododo *Cnemidophorus arubensis*	11 (0.3%)
Tropical centipede *Scolopendra morsitans*	7 (0.2%)
Cerion uva	7 (0.2%)
Pega pega *Phyllodactylus julieni*	1 (0.02%)
Strand crab	1 (0.02%)

The amount of trapping-nights with the big live-traps in tunnels under roads was 32; however, in these traps no mammals were caught. Near Hooiberg SW and near Barcadera 2 Aruba whiptail lizards *Cnemidophorus arubensis* (Van Lidth, 1887) (= kododo) were caught.

Gathering of pellets (or the remnants) of the burrowing owl *A. cunicularia* was performed on each occasion a burrow of this owl was discovered and nesting places were revisited to collect pellets. Subsequently those pellets were analyzed (table 7).

Table 7. Locations and number of mammal species found in owlpellets and débris of *Athene cunicularia*; Ch: *C. hummelincki*, Rr: *R. rattus*, Mm: *M. musculus*.

Location	Ch	Rr	Mm
Matogerai 20.viii.94	2	8	14
Wariuri 4.ix.94	1	1	4
Manzania 1.ix.95		1	
Lago Colony pipe 15.ix.95		1	6
Savaneta W 2.vii.95			2
Matogerai 4.xii.94		1	4
Rooi Lamoenchi S 16.iv.95		1	
Savaneta S 28.v.95		1	
Plantersrust 26.iii.95		1	3
Rincon 22.x.95	4		
Lago Colony W 21.x.95	1		3
Rincon terrace 21.x.95	2	1	1
Matogerai 31.v.94			2
Total	10	16	39

3.2. Species accounts

CHIROPTERA

EMBALLONURIDAE

Peropteryx macrotis (Wagner, 1843)

Account of specimens

Records of specimens examined (2)
P. macrotis is the only mammal that was described by Husson (1960b) and that was not found, trapped or seen during my stay on this island; therefore the two specimens collected by Van Zijl in 1945 at Canashito and kept in the Nationaal Natuurhistorisch Museum at Leiden were examined.

Taxonomy
Peropteryx macrotis, Wagner 1843, Archiv Naturgesch. 9, p. 367 - Mato Grosso, Brasil.
Peropteryx trinitatis, Miller 1899, Bull. A.M.N.H. 12, p. 178 - Trinidad.
Peropteryx canina phaea, G.M. Allen 1911, Bull. M.C.Z. 54, p. 222 - Grenada.
Peropteryx canina trinitatis, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 69.
Peropteryx macrotis, Husson, 1960(b), De zoogdieren van de Nederlandse Antillen, p. 57 - Aruba.

Measurements
The external measurements of two specimens, RMNH reg. nos. 14360 (male) resp. 14361 (sex unknown) of *P. macrotis* are: forearm 39.0, 41.9, fifth digit 47.0, 43.2 ear 12.3, 13.7, tragus 4.6, 4.5. The measurements of the skull are: condylobasal length 11.7, 12.7, zygomatic width 7.3, 8.0, cranium height 5.3, 5.4, interorbital width 2.7, 2.7, upper tooth-row 5.3, 5.5, C1-C1 3.4, 3.9, lower tooth-row 5.5, 6.0, mandible length 9.2, 9.5. From the forearm figures the Arubian stock is likely to be attributed to the subspecies *P. m. trinitatis*: average forearm length 38.6 (26 males) resp. 41.8 (11 females) (Eisenberg, 1989).

Description
Colour of the upper parts varying from dark yellowish- brown through greyish and reddish brown to dark brown; the under parts having about the same colour. Skull small with a sharp angle between rostrum and braincase. Tail perforating at the upper side of the interfemoral membrane. Proximal phalanx of the third finger is reflexed when the wing is at rest. Near the upper edge of the antebrachial membrane a glandular wing sac opens outward (Goodwin & Greenhal, 1962).

Areal and geographical distribution
P. macrotis ranges within the neotropical sphere from Veracruz and Oaxaca, Mexico, southward to Peru and eastward to Paraguay and southeastern Brazil (Eisenberg, 1989). The species occurs in the Caribbean on Grenada (Varona, 1974) and Trinidad and Tobago (Goodwin & Greenhall, 1961).

PHYLLOSTOMATIDAE

Pteronotus davyi davyi (Gray, 1838)

Account of specimens

Records of specimens examined (2).
Wela quarry 8.xii.1993: one male; 22.i.1994: one male.

Records of specimens observed (4).
Wela quarry 8.xii.1993: four specimes.

Taxonomy
Pteronotus davyi Gray, 1838, Mag. Zool. Bot., 2 p. 500 - Trinidad.
Chilonycteris gymnotus Wagner, 1843, Wiegmann's Archiv fur Naturgesch., 9, p. 367 - Mato Grosso, Brasil.
Pteronotus davyi davyi, Smith, 1972, Kansas Mus. Nat. Hist., Misc. publ. 56, p. 98.

Measurements and weights
The measurements of these two specimens were: forearm right 44.8 resp. 46.5 and left 44.5 resp. 46.2 mm; third finger left 79 resp. 79 mm; the fifth finger left 54 resp. 54 mm. The weight of the first specimen was 8.5 g; the second specimen has not been weighed. The forearm figures of the Arubian stock matches good with the combined forearm figures of *P. d. davyi* from Nicaragua, Trinidad and Dominica (average: 46.1, 47.3 and 46.1 resp, Smith, 1972).

Description
Small to medium sized bat with a short muzzle. Wing membrane fused dorsally and by that giving a naked appearance, sparsely covered by long, irregularly spaced hairs. Base of the muzzle bordered with a fringe of hairs covering the small and inconspicuous eyes for the most part. Nostrils incorporated into the expanded upper lip. Lower lip folded and set with small wraths. Pinnae of the ears funnel-shaped with a long and lanceolate distal portion. Lower edge of the pinna confluent with a ridge extending along the lower lip. Rostrum and braincase more or less in the same plane. Tail protruding dorsally approximately half of the distal portion from the uropatagium; the free tail end measures ca. 8 mm and does not cross the free border. Pelage short and fine and densely distributed over the body. Colour of the head brown; hairs short and more sparsely implanted, with the skin shining through pink. Back under the shoulders darkbrown, however, the normal fur is missing (fig. 1). Colour of the legs brown, belly pale brown.

Skull measurements are given from specimens from Nicaragua, Trinidad and Dominica resp. (Smith, 1972): condylobasal length: 14.9, 14.7, 14.9; zygomatic breadth: 9.0, 9.1, 9.0; upper toothrow: 6.7, 6.8, 6.6. The dental formula is I 2/2, C 1/1, P 2/3, M 3/3.

Areal and geographical distribution
P. davyi ranges within the neotropical sphere from southern Sonora, Mexico, south to north-western Peru and north-eastern Brazil (Eisenberg, 1989). *P. d. davyi* is distributed from Nicaragua south through Central America into South America, where it is known from several localities along the Caribbean coast of Venezuela (Smith, 1972). *P. d. davyi* is also recorded from Curaçao (Petit, 1995), north and south Trinidad (Goodwin & Greenhall, 1961), the Lesser Antillean islands of Grenada, Dominica, Marie Galante and Martinique (Smith, 1972). With the present findings the occurence of *P. d. davyi* on Aruba has been established.

Habitat
The habitat is characterised predominantly by dry sites and thorn forest (Handley, 1976). The species is known from caves with a humidity of more than 90%. Handley (1976) also mentions that this species is frequently seen in small groups in bigger colonies of other species of bats. On Trinidad and Tobago, Goodwin & Greenhall (1961) report that *P. d. davyi* was seen together with six different species of bats. Also in this roost the species was observed among *G. L. elongata* and *L. curasoae* (the total number of out-flyers was 1159). There was not even a trace of agonistic interspecific behaviour.

Food
The analysed faecal material showed clearly that this species is insectivorous; no indication, however, of food preference could be established. Hunting behaviour of *P. d. davyi* could not to be accessed by batdetector.

Remarks
On December 8th 1993 after counting out-flyers of an abandoned goldmine in Wela quarry the mine was inspected. In the shaft mummified specimens of *L. curasoae* (Miller, 1900) (2 ex.) and *G. l. elongata* (Miller, 1900) (1 ex.) have been collected. At the end of the shaft over 40 *G. l. elongata* still remained. In between those, five specimens of clearly another species were detected. With the (gloved) hand I succeeded in capturing one of those. This bat (*P. d. davyi*) was, at that moment not recognised as an indigenous species; for that reason the specimen was taken for determination and afterwards set free.

The distribution of this subspecies according to the map of Smith (1972) makes an attribution of the Arubian specimens likely to the northeastern Venezuelan stock. Attribution to substocks based on the forearm lengths is not possible (e.g. Nicaragua 46.1 (44.0-49.2), Trinidad 47.3 (45.9-48.8) and Dominica 46.1 (45.4-46.9); there are no figures available of the northeastern Venezuelan stock. However, it is likely that individuals from Aruba, as well as from Curaçao, come from Piedra Honda Cave in Paraguana (Venezuela) where Martino et al. (1997) reported 89 specimens.

Fig. 1. *Pteronotus davyi davyi* with the naked back; first documented record on Aruba.

Mormoops megalophylla intermedia (Miller, 1900)

Account of specimens

Records of specimens collected (29).
Canashito NE 26.ix.1995; RMNH, reg. no. 40029: sex unknown (partial skeleton).
Quadirikiri 1.i.1993; RMNH, reg. no. 38866: sex unknown (skeleton); 16.i.1993; RMNH, reg. no. 38852: sex unknown (skeleton); 30.i.1993; RMNH, reg. nos. 38855-38857: one male, one female and one sex unknown (two specimens in alcohol and one skeleton); 6.ii.1993; RMNH, reg. nos. 38862-38864: sex unknown (skeletons); 14.ii.1993; RMNH, reg. no. 38865: sex unknown (skeleton); 28.ii.1993; RMNH, reg. no. 38868: one male (specimen in alcohol); 28.iii.1993; RMNH, reg. nos. 38885, 38890 and 38892: three sex unknown (skeletons); 3.iv.1993; RMNH, reg. nos. 38884 and 38886-38889: five sex unknown (skeletons); 18.iv.1993; RMNH, reg. no. 38881: one male (specimen in alcohol); 1.viii.1993; RMNH, reg. nos. 38909 and 38910: two sex unknown; 9.i.1994; RMNH, reg. nos. 38953-38955: two males and one sex unknown; 25.i.1994; RMNH, reg. nos. 38974 and 38975: two sex unknown; 24.iv.1994; RMNH, reg. no. 38976: sex unknown; 2.iv.1995; RMNH, reg. no. 40020: one male (specimen in alcohol).

Records of specimens examined (55)
Quadirikiri 30.iv.1994: six males; 8.v.1994: one male; 21.v.1994: 17 males, five females; 18.vi.94: one male, three females, 17.vii.1994: five males, two females; 20.xi.1994: one male; 6.i.95: three males, four females, 1.iv.95: six males, one female.

Records of specimens observed.
Quadirikiri 12.xii.1992: 120; 20.v.1993: 90.

Taxonomy
Mormoops intermedia Miller, 1900, Proc. Biol. Soc. Wash. 13, p. 160, 31 October - Grot van Hato, Curaçao.
Mormoops megalophylla intermedia Rehn, 1902, Proc. Acad. Nat. Sci. Philadelphia, 54, p. 170, 11 June.
Mormoops megalophylla intermedia, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 71 - Cueba di Quadirikiri, Aruba.
Mormoops megalophylla intermedia, Husson, 1960(b), De zoogdieren van de Nederlandse Antillen, p. 61 - Cueba di Quadirikiri, Aruba.
Mormoops megalophylla intermedia, Smith, 1972, Kansas Mus. Nat. Hist., Misc. publ. 56, p. 118 - Quadirikiri Caves, Lago Oil Transport Co., E Seroe Colorado (5 mi).

Description
Medium to large-sized, slender bat with a long thin tail protruding the interfemoral membrane. Ears rounded and medial part of the edge of the pinna elongated and connected to the contralateral side, forming a band across the forehead. A prominent ridge separates the nostrils, with several wart-like tubercles in between. Lower edge of the pinnae continuing along the lower lip. Lips expanding and ornamented with various flaps and folds that form a funnel into the oral cavity when the mouth is opened (fig. 2). Forehead arising abruptly from the rostrum forming an angle of 90 degrees. Dorsal pelage long and lax; colour of the pelage reddish brown. Pelage over the head short and more sparsely implanted, with the skin shining through pink. The hairs forming a 'T'-shaped cape over the shoulders (fig. 3) yellowish and not white as suggested by Smith (1972). The dental formula is I 2/2, C 1/1, P 2/3, M 3/3.

Measurements and weights
Details of measurements and weights are given in table 8 (spec. in alcohol), table 9 (range and average of skull and bones) and table 10 (range and average of live specimens). Although the average figures are close, however, a wide variety in forearm lengths shows up in males as well as in females. Therefore no sexual dimorphism can be revealed in forearm length in this species: being 53.7 in both males and females (see table 10).

Table 8. External measurements of five specimens of *M. m. intermedia*

Collection number	38856	38857	38868	38881	40020
Sex	female	male	male	male	male
Forearm	52.4	55.2	54.8	55.0	52.9
First digit	3.5	3.2	3.1	3.0	2.6
Third digit, metacarpal	50.6	50.8	50.2	50.1	47.8
1st phalanx	10.3	10.1	9.6	10.2	9.3
2nd phalanx	22.5	22.0	21.8	21.9	22.1
3rd phalanx	15.9	15.8	15.5	15.2	14.5
Fourth digit, metacarpal	47.2	48.5	48.1	48.9	47.3
1st phalanx	12.2	12.7	12.1	12.5	12.3
2nd phalanx	12.1	12.4	11.6	12.2	12.2
Fifth digit, metacarpal	37.2	36.6	37.5	37.9	34.9
1st phalanx	16.8	17.2	16.6	16.9	16.5
2nd phalanx	10.0	10.0	9.6	10.4	10.2
Tibia	22.1	23.1	22.8	23.3	23.0
Hind foot	9.6	10.7	9.5	10.3	9.1
Spur	16.8	18.6	16.6	18.2	16.5
Head and body	57	58	59	61	57
Tail	29	27	25	27	27
Free end of tail	7	11	7	13	11

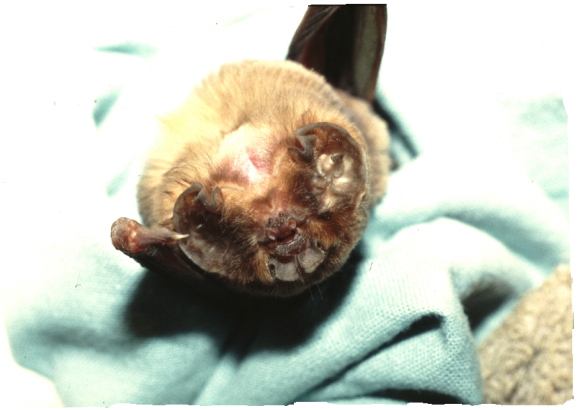


Fig. 2. *Mormoops megalophylla intermedia*, detail of face with the characteristic circle of flaps around the mouth.

Table 9. Measurements (skull-bones) of *M. m. intermedia* (number, range and average)

	n	minimum	average	maximum
Condylobasal length	17	13.6	14.15	14.5
Zygomatic width	16	8.7	9.27	9.6
Cranium height	17	9.2	10.20	10.9
Interorbital width	17	4.9	5.21	5.4
Length of upper tooth-row	18	7.0	7.62	7.9
Length of lower tooth-row	22	8.1	8.45	8.9
C1 – C1	18	4.0	4.32	4.9
Humerus length	19	30.2	31.62	32.6
Radius length	19	48.5	50.14	51.5
Femur length	18	23.9	24.47	25.7

Table 10. Measurements of *M. m. intermedia* (number, range and average) according to sex (live).

	males				females			
	n	minimum	average	maximum	n	minimum	average	maximum

Forearm length	40	51.7	53.67	56.5	15	51.4	53.67	56.0
Length of digit III	40	86	92.43	98	15	89	93.47	98
Length of digit V	40	59	63.00	66	15	59	62.87	66
Weight	32	12.5	13.98	15.5	12	12.0	14.04	16

Areal and geographical distribution

M. *megalophylla* ranges within the neotropical sphere, and the most southern part of the nearctic, from southern Texas through the Isthmus of Panama and across northern Colombia and northern Venezuela. It has colonized many of the Caribbean islands (Eisenberg, 1989). *M. megalophylla* is also recorded from Trinidad (Goodwin & Greenhall, 1961). *M. m. intermedia* is restricted to the Dutch West Indies (Smith, 1972). This author noticed a clear trend to smaller overall size from Aruba to Bonaire in this insular subspecies. However, the differences he noticed in forearm lengths in specimens of Aruba (average: 54.1, min: 54.0, max: 54.2, n = 3), Curaçao (average: 52.0, min: 49.8, max: 53.8, n = 16) and Bonaire (50.3 and 53.4 resp., n = 2) and the results shown in table 10 make a definite difference in this subspecies not marked.

Fig. 3. *M. megalophylla intermedia* on backside with the prominent 'T'.

Food
All analyzed droppings show only remains of insects. Droppings average 2.12 mm in diameter and 5.91 in length resp.

Reproductive biology
On several occasions young *M. m. intermedia* have been noticed, always in the period of September till November. In one huge cavity in the wall of the Camber di Leeuw a large number of young *M. m. intermedia* were gathered. Remarkably adult male individuals have been seen within the breeding colony in the same spot as naked young individuals. Martino et al. (1997) found the reproduction period of this species in the Cueva de Piedra Honda, Paraguana (Venezuela) in March. Formerly a large number of *M. m. intermedia* was present in Quadirikiri and Lago Colony Cave as well (Smith, 1972). The population size on Aruba is declining based on personal communications (V.d. Linden Rasmijn) and on own observations over three years. Nowadays the population seems to be restricted to the Camber di Leeuw, the rear chamber in Quadirikiri. The habitat of the dayroost place is almost exclusively restricted to moist caves such as the rear chamber of Quadirikiri and (formerly) the Lago Colony Cave (Smith, 1972). One skeleton of *M. m. intermedia* was found in Caneshito NW, although during none of the excursions any other sign of presence of this species was noticed.

Ectoparasites
Streblidae spec. have frequently been seen running backwards and sidewards on the membranes and in the fur.

Remarks
The long, but tapering wings indicate a fast and swift flight. The sound that is heard on the batdetector (74 kHz) while flying out consists of a crackling, very fast rattle without tune quality and with a short reach. Because of the low intensity of the emitted sonar, hunting *M. m. intermedia* could not be heared.

Glossophaga longirostris elongata (Miller, 1900)

Account of specimens

Records of specimens collected (10).
Andicuri NE 4.xi.1994; RMNH, reg. no. 40005: one male (specimen in alcohol).
Canashito NE 2.x.1994; RMNH, reg. nos. 39000 and 40001-40003: four males (specimens in alcohol).
Quadirikiri 28.iii.1993; RMNH, reg. no. 38869: one male (specimen in alcohol).
Savaneta E 16.v.1995; RMNH, reg. no. 40022: one female (specimen in alcohol, skull extracted).
Wela quarry 8.xii.1993; RMNH, reg. no. 38936: sex unknown; 15.v.1994; RMNH, reg. no. 38997: sex unknown; 14.viii.1994; RMNH, reg. no. 38994: one female (specimen in alcohol).

Records of specimens examined (195)
Andicuri NE 4.xi.1994: six males and four females.
Barcadera 10.ix.1995: two females.
Canashito NE 2.x.1994: eleven males and four females.
Canashito S 7.iv.1995: six males.
Rooi Franse Pas 9.vi.1995: three males and seven females.
Hooiberg SW 20.xii.94: one male.
Jamanota quarry 2.x.1994: one female.
Lago Colony Cave 8.i.1994: two males and one female; 30.ix.1995: five males.
Modansa 25.iii.1995: two females.
Quadirikiri 18.vi.1994: two males and two females; 17.vii.1994: two males and one female.
Tunnel of Love 31.x.1993: one male; 1.v.1994: one female; 21.viii.1994: five males and five females.
Wela quarry 4.xii.1993: one male and two females; 12.xii.1993: two females; 25.vi.1994: five males and two females; 14.viii.1994: 26 males and 13 females; 18.ix.1994: 15 males and five females; 21.x.94: 10 males; 22.xi.1994: nine males and four females; 20.xii.1994: one female; 18.iii.1995: one male; 30.iii.1995: 19 males and five females.

Records of specimens observed.
Arikok II 1.viii.1993: one and two.
Daimaru 12.ii.1995: six.
Fontein 12.xii.1992: one; 23.ix.1995: six.
Jamanota NW (house) 24.iv.1993: 20.
Manzania caves 8.xii.1992: nine and four and three and two; 20.xii.1992: two.
Masiduri 22.xi.1993: one.
Lago Colony Cave 15.v.1993: twelve.
Lourdes Cave 13.xii.1992: one.
Quadirikiri 12.xii.1992: 20 and 33.
Rincon W 27.xii.1992: six and seven.
Rooi Lamoenchi 27.xi.1994: one.
Seagrape Grove caves 19.xi.1992: one.
Tunnel of Love 12.xii.1992: eight and ten and 20.
Wela quarry 4.xii.1993: 300.
Westpunt (house) 8.v.1993: ten and four.
Zwarte Mangel E caves 20.xii.1992: one and two and four.

Taxonomy
Glossophaga elongata, Miller, 1900, Proc. Biol. Soc. Wah. 13, p. 124 - Willemstad, Curaçao.
Glossophaga soricina, Wagenaar Hummelinck 1940, Stud fauna Cur. 1, p. 71 - Aruba, Curaçao, Bonaire.
Glossophaga longirostris elongata, Koopman, Evolution, 12, p. 437.
Glossophaga elongata, Husson, 1960, De zoogdieren van de Nederlandse Antillen, p. 65 - Aruba, Curaçao,

Bonaire.
Glossophaga longirostris elongata, Webster & Handley, 1986, Occas. Papers Mus., Texas Tech Univ., 100 p. 9 - Aruba, Curaçao, Bonaire.

Measurements and weights
Details of measurements and weights are given in table 11 (skull and bones), table 12 (spec. in alcohol) and table 13 (range and average of live specimens).

Table 11. Measurements (skull-bones) of four specimens of *G. l. elongata*.

	38936	38966	38997	40022
Condylobasal length	23.0	-	-	22.3
Zygomatic width	9.2	-	-	9.5
Cranium height	4.5	-	-	7.7
Interorbital width	4.5	-	-	4.5
Length of upper tooth-row	8.5	-	9.2	8.7
Length of lower tooth-row	8.8	-	9.6	8.9
C1 – C1	4.2	-	4.6	4.4
Mandible length	15.6	-	15.8	15.9
Humerus length	24.6	-	-	-
Radius length	38.2	35.8	35.8	-
Femur length	15.5	-	-	-

Table 12. External measurements of eight specimens of *G. l. elongata*. (*: by trauma (?) partially dystrophic; therefore measured at right side.

Collection number	38869	38994	39000	40001	40002	40003	40005	40022
Sex	male	female	male	male	male	male	male	female
Forearm	38.2	40.6	40.1	38.2	39.3	39.3	38.5	37.9
First digit	6.7	6.0	6.1	6.1	6.1	6.2	5.3	5.7
Third digit, metacarpal	39.1	40.4	41.0	38.9	39.6	39.7	38.2*	38.0
1st phalanx	14.6	16.1	15.5	14.6	15.9	14.9	14.2	14.0
2nd phalanx	16.7	18.4	18.4	16.9	18.2	17.7	17.2	17.5
3rd phalanx	7.8	7.9	8.0	7.9	7.9	5.4	5.1	6.7
Fourth digit, metacarpal	35.2	37.5	37.5	34.5	35.9	35.4	34.6	35.4
1st phalanx	12.3	12.7	11.8	11.6	12.1	11.3	11.6	11.6
2nd phalanx	11.9	12.3	12.0	12.1	11.8	10.7	11.7	11.8
Fifth digit, metacarpal	34.7	36.2	36.3	34.4	36.1	35.2	34.9	34.9
1st phalanx	11.1	11.6	11.0	10.1	10.9	10.8	10.7	11.0
2nd phalanx	10.6	10.6	11.3	9.8	10.1	10.7	10.3	9.9
Tibia	16.0	17.1	17.3	17.6	17.9	17.0	17.4	16.0
Hind foot	10.0	10.9	10.7	11.6	10.4	11.1	10.4	10.1
Spur	5.2	4.6	4.6	4.1	5.2	4.9	5.2	4.4
Head and body	60	65	63	61	61	60	58	59
Tail	7.7	8.6	6.9	7.6	6.6	7.4	7.2	8.1

Table 13. Measurements of *G. l. elongata* (number, range and average) according to sex (live).

	males				females			
	n	minimum	average	maximum	n	minimum	average	maximum
Forearm length	131	38.0	39.16	41.2	64	37.2	39.57	42.3
Length of digit III	116	74	78.91	85	55	75	79.05	84
Length of digit V	117	53	57.08	62	55	54	57.51	61
Weight	39	12	13.73	15.5	28	11	13.57	19

Average figures are close. However, a wide variety in forearm lengths shows up, in males as well as in females. Therefore it cannot be concluded to a sexual dimorphism in forearm length in this species: being 39.16 in all males and 39.57 in all females (see table 13). Petit (1995) concludes from her data to a sexual dimorphism in forearm length (male: 37.88 +/- 0.88 mm; n = 24 and female: 38.38 +/- 0.78; n = 47).

Description

Small to medium sized bat with a long rostrum and skull; conspicuous and spade formed leaf-nose (fig. 4). Interfemoral membrane reduced and less than half of the tail is enclosed in this membrane. Colour of the upperparts brown and that of the venter light brown. Nose and ears dark brown; in older individuals a partial depigmentation of the nose was observed. The dental formula is I 2/2, C 1/1, P 2/3, M 3/3.

Fig. 4. *Glossophaga longirostris elongata* showing long tongue.

Areal and geographical distribution

Glossophaga longirostris ranges within the neotropical sphere in north-eastern Colombia and across northern Venezuela to Guyana (Eisenberg, 1989). It has colonized many of the Caribbean islands. *Glossophaga longirostris longirostris* is distributed from Grenada and the Grenadines (Webster & Handley 1986). *Glossophaga longirostris major* is recorded from Trinidad and Tobago (Goodwin & Greenhall, 1961). *G. l. rostrata* is known from Grenada northward to St. Vincent (Varona, 1974). *G. l. elongata* is restricted to the Dutch West Indies (Husson, 1960b).

Ecology

G. l. elongata regularly visits flowering plants such as cactusses, banana and aloe. Their foraging is especially accustomed to funnel-formed flowers. Some *G. l. elongata* apparently defend certain plants (e.g. agave). Besides that, feeding on cactus fruits of cadushi largo and cadushi pushi (fig. 5) have been observed. An analysis of *G. l. elongata* droppings showed a major rest of cactus-seeds and cactus pollen; sometimes other fruit items were taken. Besides those fruit items also some remains of insects have been found; number and dimensions suggests passive intake during visits of flowers rather than active insect hunting. Droppings showed a length of 9 - 11 mm and a diameter of 3.2 mm.

Fig. 5. Fruit of cadushi di pushi after several visits of *G. longirostris elongata* (dia Hans Bekker).

Reproduction
On Aruba the first newborn *G. l. elongata* have been observed as early as March (pregnant specimen), while lactating specimens were caught in July and August. Young specimens of several weeks were observed in the end of April and early May. On Curaçao nine female *G. l. elongata*, caught in February, showed no signs of reproduction whilst in August young, subadult and adult specimens were caught; this all indicates the end of reproduction in this month (Genoways & Williams, 1979). Webster & Handley (1986) collected data of the reproductive status of 383 female *G. longirostris* from all over the area of distribution. They found two periods of gestation: one from December till April and one from June till October. They concluded that the reproductive strategy of *G. longirostris* is a monotocous polyoestrus with a bimodal cycle. Based on the observations on Aruba it is plausible that the peak of birth in the colonies is the end of March/early April. There is not any sign of birth-periods in another period; on Aruba and Curaçao therefore this indicates a monotocous oestrus-cycle in *G. l. elongata*.

Population
The population size sometimes exists of several hundred individuals, however, more often small groups and sometimes even single individuals have been noticed.

Ectoparasites
Streblidae spec. have been frequently seen running backwards and sidewards on the membranes and in the fur. On 12.xii.1993 a Streblidae specimen was collected from this species and identified as *Trichobius furmani* (Wenzel, 1966) (personal communication Th. Zeegers).

Predation
Although no predation has been observed on Aruba, Van Marwijk Kooy (1991) has described predation of this species by the barnowl *T. a. bargei* on Curaçao.

Interrelation
Recently Petit (1995) demonstrated the mutualistic relationship between *G. l. elongata* (and *L. curasoae*) and columnar cactusses. She also demonstrated with respect to Cadushi largo *Lemairocereus griseus* that *L. curasoae* is more specialised than *G. l. elongata* in that relationship. However a qualitive or quantitive foundation in their interrelation is lacking. Numbers of *G. l. elongata* in roosts are fairly constant over the year suggesting a tighter bond to the same place than has *L. curasoae*. *G. l. elongata* has adapted to this situation by choosing a more varied menu; furthermore by leaving the roost on an earlier moment (approximately half an hour) this bat can visit early flowering plants with a high nectar content, or nearby located ripening fruits of cactusses.

Remarks
This species is often silent while flying around (whispering bats); on the batdetector (74 kHz) sometimes a short rattle is heard.

On August 14th 1994 a specimen had been caught with a tumor of digit four at the right wing at Wela quarry; this tumor was diagnosed as an osteoid (callus formation) of the proximal shaft of metacarpal four after a fracture. The distal part of the metacarpal was dislocated to lateral and along the axis to proximal; before a photograph could be taken the bat escaped. On September 19th 1995 this very bat was recognised and recaptured at Wela quarry. After more than a year the condition was good and a photograph has been taken; this picture also shows the secondary thickening of the proximal shaft of metacarpal four due to increased bloodflow in the osteoid (fig. 6). *G. l. elongata* have been reported flying in houses through open doors and windows; confrontations with fast spinning fans inside houses often result in death or fractured upper limbs (pers. comm. T. Barmes). The fracture of the above-described specimen and that of specimen 273 is almost certainly the result of confrontations with spinning fans.

Fig. 6. Right wing of *G. longirostris elongata* with osteoma due to callus formation after fracture of metacarpal of digiti IV.

Leptonycteris curasoae (Miller, 1900)

Account of specimens

Records of specimens collected (9).
Canashito NE 19.x.1995; RMNH, reg. no. 40030: one male (skeleton).
Tunnel of Love 3.x.1993; RMNH, reg. no. 38932: one male (specimen in alcohol).
Wela quarry 8.xii.1993; RMNH, reg. nos. 38934, 38935: sex unknown (two skeletons and two skulls); 22.i.1994; RMNH, reg. nos. 38963-38965: sex unknown (two skeletons and one mandibula); 20.viii.1995; RMNH, reg. nos. 40025, 40028: sex unknown (two skeletons and two skulls).

Records of specimens examined (93).
Jamanota quarry 2.x.1994: one female.
Tunnel of Love 3.x.1993: one male; 21.viii.1994: 14 males, ten females; 24.xi.1994: 35 males, 15 females.
Wela quarry 4.xii.1993: one sex unknown; 12.xii.1993: one male; 25.vi.1994: one female; 14.viii.1994: three males, two females; 20.xii.1994: two males, seven females.

Records of specimens observed.
Tunnel of Love 12.xii.1992: 60; 1994: 600; 1995: 600.
Vader Piet NE 1994: two.
Wela quarry 8.xii.1993: 800.

Taxonomy
Leptonycteris curasoae Miller 1900, Proc. Biol. Soc. Wash. 13, p. 126 - Curaçoae; according to Hoffmeister (1957, p. 460) Willemstad.
Leptonycteris curasoae, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 71 - Aruba.
Leptonycteris nivalis curasoae, Hoffmeister 1957, J. Mamm. 38, p. 460.
Leptonycteris nivalis curasoae, Husson, 1960(b). De zoogdieren van de Nederlandse Antillen, p. 67 - Aruba.

Measurements and weights
Details of measurements and weights are given in table 14 and table 15.

Table 14. Measurements (skull-bones) of seven specimens of *L. curasoae*.

	38934	38935	38963	38964	38965	40025	40028
Condylobasal length	27.5	27.4	-	-	-	-	26.7
Zygomatic width/breadth	11.6	-	-	-	-	-	10.4
Cranium height	7.5	-	-	-	-	-	7.3
Interorbital width	4.9	5.1	-	-	-	4.9	5.1
Length of upper tooth-row	9.3	9.7	-	-	-	9.5	9.5
C1-C1	5.1	-	-	-	-	4.7	4.5
Length of lower tooth-row	9.8	9.9	-	-	10.3	9.9	9.7
Length of mandibula	19.0	18.5	-	-	-	18.8	18.6
Humerus length	30.5	30.6	-	-	-	31.6	30.6
Radius length	51.5	52.4	51.7	52.4	-	52.0	51.1
Femur length	20.4	20.5	-	-	-	21.0	20.9

Table 15. Measurements of *L. curasoae* (number, range and average) according to sex (live).

	males				females			
	n	minimum	average	maximum	n	minimum	average	maximum
Forearm length	56	51.9	54.16	57.2	37	54.3	54.13	57.8
Length of digit III	45	94	98.44	105	27	95	98.59	103
Length of digit V	45	67	70.36	75	27	67	69.93	73
Weight	6	21	23.25	26.0	8	21.5	23.88	26.5

External measurements of a male specimen (RMNH, reg. no. 38932): Forearm, 54.3; first digit, without nail 5.4; length of third metacarpal 52.2; first phalanx 15.3; second phalanx 23.1; third phalanx 9.5; length of fourth metacarpal 47.1; first phalanx 13.2; second phalanx 16.4; length of fifth metacarpal 45.3; first phalanx 12.6; second phalanx 13.4; length of tibia 22.3; hind foot 12.0; head and body 74; tail 0.

No sexual dimorphism in forearm length could be established in this species: being 54.16 in all males and 54.3 in all females (see table 15). Petit (1995) neither found a sexual dimorphism and measurements of the forearm were completely within the same range (male: 54.10 +/- 1.51 mm; n = 151 and female: 54.54 +/- 2.28; n = 41).

Description

Medium to largesized bat (the largest bat of Aruba) with a moderately elongate muzzle; conspicuous and spade formed leaf-nose. Interfemoral membrane greatly reduced, the tail lacking or imperceptible externally (fig. 7). Colour of the upper parts brown and that of the venter light brown. Nose and ears dark brown. The dental formula is I 2/2, C 1/1, P 2/3, M 2/2.

Fig. 7. *Leptonycteris curasoae* licking and scratching with hindfoot.

Areal and geographical distribution

L. curasoae ranges from Arizona and New Mexico to El Salvador (Koopman, 1994) and further within the neotropical sphere in northern South America, predominantly along the Caribbean coast (Eisenberg, 1989). It has

colonized two of the Dutch West Indies (Husson, 1960b).

Reproduction
The first newborn *L. curasoae* have been observed as early as March, the latest female showing signs of lactation in August. Husson (1960b) mentioned the presence of young animals in Quadirikiri in June. Martino et al. (1998) investigated specimens from the Piedra Honda Cueva, Paraguana (Venezuela) and found females showing a pregnancy peak in May and a lactation peak in June; the highest frequencies of juveniles were observed in July. On Aruba, no indications sre present of reproduction in the rest of the year, indicating a seasonally monoestrus reproductive pattern.

Food
Analysis of droppings showed that the main part of the food consisted of cactusfruit, pollen and sometimes other fruit items. On a limited scale rests of insects have been found; number and dimensions suggests passive intake during visits of flowers rather than active insect hunting. Some of these nectar feeding-bats apparently defend certain plants. Droppings showed a length of 12-14 mm and a diameter of 3.8-4.4 mm.

Population
L. curasoae bats forage primarily at columnar cactusses; the mutualistic relationship between this bat and columnar cactusses (especially Cadushi largo *L. griseus*) has already been pointed out for the previous species. *Leptonycteris nivalis*, a close relative, is known from several places as a long distance migrator using feeding-corridors on the way to another area). Although this is not known of *L. curasoae* it is more than possible this bat also use corridors to travel to other areas to alternative foraging sites. Several arguments support this idea.
The population size on Aruba exists of approximately 900 to 1200 individuals, almost always staying in one colony at Wela quarry or at the Tunnel of Love (fig. 8); only once a single specimen has been caught elsewhere (Jamanota quarry). Both colonies are amidst of vast areas of cadushi largo *L. griseus*. Although on Curaçao the size of the population did not change greatly between 1992 and 1993, Petit (1995) supposes that temporary migrations took place from Cueba di Jetchi to Cueba Bosa; however, evidence of migrations from Curaçao to elsewhere is lacking. Eisenberg (1989) mentions data on bats of northern South America (specific location not mentioned, but, among others most probable, Cueba di Guano, Sancta Ana, which is ca. 70 kilometre from Aruba). The forearm lengths of these individuals are also within the same range (male: 53.42 +/- 1.16 mm; n = 101 and female: 53.40 +/- 0.91; n = 43). The lack of divergence in size between the Arubian, the Curaçao and the Venezuelan populations does not permit to determine whether *L. curasoae* actually migrates seasonally between these islands and the mainland. Nor Petit (1995) in the course of her study on Curaçao, nor during the period of investigation on Aruba, marked bats from Venezuela (or Curaçao) were captured. Further experiments with capture-mark-recapture or even with DNA-analysis have to be carried out to determine the relationship of *L. curasoae* on Aruba, Curaçao and from Sancta Ana, Venezuela.

Ectoparasites
Streblidae spec. have been frequently seen running backwards and sidewards on the membranes and in the fur.

Remark
This species is often silent while flying around; on the batdetector (70 kHz) sometimes a short and very fast rattle is heard, without tune quality.

Fig. 8. *Leptonycteris curasoae* in Tunnel of Love.

NATALIDAE

Natalus tumidorostris tumidorostris (Miller, 1900)

Account of specimens

Records of specimens collected (1).
Wela quarry 14.viii.1994; RMNH, reg. no. 38995: one female (specimen in alcohol & one foetus in alcohol).

Records of specimens examined (1).
Wela quarry 14.viii.1994: one male.

Taxonomy
Natalus tumidirostris Miller 1900, Proc. Biol. Soc. Wash. 13, p. 160 - Grot van Hato, Curaçao.
Phodotes tumidirostris, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 72.
Natalus tumidirostris tumidirostris, Goodwin 1959, Amer. Mus. Novitates 1977, p. 11 - Curaçao.

Measurements and weights
The external measurements of the collected specimen of *N. t. tumidorostris* (RMNH, reg. no. 38995) are: forearm 36.1; first digit, without nail 2.6; third digit[1], metacarpal 35.0, first phalanx 15.1, second phalanx 20.4, fourth digit, metacarpal 34.2, first phalanx 10.0, second phalanx 9.8, fifth digit, metacarpal 33.3, first phalanx 9.4, second phalanx 9.1, tibia 19.2, hindfoot 7.5, spur 15, head and body 47, tail 43 and weight 5.5 g.

Description
Fur of the back long and lax with a light, goldenbrown colour; venter paler. Rostrum of the skull rather long and narrow forming an edge of approximately 125 degrees with the globular braincase (fig. 9). Ears big and funnel-shaped; no nose leaf. Hind limbs long and slender. The long, thin tail outmeasures the length of the head body. The interfemoral membrane has approximately 40 parallel bands.
The dental formula is I 2/3, C 1/1, P 3/3, M 3/3.

Fig. 9. *Natalus tumidirostris tumidirostris*, detail of head; first documented record on Aruba.

Areal and geographical distribution
Natalus tumidorostris ranges within the neotropical sphere from northern Colombia, Venezuela, Guyana and Surinam (Eisenberg, 1989); although Husson (1962) remarked the error of Jentink (1893) by naming a *Furipterus horrens* as *Natalus stramineus*. *N. t. tumidirostris* has only been recorded from Curaçao, in which it is regarded as an endemic species (Husson, 1960b).

Reproduction
On the 14th of August a pregnant female was caught; birth could be expected at the end of September/early

[1] Third finger with only two phalanxes (see also Goodwin & Greenhall, 1960)

October. Husson (1960b) described the situation on Curaçao; he concluded that the birth of the young took place in October/November.

Food

From the analyzed faecal material it became obvious that this species is insectivorous; however there is no indication of the preference of food items. The size of the droppings was: average length 4.0 (min. 3.1 and max. 5.4) and average diameter 1.4 (min. 1.2 and max. 1.7).

Hunting behaviour of *N. t. tumidirostris* turned out not to be accessible for successful search with the batdetector: the low numbers make the positive identification of the species extremely difficult.

MOLOSSIDAE

Molossus molossus (Pallas, 1766)

Account of specimens

Records of specimens examined (9).
Colegio Arubano 9.ix.1994: one female; 29.ix.1994: three males, three females; 1.x.1995: one male, one female.

Records of specimens observed.
batdetector observations fig. 10.
Colegio Arubano (specimens leaving the roost): 38.

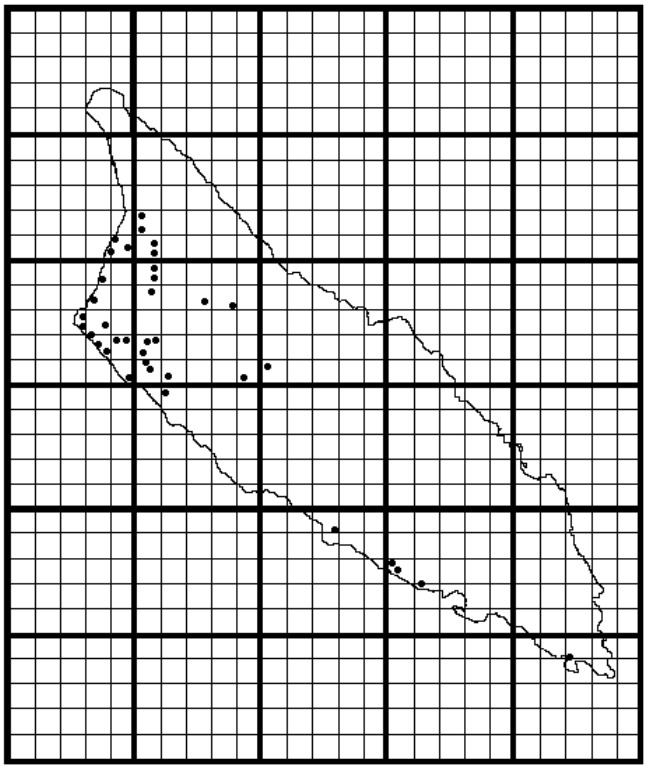


Fig. 10. Locations of hunting *Molossus molossus*, according to bat detector-signals on 38 kHz.

Taxonomy
V. (esperilio) Molossus (p.p.) Pallas 1766, Misc. Zool., p. 49-50 - Martinique, W.I.
Molossus major, Miller 1913, Proc. U.S.N.M. 46, p. 90.
Molossus molossus, Husson, 1960b, De zoogdieren van de Nederlandse Antillen, p. 67 - St. Martin.

Measurements and weights
Details of measurements and weights are given in table 16 (range and average of live specimens).

Table 16. Measurements of *M. molossus* (number, range and average) according to sex (live).

	males				females			
	n	minimum	average	maximum	n	minimum	average	maximum
Forearm length	4	38.7	39.48	40.2	5	37.1	39.8	41.6
Length of digit III	4	73	76.00	79	5	70	73.60	77
Length of digit V	4	39	40.75	42	5	39	40.80	43
Weight	3	9.0	9.33	9.5	4	7.5	9.75	12.5

Description
Medium sized bat with short rounded ears arising from a point on forehead; from that point a ridge connects the tip of the short muzzle (fig. 11). Antitragus round and conspicuous. First finger small, with two close 'crawling-pads' at the basis. Tail thick (approximately 3 mm) and enclosed by the interfemoral membrane for half its length. Feet short and broad; of the toe digits the inner three are relatively thin and slender. Toe digit I shows a lateral fringe of short hairs giving the toe a broader appearance; on the end phalanx of this phalanx two curved long hairs. Toe-digit V shows a lateral fringe of longer hairs. The dorsal side is glossy black with short fur.

Fig. 11. *M. molossus*, note the short fur; first documented record on Aruba.

Areal and geographical distribution
M. molossus ranges within the neotropical sphere from Central America south across almost all of South America well into northern Argentina and Uruguay (Eisenberg, 1989) and the West Indies (Husson 1962). Earlier, however, Husson (1960b) did not include Curaçao; . he described the *Molossus* spec from that island as *M. pygmaeus*; for St. Maarten he did record *M. molossus*. Varona (1974) lists six different subspecies for the Lesser and Greater Antilles resp.: *M. m. debilis*, *M. m. fortis*, *M. m. milleri*, *M. m. molossus*, *M. m. tropidorhynchus* and *M. m. verrilli*. With respect to the (sub)species of Aruba it is unknown whether a close relationship exists to one of those mentioned by Varona; maybe DNA-analysis can solve this problem.

Food
The analyzed faecal material shows obviously the insectivorous food choice of his species. Droppings showed a length of 6-7 mm and a diameter of 2.5 mm.

Reproduction
The presence of lactating female at the end of September indicates that young are born in August/September. The size of the population within a colony can be estimated at approximately 40 specimens.

Habitat
In Venezuela Handley (1976) found the species in 48% of the cases near houses. On Trinidad and Tobago Goodwin & Greenhall (1961) described that *M. molossus* was found together with *M. ater*. Their colonies were located between the eaves of buildings and the galvanized roofing where the temperature rises to 130^{o} F.
Most molossids need to drop 8-10 m from a roost before they can fly; they cannot readily take flight from horizontal surfaces (Belwood, 1992). At the other hand *M. molossus* bats can crawl very fast on objects (pers. observation) and also Husson (1962), citing Sanderson (1939), confirms this observation. Sanderson mentioned they 'fly in and land on the dinner table'! This species, like most molossids, has small pointed wings, is extremely agile and has a rapid flight. Although they seem to prefer the leeward side of buildings, the bats are capable flyers in open areas. For most bat species, the availability of suitable roosts is an important limiting factor; however, this species seems to benefit from the urban area and is well adapted to the modern, high buildings in plain floodlight e.g. hotels and schools.

On the bat detector hunting *M. molossus* could be heard on 38 kHz with a twittering sound with tune quality in a relative slow, irregular rhythm of two to four pulses per second. Social calls could be heard on a frequency of 15 kHz without detector. Observing this species with the batdetector gave the impression that for hunting the species is attracted by light (lampposts in streets or tennis courts). A short investigation was conducted to reveal the correlation between the hunting *M. molossus* and the amount of light. Alongside a road stops were made at every 500 m. During 5 minutes (with the bat detector at 38 kHz) the presence of hunting bats (*M. molossus*) were noted and registered as positive if present and negative if not present. The amount of light was measured with a Goertel Luxmeter. The results are given in fig. 12. The amount of light at places with bats is on average higher (7.5) than at places without bats (3.5). This investigation reveals the correlation (+ 0.48) between the amount of light and the presence of *M. molossus*.

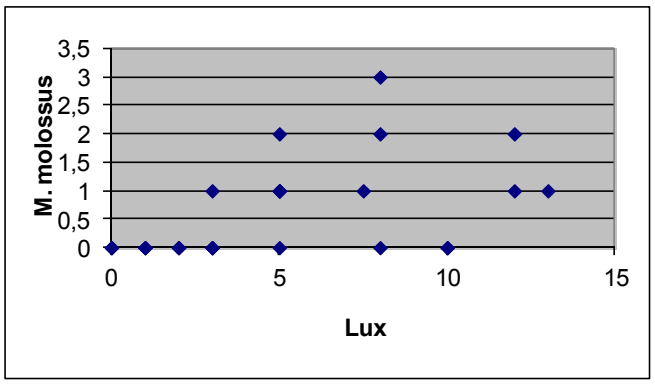


Fig. 12. Relation between amount of light (in Lux) and the number of observed *M. molossus* detected with a batdetector on 38 kHz.

M. molossus may be a little less vulnerable to human activities than other bats because they hunt at lighted areas more often and also eaves in high buildings (e.g. schools and hotels) and forms relatively small colonies as well. However, *M. molossus* is vulnerable to heavy pesticide spraying against mosquitoes in urban areas.

RODENTIA

CRICETIDAE

Calomys hummelincki (Husson, 1960)

Account of specimens

Records of specimens collected (9).
California 17.vii.1994; RMNH, reg. no. 38990: one male (dry skin & skull).
Rincon W 25.i.1995; RMNH, reg. nos. 40012, 40013: one male (dry skin & skull) and one sex unknown (skull); 19.iii.1995; RMNH, reg. no. 40014: one male (skull); 16.iv.1995; RMNH, reg. no. 40016: one female (skull).
Seroe Pretu 28.iii.1993; RMNH, reg. no. 38870: one male (specimen in alcohol).
Tanki Lender 15.xii.1993; RMNH, reg. no. 38945: one female (dry skin & skull).
Zwarte Mangel E 15.xii.1994; RMNH, reg. nos. 40009, 40008: one male (dry skin & skull) and one female (dry skin & skull).

Records of specimens examined (82).
(Marked specimens during study at Rincon listed only for the first time).
Alto Vista N II 17.xii.1994: one female.
Arikok II 5.ix.1993: one male.
Banki Jerome 13.xii.1994: one male.
Boca Grandi 3.ix.1994: one male, one female.
Boca di Pos di Nord: one male.
Budui 4.ix.1994: sex unknown.
California 20.xi.1994: one female.
Druif NO 28.viii.1994: two males.
Quadirikiri Plains 1.v.1995: one female.
Rincon E/W 15.xii.1994: one male, one female; 21.i.1995: 13 males, seven females; 22.i.1995: five males, one female; 23.i.1994: two males, one female; 25.i.1994: two males, two females; 28.1.1994: two females; 29.i.1995: one male; 30.i.1995: two females; 31.i.1995: two females; 18.iii.1995: two females; 19.iii.1995: one male; 20.iii.1995: two males, one female; 21.iii.1995: one male, one female; 11.iv.1995: three males, one female; 1.vi.1995: five males. 19.viii.1995: one female; 9.ix.1995: one male; 23.ix.1995: one male, two females.
Seroe Pretu 27.xi.1993: one female; 28.xi.1993: one male; 5.xii.1993: one male, one female; 11.xii.1993: one male.
Tanki Tres Cabes 28.viii.1994: one male, one female.

Records of specimens observed.
Rincon E 1.ii.1995: sex unknown.

Taxonomy
Hesperomys? spec., Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 69 - Aruba. (*Hesperomys? [lau**n**cha*[1] *aff.]*, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 111 - Aruba).
Baiomys hummelincki Husson 1960a, Stud. fauna Cur. 10, p 33-40, fig. 7, pl. 6-7 - Klein St. Martha, Curaçao.
Baiomys hummelincki, Husson, 1960b, De zoogdieren van de Nederlandse Antillen, p. 86 - Aruba.
Calomys laucha laucha, Hershkovitz 1962, Fieldiana 46, 142 - Shiribana, Airport Dakota, Boca Morto, Aruba.
Calomys hummelincki, Handley, 1976, Brigham Young Univ. Sci. Bull.; Biol. Ser. 20 (5), p. 53.

Measurements and weights
The measurements and weights are given in table 17 (external and cranial measurements).

[1]Bold by J.P.B.

Table 17. External and cranial measurements of nine specimens of *C. hummelincki* (* spec. in alcohol, skull not extracted).

Reg. Number RMNH	38870*	38945	38990	40008	40009	40012	40013	40015	40016
Sex	m	v	m	v	m	m	-	m	f
Head and body	59	57	67	63	66	57	58	59	55
Tail, without tuft	48	45	54	51	51	45	49	-	-
Hind foot, without nail	13.4	13.7	13.7	14.0	13.4	13.6	13.6	-	-
Ear, from notch	11.0	10.3	10.1	11.2	11.7	11.1	11.0	-	-
Condylobasal length	-	16.8	18.9	17.7	18.6	17.2	17.4	16.2	17.8
Basal length	-	15.5	16.7	16.4	16.7	15.8	16.2	15.2	16.2
Palatinal length	-	9.6	10.3	9.8	9.8	9.4	9.4	9.0	9.8
Length of foramen inc.	-	4.1	4.7	4.2	4.5	4.2	4.3	3.8	4.3
Length of nasals	-	6.7	8.2	7.5	7.9	7.3	7.0	6.1	7.1
Diastema	-	4.5	4.9	4.6	4.5	4.5	4.8	4.0	4.7
Zygomatic breadth	-	10.2	11.5	10.8	11.2	10.6	10.7	10.0	10.5
Interorbital width	-	3.2	3.5	3.1	3.2	3.4	3.2	3.4	3.4
Length upper molar row	-	3.0	3.0	3.0	2.9	3.0	2.9	2.8	2.9
Length lower molar row	-	3.1	3.5	3.1	3.2	3.4	3.2	3.4	3.4
Length of mandible	-	9.5	9.6	9.9	10.1	10.3	9.9	9.3	10.0

Fig. 13. *Calomys hummelincki* in favourite habitat at Rincon W.

Description

The description of the exterior by Husson (1960a) of *C. hummelincki* is in general correct (fig. 13). However, from his description it is clear that his novum species was a museum-discovery. The characteristics refer by no means to the living organism. The exact description of Husson is as follows:

> "The pelage is soft and silky, especially on the upper parts. The pelage of the dorsal surface is yellowish brown, while this colour gradually passes into the more yellowish tinge of the sides. The basal parts of the hairs are slaty grey, the median parts light yellowish brown, while the tips are darker brown. The hairs of the under parts are whitish or very light cream-coloured to the roots, the line of demarcation on the sides being well marked. The ears are thinly furred with appressed hairs both inside and out, the colour being that of the dorsal surface; the outline of the ears is, however, distinct. The upper surface of the hands and feet is densely furred with whitish hairs, the palms and the soles

> are naked and bright brownish in the dried skin; the number of pads is six (...) Fore foot with the thumb reduced to a small tubercle with rudimentary appressed nail(...) The tail, which is about four fifths the length of head and body, is bicoloured and less hairy on the dorsal surface than on the ventral; the tail rings, about 20 per centimetre, are hardly visible because of the appressed whitish hairs; a true pencil is present. Unfortunately, I have been unable to determine the mammary formula for the type specimen and for the other females in the collection to hand. (...) The rostrum is relatively short; the supra-orbital edges are not ridged; the interparietal bone is very narrow antero-posteriorly, but stretches right across the skull. The foramina incisiva are considerably longer than the molar series, extending backwards to the anterior body of the first molars. The front cusp of the first upper molar is only indistinctly divided, probably due to the fact that the teeth are moderately worn. The small last upper molar is more or less ring-shaped. The coronoid process of the mandible is relatively large and strongly recurved (Husson, 1960a)."

Hershkovitz (1962) describes the genus *Calomys* as a *Mus*-like animal without a terminal tail brush and the lower first molar with three or four roots. He describes *Calomys laucha* more precisely:

> "...pelage long, thick, smoothly adpressed; tail from approximately 35 per cent to 108 per cent of combined head and body length, brownish above, beneath paler but never sharply defined white; fifth hind toe, less claw, not extending to tip of first phalanx of fourth toe [...]; pale buff to white postauricular patches usually present; upper parts of body buff to tawny finely mixed with black; an ochraceous lateral line often present; under parts of body well-defined greyish with or without an ochraceous wash, base of hairs of belly and chest slaty; mammae from 8 to 14; borders of supraorbital region of skull [...] divergent, the edges square, never beaded; mid-frontal width equal to or more than greatest width of rostrum; interparietal usually narrow antero-posteriorly."

The description of Eisenberg (1989) is short and for several characteristics incorrect:

> "Head and body ranges from 60 to 79 mm; the tail is 31 to 54 mm, the hind foot 13 to 16 mm, and the ear 10 to 13 mm. The skull is drawn in figure [follows specific number] and the dentition in figure [follows specific number]. The dorsum is brown; the venter is paler (greyish white) but never sharply defined..."

Obviously Eisenberg (1989) misquoted the text of Hershkovitz (1962) in describing *'The dorsum is brown; the venter is paler (greyish white) but never sharply defined...*' instead of '*The dorsum of the* ***tail***[2] *is brown; the venter is paler (greyish white) but never sharply defined...*'

External, internal and cranial characters of the species

This species does not belong to the genus *Baiomys* because of the structure of the glans penis (Hershkovitz, 1962). The basic type of baculum and glans penis in most of the New World Cricetinae is the complex one: the baculum is composed of a bony shaft with three osseous, cartilaginous or soft tissue, fingerlike processes attached to the tip. *Baiomys* (and some other genera) differs from this in having a simple type of baculum and glans penis. Preparation of the glans penis and baculum of two specimens (reg. nos. 40009 and 40013) shows a baculum and glans penis of the complex type (fig. 14).

[2] Bold by J.P.B.

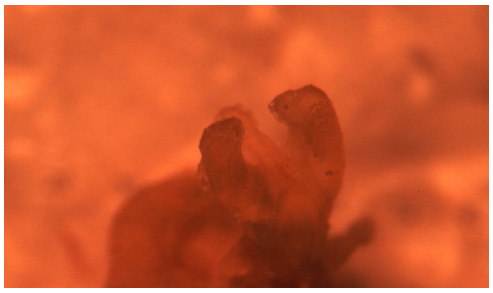


Fig. 14. Tip of glans penis of *C. hummelincki*; note the three fingerlike processus attached to the tip.

This species is not synonymous to *Calomys laucha* (as proposed by Hershkovitz (1962), because of the number of mammillae (and the supraorbital region). In *Calomys* the number of mamillae varies from 6 to 14; Hershkovitz (1962) explicitates the maximum number of mammillae noted in *C. laucha* (and *C. callosus*) on 14 and adds that most females of these species show only 8 mammae. In *C. sorellus* he found the normal number of mammae to be 8, but usually only 4 to 6 show. In *C. callosus* and *C. laucha* the maximum number is 14, but most females of these species show only 8. Observations of our lactating specimens reveal 6 mamm(ill)ae. The attribution to *C. hummelincki* is also advocated by Handley (1976) without further comment. Pérez-Zapata et al. (1987) demonstrates that one male *C. hummelincki* from Los Cocos, Anzoategui (Venezuela) showed karyotype of 2n = 60 chromosomes (FN = 64 arms); this is fairly distinct from that of 2n = 64 chromosomes (FN = 68 arms) of specimens of *C. laucha* from Buenos Aires Province (Argentina). Also the spermatozoa are different: *C. hummelincki* having a hooked head and an excentrically inserted tail, while the head being hookless and the tail inserted centrally in *C. laucha*.

In *Muridae* in general, the borders of the supraorbital region are either divergent or concave mid-frontally. In some species the sides of the supraorbital region vary from parallel to concave or divergent. In the concave type the distance across the sides of the supraorbital region, measured at the mid-frontal plane, is always less than the greatest width of the rostrum, while in the divergent type, the width across the sides is always more; in the parallel type the measurements are equal. In *C. laucha* the sides vary from parallel to slightly divergent and divergent (Hershkovitz, 1962). Measurements show that in six out of the seven specimens of C. hummelincki the type of the supraorbital region is concave and in one parallel/slightly divergent.

Of the specimens on Aruba only one specimen showed a sharply defined greyish white venter, all other had white venter with a sharply defined demarcation. In some, the colour of the back was grey-brown while in the majority the back was orange-brown tainted. The white hairs of the dorsum of the hindfeet, giving this species the Dutch name ‘dwergwitvoetmuis’, are clearly longer than the nails.

The postdiastemal portion of the hard palate of nearly all cricetine species may be classified as short or long (with median posterior borders of palatines not extending or extending behind posterior plane of third molars) and as wide or narrow (with distance between inner borders of first molars greater than or less than length of first molar). Comparisons and measurements of seven specimens show that all bony palates are of the long and wide type. The dental formula is: I 1/1, C 0/0, P 0/0, M 3/3.

Areal and geographical distribution

According to Eisenberg (1989) *C. hummelincki* ranges within the neotropical sphere, besides on the islands of Aruba and Curaçao, from Venezuela, north of the Orinoco in scattered localities, including the llanos and the more semiarid regions around the mouth of Lake Maracaibo, where it extends to Colombia. The description of the distribution on Aruba is based on field observations (2), caughts with live-traps (90) and owlpellets (10). The distribution is almost restricted to an almost continuous band alongside the Northcoast. Besides that there are three areas where *C. hummelincki* was also present (Seroe Pretu, Tanki Lender and Arikok) (fig. 15). Husson (1960 b) described the presence of *C. hummelincki* in fields of maize (= maisi chicitu). Nowadays this agricultural product is almost vanished on Aruba. It is quite possible that the area around Seroe Pretu, Tanki Lender and Arikok nowadays form new relicts, because there seems to be no continuing distribution to the main area.

Habitat

The habitat of *C. hummelincki* is positively associated with flat area and negatively with hilly ground and cliffs. It is further characterised by a positively association with alluvial and colluvial soils; there is a negative association with diabase soils. The texture of the soil reveals a positive association with loam and gravel, while there is a negative association with stones and boulders. With respect to the vegetation only a positive association with grass was found, while a negative association was noted with all other vegetation: herbs, succulents, meloncactus, low bushes, high bushes and trees. With landscape elements there was a positive correlation with green isles and tanki's: a negative association was found for stone walls, trancheru's, caves and arroyo's. A negative association was revealed for the covering degree of the leaf-litter and garbage.

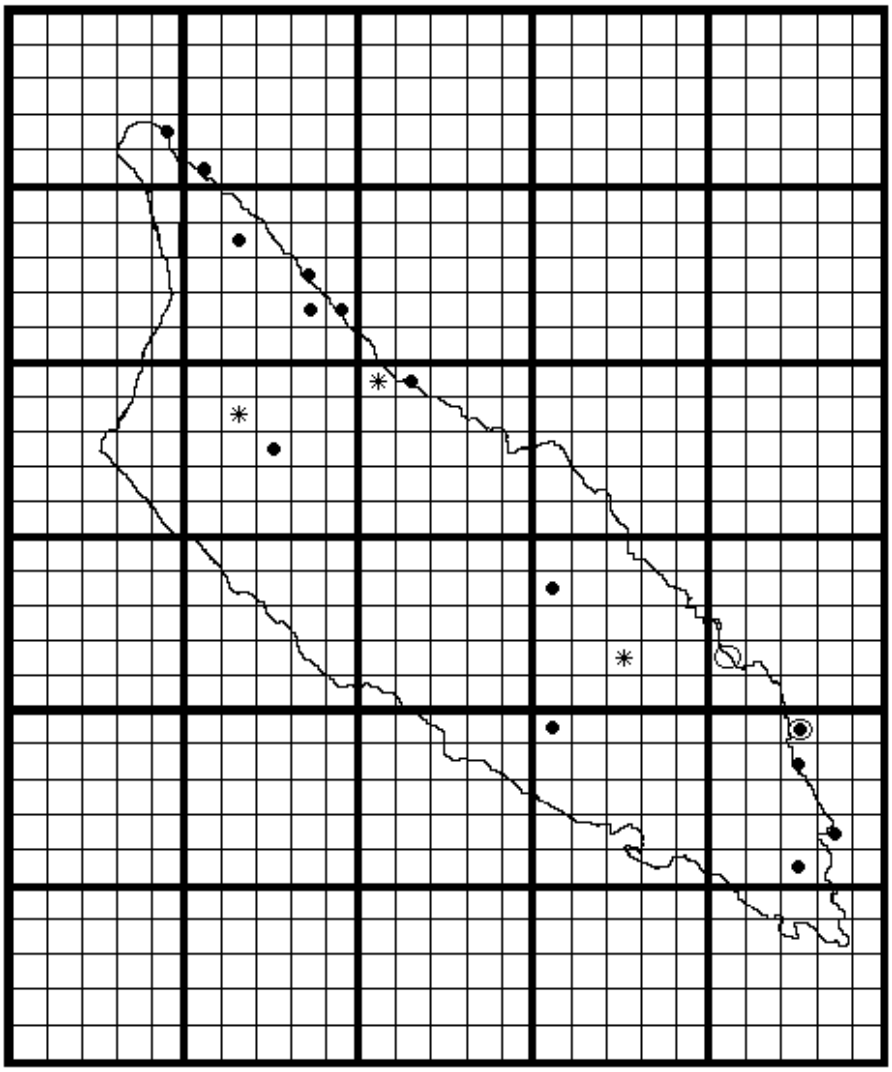


Fig. 15. Grid squares (1 x 1 kilometre) with observations of *C. hummelincki* during November 1992 till November 1995. Explanation of symbols: O = field observation, • = catch, * = owlpellet.

Soil structure

During 1995 an analysis of the A-stratum soil was performed of the 13 sites on Aruba where *C. hummelincki* was trapped. The results show that the loam content of the soil forms a relative constant factor (< 2%). Only in four occasions (Boca Grandi, Tres Cabes, Banki Jerome and Druif NO) hardly any loam was found (fig. 16). The amount (weight %) of gravel varied from 1% to 31%. Grove sands are abundant in Banki Jerome and Druif NO (over 90%). The soil of these is also characterised by a low presence of small grained sands (resp. 8% and 6%). In the other sites the small grained sands are approximately 30%, with exceptions of high percentages of Tanki Lender (43%), Boca di Pos di Nord (48%) and Budui (44%).

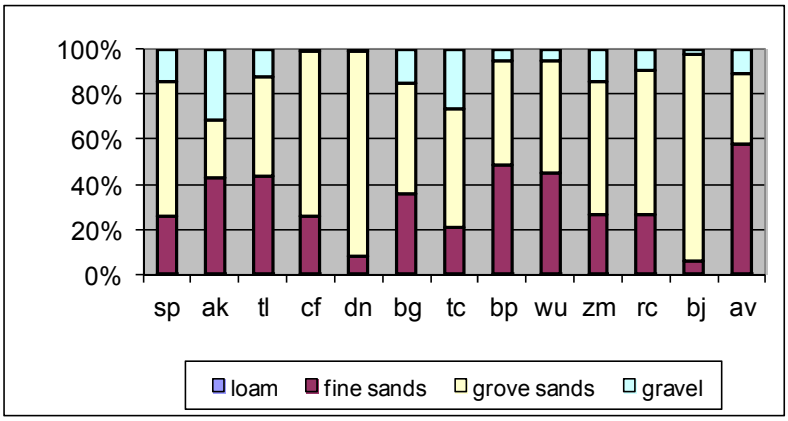


Fig. 16. Loam soil contents on sites where *C. hummelincki* on Aruba had been captured; sp: Seru Pretu, ak: Arikok, tl: Tanki Lender; cf: California; dn: Druif NO; bg: Boca Grandi; tc: Tres Cabes; bp: Boca di Pos di Nord; wu: Wari Uri; zm: Zwarte Mangel; rc: Rincon; bj: Banki Jerome; av: Alto Vista NII.

Population structure

From 21 January 1995 till 10 October 1995 a study on this species has been performed with the capture-mark-recapture method at Rincon E&W on the rifle range of the Dutch Royal Marines at Vader Piet. This time was split up in nine periods; table 18 gives an overview. A grid of 56 traps was set with rows of 7 and 8 traps resp. at distances of 10 meter during period I. During this first period the displacement distance of some individuals almost exceeded the maximum possible distance within the grid. Therefore in the next periods the distance between the traps was enlarged to 15 m.

Table 18. Trapping results of *Calomys hummelincki* (Ch) during the population study in 1995 at Rincon W.

Period	start	controles	end	new Ch	Known Ch	total captures Ch	sex ratio males
I	20 - I	11	1 - II	40	-	140	56
II	17 - III	3	21 - III	8	15	23	48
III	13 - IV	4	17 - IV	4	10	30	57
IV	30 - VI	1	1 - VII	5	5	10	80
V	18 - VIII	1	19 - VIII	1	4	5	40
VI	26 - VIII	1	27 - VIII	-	5	5	80
VII	8 - IX	1	9 - IX	1	4	5	80
VIII	22 - IX	1	23 - IX	3	14	17	64
IX	6 - X	1	7 - X	-	4	4	100
Total	20 - I	24	7 - X	62	61	239	58

In period I 40 specimens of *C. hummelincki* were caught (22 males and 18 females); fig. 17 gives the frequency distribution of the number of trappings of these individuals. In this period weight categories were used as a parameter for age. The population structure according sex and weight categories shows a regular form for the males (fig. 18). For the females the categories 3-4.5 and 7-8.5 seem to be small. The higher proportion of 13+ adult females is suggestive for the presence of pregnant individuals, but the numbers are to low for definite conclusions.

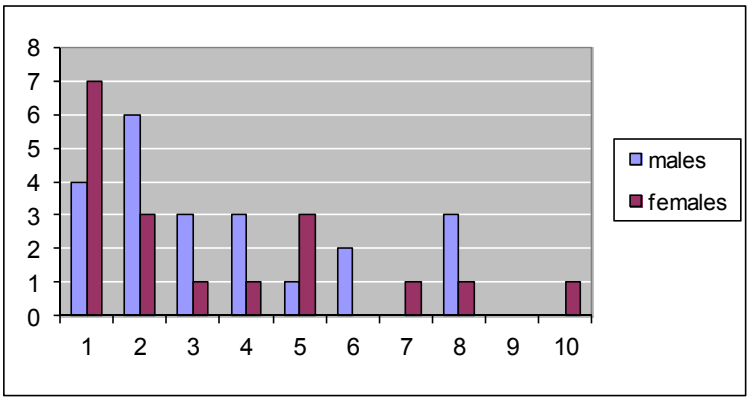


Fig. 17. Frequency distribution of the number of trappings of *C. hummelincki* (22 males and 18 females), in period I.

Within the grid three nesting places were discovered under flat coral stones. The returning of juvenile individuals into the circular openings discovered the nesting places. Young individuals were caught in early January and late August, indicating births in end December and middle of August, respectively. In February two nesting places were occupied; in August three nesting-places seemed to be occupied, respectively.

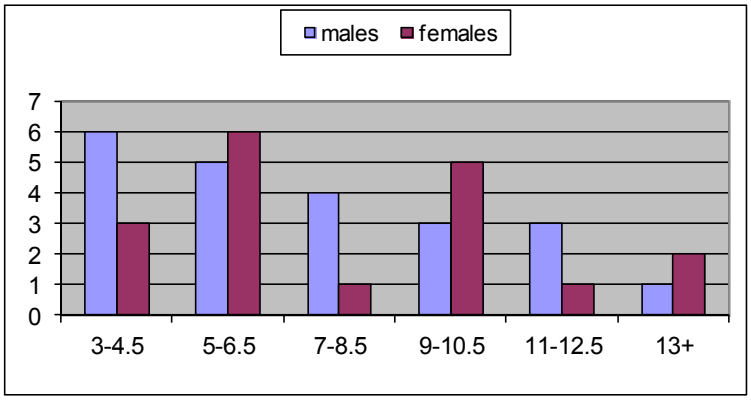


Fig. 18. Frequency distribution of weight categories of *C. hummelincki* (22 males and 18 females), in period I.

During period I home ranges were computed by using the minimal-areal-method and found to be at least 4100 m^2 for an adult male (Ch02; based on 7 captures), at least 700 m^2 for a juvenile male (Ch03; based on 8 captures), at least 713 m^2 for an adult female (Ch18; based on 6 captures) and 1175 m^2 for a juvenile female (Ch14; based on 10 captures). The greater activity of the adult male in that period is also reflected in the average displacement distance of 33.98 m in adult males versus 21.00 m, 20.01 m and 17.68 m in juvenile males, adult females and juvenile females, resp. (table 19). Dispersion as the average displacement distance during all periods was computed and resulted in 38.16 m in adult males versus 78.33 m, 24.68 m and 52.07 m in juvenile males, adult females and juvenile females, resp. (table 19).

Table 19. Average displacement distances (in meters) of *C. hummelincki* in two periods during the study at

Rincon W.			
Period	n	I	II - IX
Adult males	20	33.98	38.16
Adult females	16	20.01	24.68
Juvenile males	34	21.00	78.33
Juvenile females	28	17.68	52.07

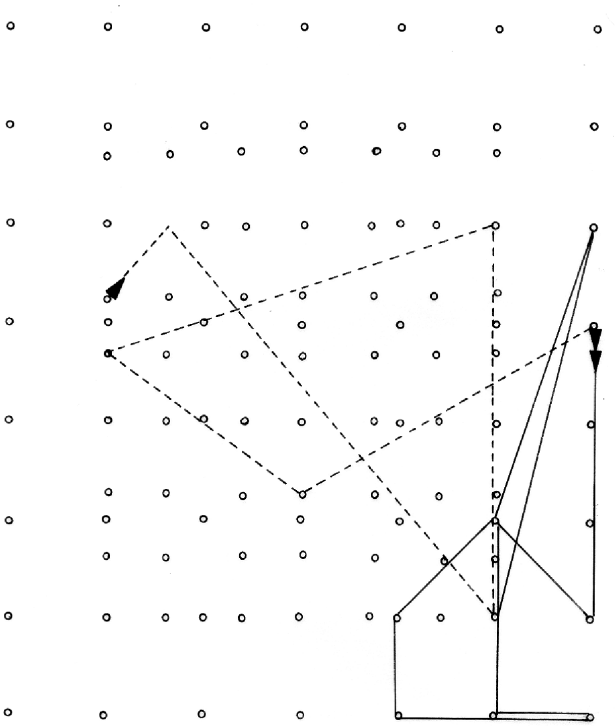


Fig. 19. Displacements at study area Rincon W during period I (-----) and during periods II - IX (──) of C. hummelincki Ch02 (adult male).

Fig. 19 depicts in the black line the minimum movements between the capture-sites of CH02 (an adult male) during the period of 21 January 1995 till 1 February 1995 and in dotted lines during the total population study. Fig. 20 shows those movements in these periods for a juvenile female growing up to an adult (CH14).
Sex ratio's are given for all periods as the number of trappings of *C. hummelincki* (table 18). During most periods the result indicates that sex ratios in captured specimens are in favour of male *C. hummelincki.* This indicates a greater spatial activity of males (supposingly the equal distribution of numbers in both sexes) and indeed the greater spatial activity of males is reflected in the average displacements in period I as well as the average displacements over all periods. On an individual basis the greater spatial activity is demonstrated in the figures 17 resp. 18 giving all displacements during the total study period of resp. Ch02 (adult male) and Ch14 (juvenile-adult female).

During the study period two periods of reproduction were revealed. The appearance of young individuals started in January and in August indicates a bimodal polyoestrus-cycle. From table 19 it can be concluded that during the juvenile period both sexes, on average, displace equally. Entering the subadult period, young male *C. hummelincki* disperse over a considerable longer distance (78 m on average) while young females disperse over a shorter distance (52 m on average). Dispersal distances over longer distances are beyond the scope of this study.

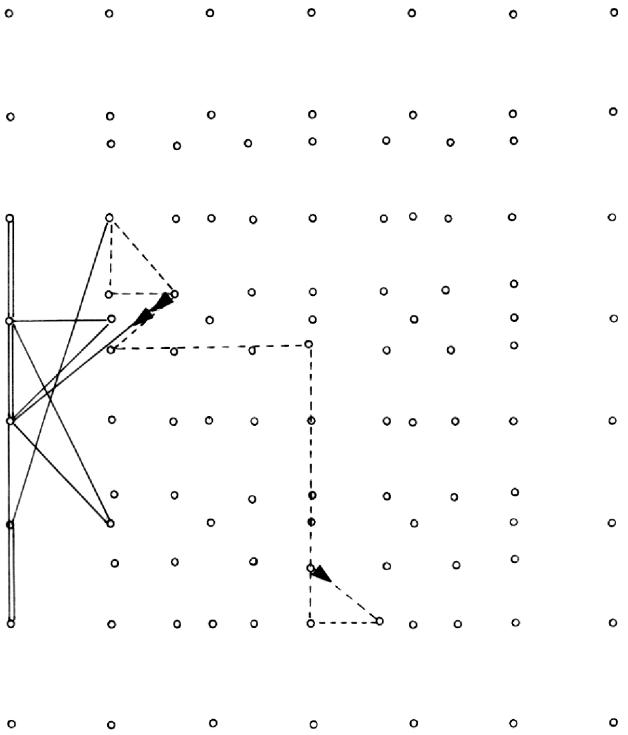


Fig. 20. Displacements at study area Rincon W during period I (-----) and during periods II - IX (──) of C. hummelincki Ch14 (juvenile - adult female).

Food

The exterior of the droppings is slightly curved and sometimes the proximal part shows a long vegetation fragment. The length varies between 2.1 mm and 3.8 mm; the average length is 3.02 mm. The diameter varies between 1.0 mm and 1.8 mm; the average diameter is 1.22 mm. Analysis of droppings revealed predominantly vegetational food-items; however the results vary with the location. At Seroe Pretu in each dropping (n=20) remains of seeds were present, while at Rincon (n=20) almost always parts of roots were present (90%). In the latter also remains of insects where found (20%). In both also leaf and fibre structures where present: 50% and 55% (Seroe Pretu) respectively 80% and 10% (Rincon).

Interspecific competition

The Venezuela whiptail lizard *Cnemidophorus lemniscatus* (Linnaeus, 1758) is a close relation of *C. arubensis* and an opportunistic feeder eating a variety of plants and when available, insects and carrion (Odum, 1994). This lizard and *C. hummelincki* also share holes, although a difference exists in the construction of the opening (round for the latter and oval for the first).

Predation

Besides proof of predation by *A. cunicularia* of *C. hummelincki* in pellets (see table 7) and, during the population structure study, predation by the tropical centipede *S. morsitans*, indications can be found of two other predators. The presence of the Arubian rattlesnake *C. d. unicolor* (2.i.1995) in the area of the population study at Rincon makes predation more than probable. The same holds for the activities of an American kestrel during the onset of the evening by positioning just near the opening of a *C. hummelincki* burrow. Signs of a digging dog at nesting places have been noticed at Rincon E and some demolished traps as well (later on two stray dogs were observed in the area).

Remarks

In hand, the only species on Aruba which *C. hummelincki* can be confused with, is *M. musculus*. However, the relative length of head-body and tail (in *C. hummelincki* less than 100% and in *M. musculus* more than 100%), the length of the hind-foot (in *C. hummelincki* shorter than 15 mm, while in *M. musculus* 16 till 18 mm) and the typical musky scent of *M. musculus* (lacking in *C. hummelincki*) are features that always lead towards the right determination. As mentioned before (2.3. Recordings) mandibles in owl pellets can be differentiated by three roots in the first molar for *C. hummelincki* and two in *M. musculus*.

MURIDAE

Rattus rattus (L., 1758)

Account of specimens

Records of specimens collected (35).
Alto Vista N I 3.vii.1993; RMNH, reg. nos. 38907, 38908: two males (skull).
Andicuri SW 28.viii.1993; RMNH, reg. no. 38918: one male (skull).
Arikok 5.ix.1993; RMNH, reg. no. 40021: one male (skull).
Casheru 19.viii.1994; RMNH, reg. no. 38996: one female (skull).
Cudawechi 12.xii.1993; RMNH, reg. no. 38939: one female (skull).
Golfclub Road 14.xi.1993; RMNH, reg. no. 38927: one female (skull).
Hooiberg SW 23.i.1993; RMNH, reg. nos. 38853, 38854: two males (skin in alcohol & skull); 22.viii.1993; RMNH, reg. no. 38916: one female (skull); 7.vi.1994; RMNH, reg. no. 38986: one male (skull).
Hooiberg NW 26.vi.1993; RMNH, reg. no. 38906: one female (skull).
Hudishibana 13.vi.1993; RMNH, reg. no. 38902: one male (skull).
Jamanota W 25.ix.1994; RMNH, reg. no. 38999: one female (skull).
Kibaima 8.x.1995; RMNH, reg. no. 40027: one male (skull). Lago Colony Cave 15.v.1993; RMNH, reg. no. 38891: sex unknown (skull).
Manshebu 12.vi.1995; RMNH, reg. no. 40018: one female (skull). Marriot Hotel 5.vi.1994; RMNH, reg. no. 38985: one male (skull).
Modansa 18.iii.1995; RMNH, reg. no. 40015: sex unknown (skull).
Rooi Cochi 16.i.1994; RMNH, reg. no. 38962: one female (skull).
Rooi Prins E 31.i.1993; RMNH, reg. no. 38858: one male (skull).
Rooi Taki 1.x.1994; RMNH, reg. no. 40004: one male (skull). San Cruz 25.xii.1994; RMNH, reg. no. 40011: one female (skull).
Seagrape Grove 31.i.1993; RMNH, reg. nos. 38859, 38860: two males (skull).
Seroe Tishi 5.vi.1993; RMNH, reg. nos. 38899, 38898: one male and one female (skulls).
Simonslust 1.v.1994; RMNH, reg. no. 38971: one female (skull). Terra del Sol 12.vi.1993; RMNH, reg. nos. 38900, 38901: one male and one female (skulls).
Washington (house) 24.xii.1992; RMNH, reg. no. 38851: sex unknown (skull).
Wela quarry 22.i.1994; RMNH, reg. no. 38960: sex unknown (skull); 18.ix.1994; RMNH, reg. no. 38998: sex unknown (skull); 22.xi.1994; RMNH, reg. no. 40006: one male (skull); 20.viii.1995; RMNH, reg. no. 40026: sex unknown (skull).

Records of specimens examined (19)
Balashi 2.x.1994: one female.
Budui 4.ix.1994: one female.
Cadushi 10.ix.1994: one male.
Jan Flemming 3.xi.1993: sex unknown.
Jucuri 9.x.1994: one female.
Lago Heights 14.xii.1994 : sex unknown.
Mangel Altu 6.viii.1995: sex unknown.
Pet Cemetry 15.x.1994: sex unknown.
Quadirikiri 20.xi.1994: sex unknown.
Sabana Berde 4.ii.1995: sex unknown.
Salina Balashi 26.vi.1994: sex unknown juv.
Salina Cerca 11.vii.1994: one male.
Seroe Corobori 11.ix.1994: two females.
Seroe di Pos di Noord 12.vi.1994: one male.
Spaans Lagoen 12.ix.1993: one female.
Tanki Cebuju 27.viii.1994: one female.
Tunnel of Love 15.vi.1995: one.
Una Una 15.i.1994: sex unknown.

Table 20. External and cranial measurements of male specimens of *R. rattus*.

Register number	38853	38854	38858	38859	38860	38899	38900	38902	38907	38918	38985	38986	40004	40006	40021	40027
Head and body	134	148	146	173	137	152	141	156	103	168	147	145	168	165	163	168
Tail, without tuft	180	189	208	210	187	193	168	189	128	175	184	185	198	182	179	191
Hind foot, without nail	32	31	33	32	33	31	31	32	28	33	31	31	33	31	33	33
Ear, from notch	21	22	22	23	21	20	22	21	19	22	21	21	22	18	20	22
Occipitalnasal length	37.0	38.7	39.7	43.4	38.8	40.5	40.0	39.1	-	39.7	38.0	37.6	42.5	41.4	-	42.5
Condylobasal length	34.7	36.4	37.2	40.5	35.3	36.8	35.5	36.6	-	37.2	35.6	35.2	38.7	38.8	36.2	38.7
Basal length	32.0	34.0	34.9	37.5	32.6	34.4	33.5	34.4	-	34.6	32.7	32.9	36.1	36.2	33.7	36.1
Palatinal length	19.8	19.8	20.9	22.8	20.0	20.7	21.1	20.6	16.1	20.8	19.9	19.7	22.0	21.9	20.1	22.0
Length of foramen incisivum	6.9	7.3	6.8	7.9	6.8	7.0	6.9	7.0	5.7	7.6	7.0	6.6	7.5	7.0	7.1	7.5
Length of nasals	13.1	13.4	14.4	15.9	13.6	14.8	14.0	13.4	9.4	14.6	13.0	14.3	15.1	15.6	-	15.1
Diastema	10.1	10.4	10.7	12.0	10.1	10.7	10.5	10.9	7.9	10.7	10.0	9.9	11.5	11.5	10.5	11.5
Zygomatic breadth	17.5	18.7	18.7	19.8	18.3	18.3	17.1	17.7	12.2	18.4	17.7	17.8	20.1	19.0	17.6	20.1
Breadth of braincase	-	-	-	-	-	14.3	-	13.3	-	13.1	13.0	14.0	13.9	13.3	-	13.9
Interorbital width	5.5	6.0	5.9	6.6	5.6	5.6	5.5	5.6	5.1	5.6	5.5	5.6	6.5	6.1	5.7	6.5
Length of upper molar row	6.0	6.4	6.2	6.6	6.5	6.5	5.9	6.2	5.9	6.2	6.3	6.1	6.4	6.1	5.9	6.4
Length of lower molar row	5.6	6.2	6.4	6.6	6.4	6.4	6.4	6.7	6.1	6.3	6.2	6.3	7.2	6.0	6.0	7.2
Length of mandible	21.1	21.7	21.9	23.5	21.6	22.5	21.6	21.2	17.6	22.0	20.6	20.6	23.4	22.9	22.4	23.4

Table 21. External and cranial measurements of female specimens of *R. rattus*.

Register number	38898	38901	38906	38916	38927	38939	38962	38971	38998	38999	40011	40018
Head and body	138	162	162	156	165	114	170	172	-	156	174	167
Tail, without tuft	171	181	205	183	191	138	196	189	-	192	204	207
Hind foot, without nail	30	30	33	31	32	29	32	31	-	30	33	32
Ear, from notch	19	21	24	24	21	19	23	21	-	21	22	24
Occipitalnasal length	-	41.0	40.9	41.1	42.4	32.0	41.7	40.9	27.4	40.2	42.2	42.6
Condylobasal length	34.1	38.4	39.0	38.3	39.3	29.3	39.7	38.7	24.9	38.0	39.3	39.3
Basal length	31.7	36.1	36.7	35.9	37.1	26.8	37.2	36.4	21.7	35.7	36.9	36.7
Palatinal length	19.0	22.4	21.7	22.9	22.3	16.2	22.9	21.0	23.5	21.5	22.8	22.3
Length of foramen incisivum	6.7	7.6	7.1	7.0	7.8	5.6	7.6	7.1	4.6	7.2	7.2	7.7
Length of nasals	-	15.1	14.1	15.2	15.4	10.8	15.3	14.8	8.8	14.9	15.4	16.6
Diastema	9.9	11.7	11.4	10.3	11.2	7.9	12.0	10.9	6.2	11.3	11.9	10.9
Zygomatic breadth	17.7	18.9	19.5	18.7	19.2	15.6	18.7	19.2	13.8	18.9	20.2	20.0
Breadth of braincase	14.0	13.7	-	13.8	13.9	-	-	14.2	-	15.0	13.9	-
Interorbital width	5.7	6.1	5.9	6.0	5.8	5.3	6.6	6.1	4.9	5.9	6.7	6.3
Length of upper molar row	5.9	6.3	6.0	6.9	6.6	6.2	6.5	6.4	5.2	6.2	6.6	6.7
Length of lower molar row	6.0	6.0	6.1	6.5	6.4	6.1	6.3	6.0	5.3	6.4	6.6	6.3
Length of mandible	19.6	23.4	22.8	23.2	23.4	17.7	23.7	22.7	14.4	22.5	23.9	23.8

Records of specimens observed (12).
Boca Mahos 4.ix.1994: (t).
Cumana 27.xii.1994 (s): one.
Hospitaal 5.vi.1994: (d).
Hooiberg 7.v.1993 (s): one.
Esso Heights 28.v.1995: (d).
Lago Ville 23.i.1995 : one.
Oranjestad E (house) 11.v.1994: one.
Pos Grandi 26.iii.1994: (d).
Roncado 11.vi.1994: (d).
San Miguel (s) 27.ii.1994: one.
Oranjestad E (s) 6.v.1993: one.
Zwarte Mangel W 23.xii.1994: (d).
(d: droppings, s: sight, t: tracks).

Taxonomy
Mus rattus Linnaeus 1758, Systema Naturae 1, ed. 10, p.61 - Upsala, Zweden.
Mus Alexandrinus Geoffroy 1803, Catal. Mamm. Mus. Hist. Nat., p. 192 - Alexandrië, Egypte.
Musculus frugivorus Rafinesque 1814, Précis Découv. Trav. Somiologiques, p. 13 - Sicilië.
Epimys rattus, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 69 - Aruba.
Rattus rattus, Husson 1960b, Stud. fauna Cur. 10, p 33-40, fig. 7, pl. 6-7 - Aruba.

Measurements and weights
The measurements and weights of 16 adult male and 12 adult female *R. rattus* are summarized in the tables 20 and 21.

Description
Medium sized rodent with acute head and long tail. Ears big, oval-shaped and naked. Pelage on the back rough, dark brown with long guard hairs (fig. 21). Fur on the venter shorter and soft, dark grey or white. Twenty-five of the 30 specimens examined have a white venter, with a sharp demarcation line. The dental formula is I 1/1, C 0/0, P 0/0, M 3/3. The molar abrasion pattern was coded into two categories: 'unworn' and 'worn'. Category 'worn' comprised cases in which at least one molar showed concave surfaces of the occlusal plane. Category 'unworn' comprised all other cases. Table 22 shows no difference in abrasion according to the substrates quartz-diorite and limestone.

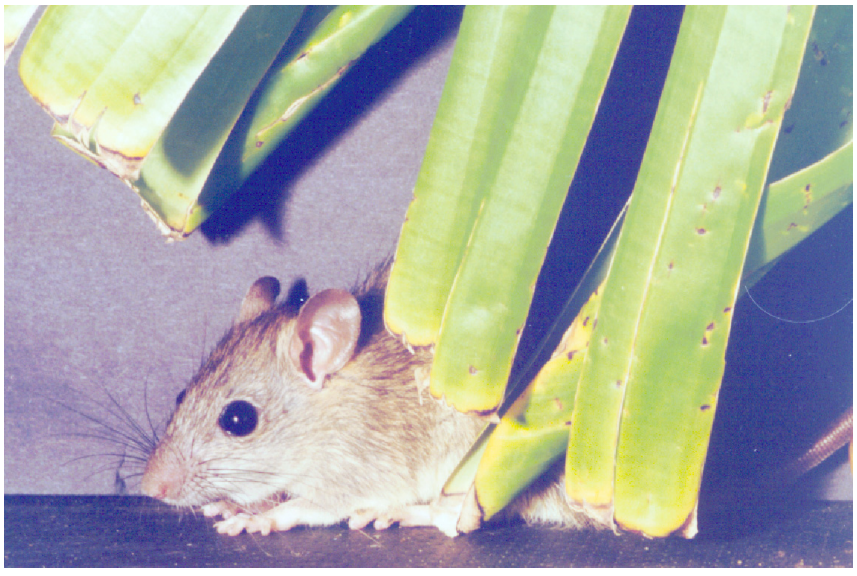


Fig. 21. *Rattus rattus* near banana-tree: one of the favourite habitats.

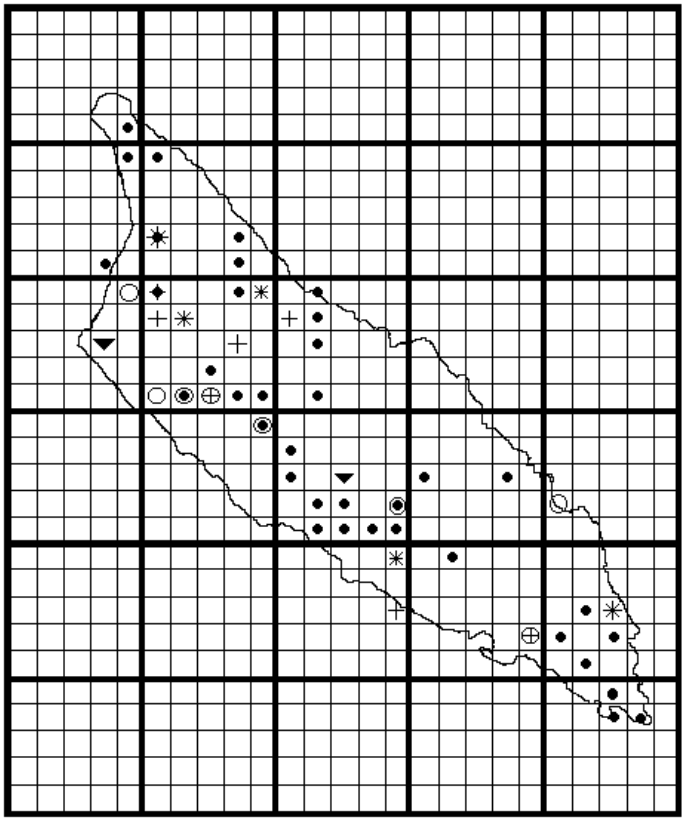
Table 22. Molar abrasion pattern of *R .rattus* according to substrate.

Degree of abrasion	substrate		Total
	quartz-diorite	limestone	
Unworn	9	5	14
Worn	13	7	20
Total	22	12	34

Areal and geographical distribution

R. rattus now has an anthropogenic cosmopolitical distribution and probably originated in South East Asia, but development of commensal habit led to early spread along ancient trade routes to Europe and from there to the rest of the world. Present day distribution includes urban areas throughout tropics and sub-tropics extending to many small villages and even remote farms. The species does not live away from buildings however, except on islands where there are few or no indigenous competitors, e.g. in the Caribbean and the Pacific (Taylor, 1977). The description of the distribution of *R. rattus* on Aruba is based on field observations (8), caughts with live-trap (44), traffic victims (4), found dead (5), owlpellets (16), other predation (2), tracks (2) and droppings (5). The distribution extends from Seroe Colorado in the Southeast towards California Lighthouse in the Northwest (fig. 22). Clusters with a higher density are found around Pos Chicito, Oranjestad, Bushiri and Alto Vista. The distribution also extends to the more deserted areas alongside the Northeast coast near caves.

Fig. 22. Grid squares (1 x 1 kilometre) with observations of *R. rattus* during November 1992 till November 1995.



Explanation of symbols: O = field observation, • = catch, + = predation, * = owlpellet, ▼ = traffic victum.

Food
A potential food source is provided in caves where the large quantity of bat droppings reveals a great number of cactus seeds. This also gives an explanation for the presence of *R. rattus* in caves.

Habitat
The habitat of *R. rattus* is positively associated with undulating terrain and negatively with hilly ground and flat area. It is further characterised by a positive association with alluvial and colluvial soils and quartz diorite soils; there is a negative association with diabase soils and limestone. The texture of the soil reveals a positive association with sand and a negative association with stones, boulders and rock. With respect to the vegetation only a strong positive association with trees was found (see fig. 21), while a negative association was noted with other vegetation types: succulents, meloncactus, low bushes and agaves. For landscape elements the correlation with green isles, tanki's, arroyo's and caves was positive, with trancheru's negative. A positive association showed up for the covering degree of the leaf-litter.

Predation
R. rattus is subjected as a prey for many a predator. In the field *R. rattus* is regularly caught by burrowing owls *A. cunicularia* (see table 7), crested cara cara *Polyborus plancus* (pers. obs. Hein Gooskens) and American kestrel (pers. obs.). The larger specimens of the Arubian rattlesnake *C. d. unicolor* (Van Lidth, 1887) depend to a large extend on this mammal; this is especially true around the hills on Aruba. On November 30th 1993 a dead female rattlesnake (length 860 mm) was found (traffic victim) by Robert Rupert near San Fuego at Mira Lamar. Autopsy revealed hairs from *R. rattus* in the stomach. On December 23 1994 during a trapping control at Zwarte Mangel W a rattlesnake was curled up 10 cm in front of the live-trap; this trap showed droppings of *R. rattus* inside of an escaped individual. This snake apparently followed the rat but probably was mislead by the odour signs. Besides the natural predators also housecats and dogs take their part.

Remarks
In one individual the tail was partly cut off, while in another (young) one the left hind feet was missing. Both wounds were healed perfectly. Both observations were made at areas densly inhabited by hermit crabs (*Coenobita clypeatus*) and tropical landcrabs (*Cardisoma carnifex*). Also several holes showed tracks of the latter and that of *R. rattus* together, making it probable that tropical landcrabs or hermit crabs made the amputations. In one individual the pelage was partly bald at the left side; in the same individual the basis of the skull was partly missing by an osteoclastic process.

Rattus norvegicus (Berkenhout 1769)

Account of specimens

Records of specimens collected (3).
Jan Flemming 13.viii.1995; RMNH, reg. no. 40023: one male (skull).
Macuarima 16.i.94; RMNH, reg. no. 38961: one female (skin in alcohol).
Piedra Plat 29.vi.1994; RMNH, reg. no. 38989: one female (skull).

Records of specimens examined (2).
Cura Cabai 28.v.1995: 1.
Hooiberg SE 24.ix.1994: one male.
Piedra Plat 29.vi.1994: one female.

Taxonomy
Mus norvegicus Berkenhout 1769, Outlines Nat. Hist. Gr. Britain Ireland 1, p. 5 - Great Britain.
Epimys norvegicus, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 68. – Curaçao.
Rattus norvegicus, Husson, 1960b, De zoogdieren van de Nederlandse Antillen, p. 100 - Curaçao; Saba.

Measurements and weights
The measurements and weights of (parts of four specimens of *R. norvegicus* are summarized in table 23.

Table 23. External and cranial measurements of *R. norvegicus.*

Reg. Number RMNH	38961	n.c.	38989	40023
Sex	female	female	female	male
Head and body	177	205	235	201
Tail, without tuft	175	177	209	190
Hind foot, without nail	40	43	43	42
Ear, from notch	20	19	22	19
Greatest length of skull	-	-	-	47.0
Condylobasal length	-	-	-	43.7
Basal length	-	-	-	40.7
Palatinal length	-	-	28.0	24.9
Length of foramen inc.	-	-	8.7	7.4
Length of nasals	-	-	19.3	17.2
Diastema	-	-	15.3	13.0
Zygomatic breadth	-	-	24.7	22.2
Interorbital width	-	-	7.0	6.7
Length upper molar row	-	-	7.3	7.0
Length lower molar row	-	-	7.1	6.8
Length of mandible	-	-	26.8	24.9

Description
Medium sized rodent with a relatively pointed muzzle and a scaly tail that is a little shorter than head-body length. Ears are oval-shaped and finely furred. Pelage on the back grey-brown, venter pale grey or white.

Areal and geographical distribution
R. norvegicus has an anthropogenic cosmopolitical distribution and occurs in urban areas except in low altitude towns in the mainland tropics and sub-tropics (Africa, Asia, South America). It occurs in cultivated land and away from human habitation only in temperate regions and tropical islands where there are no or few indigenous competitors (Taylor, 1977). The description of the distribution of *R. norvegicus* on Aruba is based on traffic victims (5) and found dead (snare-trapped elsewhere) specimens (2). The first documented specimen on Aruba was a lactating female (traffic victum; fig. 23). Around Santa Cruz a small cluster was present and besides that

Fig. 23. *Rattus norvegicus* lactating female, traffic victim; first documented record on Aruba.

there was a single case near Brasil (fig. 24). With these findings the occurence of *R. norvegicus* on Aruba has been established.

Ectoparasites
Ctenocephalides felix (Bouche, 1835) on 30-vi-1994 on host *R. norvegicus*, found dead near Santa Rosa.

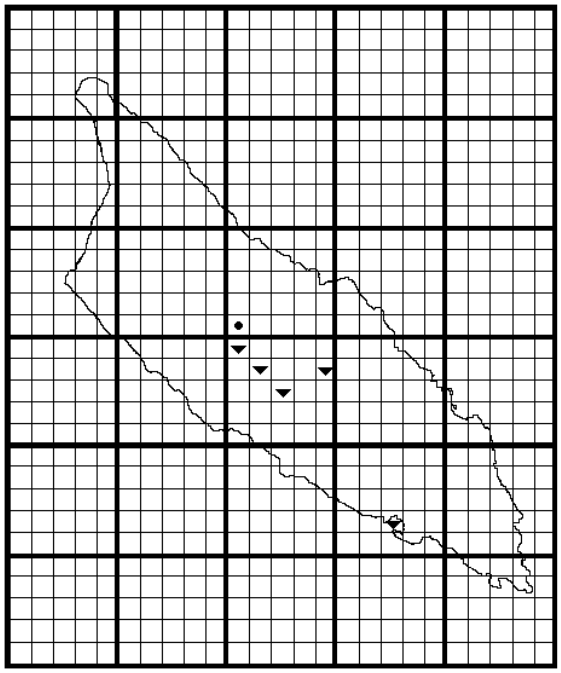


Fig. 24. Grid squares (1 x 1 kilometre) with observations of *R. norvegicus* during November 1992 till November 1995. Explanation of symbols: • = catch, ▼ = traffic victum.

Mus musculus (L., 1758)

Account of specimens

Records of specimens collected (73).
Airport E 10.iv.1993; RMNH, reg. nos. 38871-38874: two males and two females (three specimens in alcohol and one skull); 11.iv.1993; RMNH, reg. nos. 38875-38877: three males (specimens in alcohol).
Alto Vista N II 18.xii.1994; RMNH, reg. nos. 40010: male (dry skin & skull).
Alto Vista W 12.vi.1994; RMNH, reg. no. 38987: male (skull).
Cudawechi 12.xii.1993; RMNH, reg. no. 38937, 38938 and 38940: one male and two females (skulls).
Golfclub road 13.xi.1993; RMNH, reg. nos. 38920-38922: three males (skulls); 14.xi.1993; RMNH, reg. no. 38923-38926: one male and three females (skulls).
Hooiberg SW 31.i.1993; RMNH, reg. no. 38861: male (skull); 10.iv.1993; RMNH, reg. no. 38878: male (skull); 17.iv.1993; RMNH, reg. nos. 38879 and 38880: one male and one female (skulls); 18.iv.1993; RMNH, reg. nos. 38882 and 38883: one male and one female (skulls); 27.v.1993; RMNH, reg. no. 38894: male (skull); 28.v.-1993; RMNH, reg. no. 38893: female (skull); 15.viii.1993; RMNH, reg. no. 38912: female (skull); 21.viii.1993; RMNH, reg. nos. 38913 and 38914: two males (skulls); 22.viii.1993; RMNH, reg. no. 38915: male (skull); 27.viii.1993; RMNH, reg. no. 38917: male (skull); 3.ix.1993; RMNH, reg. no. 38919: female (skull); 29.xi.1-993; RMNH, reg. no. 38928: female (skull); 1.xii.1993; RMNH, reg. nos. 38929 and 38930: two males (skulls); 7.xii.1993; RMNH, reg. no. 38933: male (skull).
Hooiberg NW 26.vi.1993; RMNH, reg. no. 38904 and 38905: male and female (skulls).
H.O. Hospitaal 5.vi.1994; RMNH, reg. no. 38983: male (skull).
Jaburibari 18.xii.1993; RMNH, reg. nos. 38946-38952 five males and two females (skulls).
Marriot Hotel 5.vi.1994; RMNH, reg. no. 38984: male (skull).
Montserat 25.vi.1994; RMNH, reg. no. 38992: male (skull).
Noord S 14.v.1994; RMNH, reg. nos. 38981 and 38980: male and female (skulls).
Palm Beach 4.vi.1994; RMNH, reg. no. 38982: male (skull).
Porto Rico 15.i.1994; RMNH, reg. nos. 38956-38959: two males and two females (skulls).
Pos Abao 2.vii.1994; RMNH, reg. no. 38993: male (skull).
Pos Grandi 26.iii.1994; RMNH, reg. no. 38977: female (skull).
Rooi Lagoen 20.v.1994; RMNH, reg. no. 38973: male (skull).
Sabana Blancu 21.vi.1994; RMNH, reg. no. 38991: male (skull).
San Miguel 27.ii.1994; RMNH, reg. nos. 38968-38970: two males and one female 38969 (skulls).
Seroe Bientu 29.v.1993; RMNH, reg. nos. 38895 and 38896: male and female (skulls); 30.v.1993; RMNH, reg. no. 38897: female (skull).
Seroe Patrichi 13.v.1994; RMNH, reg. nos. 38972, 38978 and 38979: two males and one female (skulls).
Tanki Lender 15.xii.1993; RMNH, reg. nos. 38941-38944: three males and one female (skulls).

Records of specimens examined (83).
Airport W 20.xii.1994: one male.
Anana 15.vii.1994: one.
Baby Beach 15.x.1994: one male, four females.
Boton (enclosure) 22.v.1994: eight sex unknown.
Bushiribana 3.ix.1994: one male.
Casibari 11.vi.1994: one female.
Cumana 27.xii.1994: one male.
Esso Heights 16.xii.1994: one male, one female.
Hooiberg SE 7.vii.1994: one male.
Jan Flemming 25.ix.1994: one female.
Lago Ville 10.xii.1994: one male.
Mabon 27.xi.1994: two females.
Malmok 2.vii.1994: one male, one female.
Mill 25.vi.1994: two sex unknown.
Montana 8.xii.1994: one female.
Montserat 25.vi.1994: two males.
Oranjestad haven 29.xii.1994: one male.
Oranjestad E 30.xii.1994: one male, one female.
Paramira 28.xii.1994: one female.

Porto Rico 15.i.1994: one.
Pos Abao 2.vii.1994: two females.
Pos Grandi 26.iii.1994: one male.
Punto Brabo 16.x.1994: two males, one female.
Roncado 11.vi.1994: one male, one female.
Sabana Blancu 21.vi.1994: one.
Sabana Lodo 20.xii.1994: one male.
San Miguel 27.ii.1994: two males, five females.
San Cruz 25.xii.1994: three males, two females.
Savaneta W 28.v.1995: one female.
Seroe Alejandro 21.i.1994: one male.
Seroe Colorado 20.ii.1994: one.
Seroe Corobori 11.ix.1994: one female.
Seroe di Pos di Nord 12.vi.1994: one male, one female.
Simonslust 1.v.94: one.
Spaans Lagoen 12.ix.1993: one male, two females.
Tanki Cebuju 27.viii.1994: two males.
Tanki Flip 21.v.1994: one.
Tanki Salina 13.viii.1994: three males, one female.
Village 19.xii.1994: one male, one female.
Wajaca 9.x.1994: one female.
Wara Wara 24.ix.1994: one male.
Westpunt 10.vii.1994: two males, one female.

Records of specimens observed (2).
Modansa 18.iii.1995: one.
Oranjestad E (house) 23.iii.1994: one.

Table 24. External and cranial measurements of male specimens of *M. musculus*

Reg. Number RMNH	38880	38920	38930	38959	38991	38992	40010
Head and body	70	67	78	70	70	83	73
Tail, without tuft	-	81	86	75	80	84	86
Hind foot, without nail	16.3	17.0	17.9	16.7	17.5	17.1	16.5
Ear, from notch	12.4	12.5	13.4	11.9	-	13.6	13.6
Greatest length of skull	20.2	20.3	21.6	20.4	22.9	-	21.4
Condylobasal length	19.0	19.3	20.4	19.4	21.7	22.3	20.3
Basal length	17.2	17.6	18.5	17.6	19.5	20.2	18.2
Palatinal length	10.0	10.3	10.9	10.8	11.8	12.2	11.1
Length of foramen inc.	4.5	4.4	4.9	4.7	5.2	5.6	4.7
Length of nasals	7.4	7.2	8.4	7.4	8.7	-	8.2
Diastema	4.7	5.0	5.9	5.4	6.0	6.0	5.8
Zygomatic breadth	10.9	10.6	10.9	10.9	11.8	11.6	10.9
Interorbital width	3.5	3.5	3.4	3.7	3.8	3.6	3.4
Length upper molar row	3.7	3.4	3.6	3.3	4.2	4.0	3.2
Length lower molar row	3.0	3.0	3.2	2.7	3.5	3.2	2.9
Length of mandible	10.9	10.9	12.0	10.8	13.1	12.8	11.6

Taxonomy
Mus musculus Linnaeus 1758, Systema Naturae 1, ed. 10, p. 62 - Upsala, Zweden.
Mus domesticus Rutty 1772, Essay Nat. Hist. County Dublin 1, p 281 - Dublin, Ireland.
Mus brevirostris Waterhouse 1837, Proc. Zool. Soc. London 1837, p. 19 - Maldano, Uruguay.
Mus musculus, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 68-69 - Curaçao.
Mus musculus, Husson 1960b, De zoogdieren van de Nederlandse Antillen, p. 102 - Aruba.
Measurements and weights
The measurements and weights of 7 adult male and 5 adult female *M. musculus* are summarized in table 24 resp. table 25.

Table 25. External and cranial measurements of female specimens of *M. musculus*

Reg. Number RMNH	38895	38925	38928	38969	38977
Head and body	71	75	74	79	68
Tail, without tuft	76	75	78	83	71
Hind foot, without nail	16.0	16.3	16.0	17.5	16.3
Ear, from notch	13.0	13.4	12.9	13.5	12.4
Greatest length of skull	20.7	21.7	20.7	21.9	21.6
Condylobasal length	19.8	20.6	20.0	20.7	20.6
Basal length	18.2	18.8	18.0	19.0	18.4
Palatinal length	10.8	10.9	10.6	11.6	11.0
Length of foramen inc.	4.8	4.9	4.7	4.8	5.0
Length of nasals	8.5	8.0	-	8.0	8.1
Diastema	5.9	5.6	5.2	5.9	5.7
Zygomatic breadth	11.0	11.4	11.0	11.7	11.3
Interorbital width	3.4	3.4	3.4	3.5	3.6
Length upper molar row	3.3	3.7	3.4	3.9	3.2
Length lower molar row	2.7	2.7	3.0	3.6	2.9
Length of mandible	11.8	11.9	10.8	11.7	11.3

Description

Small rodent. Colour of the fur yellow-brown on the backside, ventral side pure white till yellow-grey (fig. 25). In only one case (RMNH, reg. no. 38987: full grown male, 13.5 g) the colour of the back was dark-grey while the ventral side was lighter grey; this specimen was attributed to the subspecies *M. m. domesticus* (Rutty, 1772). The colour of the ventral side, the degree of demarcation between back and ventral side (table 26) and the presence of an ochreous band on the flank (table 28) was determined of collected and examined specimens.

Fig. 25. *Mus musculus* in crushed beer bottle: biba dushi den sushi (life is wonderful in the trash).

Table 26. Presence of a sharp demarcation between back and ventral side in relation to colour of the venter in *M. musculus*.

	sharp demarcation		
Colour of venter	present	absent	total
White	35	13	48
Yellow/grey	5	55	60
Dark grey	0	1	1
Total	40	69	109

Table 27. Presence of a band at the flank between back and ventral side in relation to colour of the venter in *M. musculus*.

	band at flank		
Colour of venter	present	absent	total
White	30	18	48
Yellow/grey	5	55	60
Dark grey	0	1	1
Total	40	69	109

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Dental characters

In ideal cases, *M. musculus* can be recognised at the notch in the upper incisors. However, already Reichstein (1978) remarked the inconsistency of this character. In our specimens the notch is not consistent. The lateral side of several incisors showed clear, dubious or absent notches. Distribution of these categories in 64 *M. musculus* show that only in 17 out of 64 specimens (27%) a clear notch in both the upper incisors in *M. musculus*. On the other hand in 23 out of 64 specimens (36%) not even a trace of a notch was present. An influence of the geological substrate (sand of quartz-diorite or limestone) for the development of the notch could not be demonstrated. The data of the notch are important for the determination of skulls in owl pellets. Using the absence of this character for estimating the number of *C. hummelincki* in owl pellets, as was done by Van Marwijk Kooy (1991), obviously resulted in an overestimate of the numbers of *C. hummelincki* compared to the numbers of *M. musculus*.

The molar abrasion pattern was coded into two categories: 'unworn' and 'worn'. Category 'worn' comprised cases in which at least one molar (most of all M^3) showed plane or concave surfaces of the occlusal plane. Category 'unworn' comprised all other cases. Table 28 shows no difference in abrasion according to the substrates quartz-diorite and limestone.

Table 28. Molar abrasion pattern of *M. musculus* according to substrate.

Degree of abrasion	substrate		total
	quartz-diorite	limestone	
Unworn	22	7	27
Worn	26	9	35
Total	48	16	64

Areal and geographical distribution

M. musculus has an anthropogenic cosmopolitical distribution; the species originally range probably in the steppe zone of the southern Palaearctic. *M. musculus* now is predominantly associated with human dwellings (Rowe, 1977). The description of the distribution of *M. musculus* on Aruba is based on field observations (1), caught with live-traps (153), owl pellets (39) and other predations (2). The distribution is predominantly around

Oranjestad extending to the North to Alto Vista and alongside the West coast. A scattered distribution can be seen alongside the Southeast towards Savaneta, San Nicolas and Seroe Colorado. The more desolated areas Southeast from Alto Vista Seroe Colorado seem to lack *M. musculus* (fig. 26).

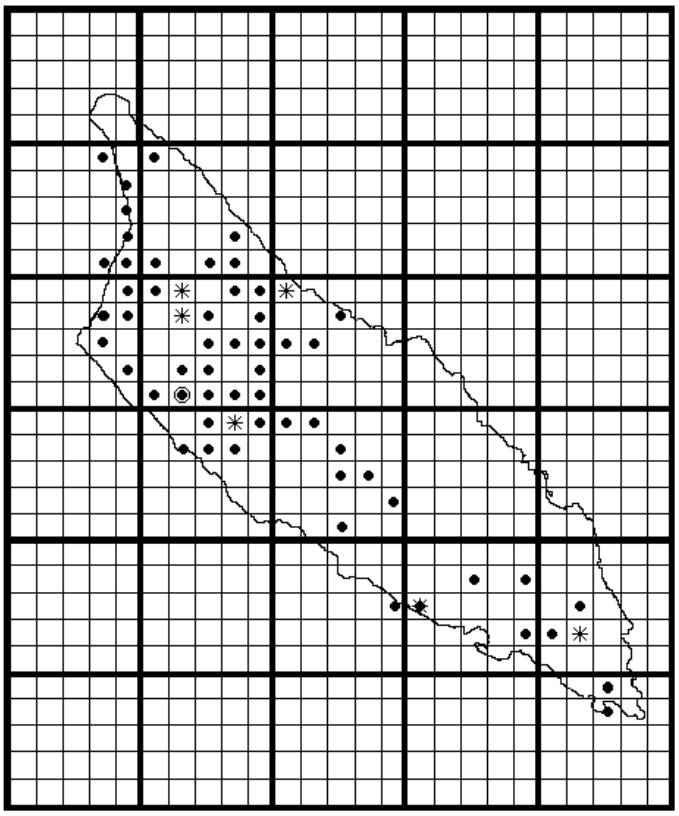

Fig. 26. Grid squares (1 x 1 kilometre) with observations of *M. musculus* during November 1992 till November 1995. Explanation of symbols: O = field observation, • = catch, + = predation, * = owlpellet.

Food

A potential food source is provided in caves where the large quantity of bat droppings reveals a great number of cactus seeds. This also gives an explanation for the presence of *M. musculus* in caves, although the presence of this species is less pronounced than that of *R. rattus.*

Habitat

The habitat of *M. musculus* is positively associated with flat area and negatively with hilly grounds and undulating terrain. It is further characterised by a positively association with limestone and quartz-diorite soilsand a negative association with diabase soils. The texture of the soil reveals a positive association with sand a negative one with gravel, stones, boulders and rocks. With respect to the vegetation only a strong positive association with herbs and with grass was found and a negative one with succulents and meloncactus. With landscape elements a negative association was noted for green-isles and arroyo's. Leaf-litter and garbage associated negatively for the covering degree (see also Appendix II).

Predation

Proof of predation by *A. cunicularia* of *M. musculus* is seen in pellets (see table 7), *F. sparverius* and the house cat. Potential predators for this species are the tropical centipede *S. morsitans* and the Arubian rattle snake *C. d. unicolor*.

LAGOMORPHA

LEPORIDAE

Sylvilagus floridanus nigronuchalis (Hartert, 1894)

Account of specimens

Records of specimens collected (11).
Canashito NW 8.ii.1994; RMNH, reg. no. 38967: one sex unknown (skull).
Du Chei 17.vi.1995; RMNH, reg. no. 40019: one male (skull).
Hooiberg SW 20.vi.1994; RMNH, reg. no. 38988: one male (skull).
Jamanota NW 4.xii.1993; RMNH, reg. no. 38931: one female (skull).
Mira Lamar 12.xii.1992; RMNH, reg. no. 38850: one female (skull), 1.vii.1995; RMNH, reg. no. 40024: sex unknown (skull).
Rooi Balashi 28.iii.1993; RMNH, reg. no. 38867: one female (skull).
Seroe Cabai 8.viii.1993; RMNH, reg. no. 38911: sex unknown (skull).
Seroe Muskita 27.viii.1994; RMNH, reg. no. 40017: one sex unknown (skull).
Washington 24.vi.1993; RMNH, reg. no. 38903: one (juv) (specimen in alcohol).
Zwarte Mangel W 11.xii.1994; RMNH, reg. no. 40007: one female (skull & one foetus in alcohol).

Records of specimens examined (1)
Matidiviri 4.ix.1994: one female.

Records of specimens observed (56).
Andicuri SW 28.viii.1993: one.
Andicuri NE 4.xi.1994: one.
Andicuri SE 28.viii.1993: one.
Arashi 19.vi.1993: one.
Arikok 5.ix.1993: one.
Banki Jerome 28.ii.1993: one; 6.ii.1994: one.
Baranca Cashunti 3.ix.1993: one.
Baranca Cora 26.xii.1994: one.
Block 23 12.xii.1993: one.
Buena Vista 9.ii.1993: one.
Butucu E 4.xii.1994: one.
Canashito S 10.ix.1995: one.
Cadushi 10.ix.1994: one.
Casibari 11.vi.1994: one.
Cumana 27.xii.1994: one.
Golfclub Road 24.i.1993: one.
Hooiberg ZW 23.i.1993: one.
Hooiberg NW 26.vi.1993: one.
Hooiberg NO 26.vi.1993: two.
Hooiberg SE 24.ix.1994: one.
Hospitaal 9.ii.1993: one; 5.vi.1994: one.
Esso Heights 28.v.1995: one.
Jamanota W 14.ii.1993: one.
Jamanota N 24.iv.1993: one.
Lagoville 28.v.1995: one.
Macuarima 8.x.1994: one.
Mangel Altu 26.v.1995: one.
Manzania 24.i.1993: one.
Masiduri 22.xi.1993: one.
Ponton 19.vi.1993: one.
Rooi Prins 17.12.1994: one.
Rooi Juditi 30.iv.1993: one.

Sabana Lodo 20.xii.1994: one.
San Fuego 11.iv.1993: one.
San Miguel 27.ii.1994: three.
Seroe Bientu 29.v.1993: one.
Seroe Oliva 27.iii.1993: one.
Seroe Pretu 27.iii.1993: one.
Simonslust 1.v.1994: one.
Tanki Cebuju 27.viii.1994: one.
Tanki Lender 15.xii.1993: one.
Tibushi 27.viii.1994: one.
Vader Piet NE: 21.i.1995: one.
Vader Piet NW 27.ii.1993: two; 1.iv.1993: one.
Washington 20.xi.1992: one.
Wiriwari 12.xii.1993: one.
Wela quarry 14.ii.1993: one; 1.iv.1993: one.
Wela quarry W 13.ii.1993: one.
Zwarte Mangel E 15.xii.1994: one.

Taxonomy
Lepus nigronuchalis Hartert 1894, Novit. Zool. 1, p. 40 - Aruba.
Sylvilagus nigronuchalis nigronuchalis, Wagenaar Hummelinck 1940, Stud. fauna Cur. 1, p. 67, pl. 11; 2, p. 95-100, 102 - Aruba Curaçao.
Sylvilagus floridanus nigronuchalis, Hershkovitz 1950, Porc. U.S.N.M. 100, p. 342.
Sylvilagus floridanus nigronuchalis, Husson, 1960b, De zoogdieren van de Nederlandse Antillen, p. 120 - Aruba, Curaçao.

Measurements and weights
The measurements and weights of collected specimens are listed in table 29. Of the female specimen found dead at Matidiviri on 4.ix.1994 (not collected because of a crushed skull) the measurements are: head and body 275 mm; tail, without tuft 27 mm; hind foot, without nail 71 mm; ear, from notch 53 mm; weight 680 g.

Table 29. External and cranial measurements of ten specimens of *S. f. nigronuchalis* (M_4 extra buccaal).

Reg. Number RMNH	38850	38867	38911	38931	38967	38988	40007	40017	40019	40024
sex	f	-	-	f	-	m	f	-	m	-
Head and body	364	320	-	320	-	336	303	-	315	-
Tail, without tuft	35	24	-	25	-	31	31	-	30	-
Hind foot, without nail	71	75	-	72	-	75	75	-	76	-
Ear, from notch	57	54	-	57	-	56	57	-	57	-
Greatest length of skull	71.3	68.1	72.8	65.3	73.1	72.7	67.5	-	69.7	-
Condylobasal length	61.1	58.9	62.7	55.2	62.4	58.9	55.2	-	58.2	-
Diastema	19.5	17.3	19.7	17.9	20.3	19.2	18.6	19.4	19.6	17.7
Zygomatic breadth	34.2	32.9	33.4	32.9	35.4	33.8	32.9	35.4	34.7	34.6
Length upper molar row	14.2	13.2	13.7	13.3	14.3	14.4	13.6	14.4	13.2	13.8
Length lower molar row	14.8	13.2	13.7	13.3	-	15.3	14.9*	-	14.0	-
Length of mandible	51.6	47.1	49.9	47.9	-	50.8	48.0	-	49.6	-

Description
This lagomorph has the characteristic oval-shaped head, long ears, and considerably longer hind limbs than the forelimbs. The fur on the back is grey brown, while that on the venter is white with a marked demarcation line. The medial side of the front and hind limbs is white while the lateral side is brown. The most conspicuous feature of *S. floridanus nigronuchalis* is, as indicated by the name, the black patch on the back of the neck. A white line surrounds the eye and small white spots often scattered around the nose. The very margin of the ears is white. The fluffy short tail is white at the ventral side. The colour of the young specimens is different. The upper parts are dark intermingled with some brown hairs. A black dorsal line runs from the nape of the neck till the onset of the tail. A yellow brown demarcation band is present dividing the dark back and the white under

parts. Under and besides the nose white spots show up. The margins of the eyelids are dark surrounded by yellow white. Parallel to the eye and approximately 12 mm below, a white line runs till under the chin. The innerside of the ears are white (fig. 27); at the backside the colour changes from grey in the central part, to brown in the middle and black at the rim. Under the ears the part of the later characteristic black spot is grey; the colour proximal and distal of that spot is brown. The dental formula is I 2/1, C 0/0, P 3/2, M 3/3. In specimen RMNH, reg. no. 40007 an extra molar was found (right buccal).

Fig. 27. Young specimen of Arubian cottontail *Sylvilagus floridanus nigronuchalis*.

Areal and geographical distribution

S. floridanus ranges within the southern part of the nearctic and the neotropical sphere from southern Manitoba, Canada, south to Costa Rica. It appears again in the llanos of Colombia and Venezuela (Eisenberg, 1989). *S. f. nigronuchalis* is recorded on the Caribbean islands of Aruba and Curaçao (Husson, 1960b). Although *S. floridanus nigronuchalis* seems to be restricted to Aruba and Curaçao, *S. floridanus* from the region of Maracaibo do also have a black spot. As Husson (1960b) mentions it is therefore highly plausible to assume that *S. floridanus nigronuchalis* was introduced from the vicinity of Maracaibo. The description of the distribution of *S. f. nigronuchalis* is based on field observations (59), traffic victims (10), predation (2), found dead (2) and findings of droppings (92). The distribution seems to occur almost all over the island; restrictions have to be made for alongside the Southwest coast (near and around human settlements) and the baranca area east of Boca Prins (fig. 28).

Food

On a limited scale gnawmarks were found on tuna cactusses and herbs. Analysis of droppings showed fibres of bushes and leafrests. The size of the droppings was average length 10.78 (min. 9.3 and max. 12.7), average breadth 7.26 (min. 6.4 and max. 8.2).

Reproductive biology

In December a pregnant female had been found dead (RMNH, reg. no. 40007) and in July a young specimen odf several weeks had been predated by a cat (RMNH, reg. no. 38903). These rather limited number of data are in line with Husson (1960) as this species is continuously breeding, particulary from October till April but less in more dry periods.

Habitat

The habitat of *S. f. nigronuchalis* is positively associated with light hilly ground (predominantly the south- and eastside of the hills) and negatively with flat area. It is further characterised by a positive association with quartz-diorite soilsand a negative association with limestone soils. The texture of the soil only reveals a negative association with rock. With respect to the vegetation only a strong positive association was found with succulents and melon cactus and a negative association with grass. With landscape elements a positive

correlation was found for trancheru's and green isles. A negative association was revealed for the covering degree of the leaf-litter (see also Appendix II).

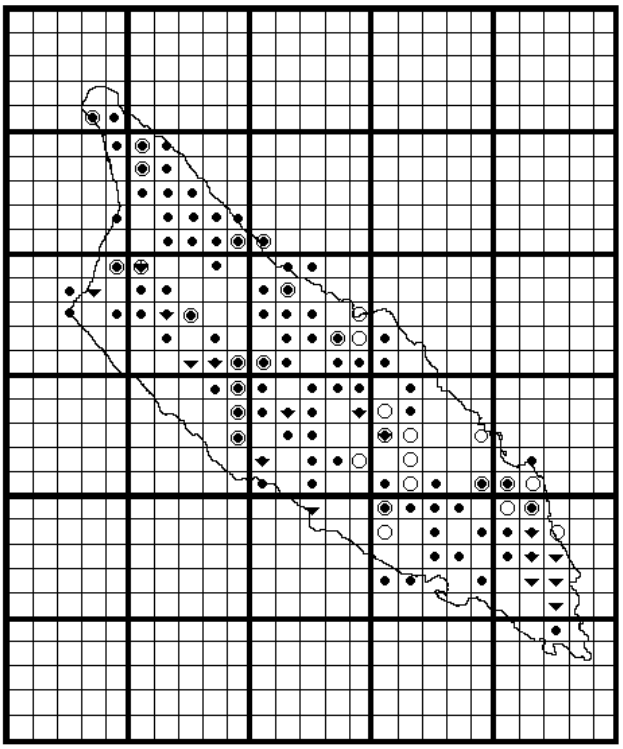

Fig. 28. Grid squares (1 x 1 kilometre) with observations of *S. f. nigronuchalis* during November 1992 till November 1995. : O = field observation, • = droppings, + = predation, ▼ = traffic victum.

Predation

Proof of predation of a young specimen shows for the house cat. Before this study period an observation of predation by the Arubian rattlesnake *C. d. unicolor* is documented (dia-positive by Olinda van der Linden-Rasmijn in 1984 showing a rattlesnake ingesting a *S. f. nigronuchalis)*.

Ectoparasites

Rhipicephalus sanguineus (Latreille) found on 11-8-1994 on host *S. f. nigronuchalis*, freshly killed traffic victim at Morgenster.

4. Discussion

4.1. New mammals

Are the newly discovered mammals on Aruba overlooked until now or are they really new? Several factors can be mentioned why the newly found species (*P. d. davyi*, *N. t. tumidirostris*, *M. molossus*, *R. norvegicus*) remained unnoticed until now. In the first place it is the disinterestedness for wild animals in general. This is especially true for small rodents and bats in the Caribbean and South-America. In 1960 Husson gave an important impulse to the Netherlands Antilles (in those days including Aruba as well) by publishing 'De zoogdieren van de Nederlandse Antillen'. However, before publishing, he never visited Aruba or the other islands himself (Holthuis & Smeenk, 1988). The lack of appropriate trapping material and limited technical resources are also important factors. Research covering a period of several years can reveal new species for a country; this is especially true if new capture methods are used. However, the possibility is not excluded that species have reached Aruba only after 1960.

4.2. Conservation

Introduction

In general, populations of species inhabiting certain islands are special as far as they are restricted to a small area; they are very special when these (sub)species are restricted to one island or group of islands. This gave these species a high ranking in lists for threatened species. Aruba, Bonaire and Curaçao, commonly referred to as the ABC-islands, form such a group of islands. The concern for nature in the general public is growing, the goals are especially focused on conservation and less in performing field-investigations. Nature conservation organisations play an important role in the awareness of the general public. With respect to Aruba 'Stimaruba' is the active and capable organisation concerning the 'naturalesa di Aruba'.

Although a list of endangered species on Aruba (LMA, 1993) is made, it does not include mammals. It is imperative to make a list before it is too late, therefore Bekker (1996) proposed a Red List of the Mammals of Aruba by using the best professional judgement (table 30), the criteria for this Red List are discussed in Appendix IV.

Table 30. Red list of threatened mammals on Aruba. Explanation of abbrevations: EX = extinct, CR = critical, EN = endangered, VU = vulnerable and LR = low risk.

Species	EX	CR	EN	VU	LR
P. macrotis	*				
P. d. davyi		*			
M. m. intermedia		*			
G. l. elongata			*		
L. curasoae		*			
N. t. tumidorostris		*			
M. molossus			*		
C. hummelincki				*	
S. f. nigronuchalis					*

Hooijer (1960) mentioned rests of *Dasyprocta* spec., *Dusicyon* cf. *thous* and *Felis* cf. *tigrina*, found in an Indian camp in Santa Cruz. These findings are not included in the Red List because of their semi-paleontological character.

A worldwide (-unoutspoken) consensus exists that *R. rattus*, *R. norvegicus* and *M. musculus* are not endangered. Besides they damage food and goods. So a platform for the conservation of those animals is missing. On the contrary, in most countries (including Aruba) they (and many other rodents) are heavily prosecuted (fig. 29). The populations of these mammals can survive the heavy prosecution due to intact manmade habitat conditions

and the use of their highly developed reproduction capacity.

Fig. 29. Aruba cuidad: Sushedad ta causa enfermedad y enfermedad ta causa MORTO (Aruba be careful: garbage causes illness and illness causes DEATH); there obviously is no Arubian support for conservation measures of *R. rattus*.

Chiroptera

For most bat species, the availability of suitable roosts is an important limiting factor and this is also true for Aruba. Caves become unavailable to bats if humans enter the cave frequently. Life in caves has been affected by loss of caves due to open mining activities, commercialisation for tourism and disturbance by vandals or even direct killing of bats. In Quadirikiri a primitive sort of baseball club was found with the text 'bat-gang'. In the same cave 'noise gang' was grafittied as well as rests of fires were noticed. The mining activities at Canashito almost certainly effected the disappearance of *P. macrotis*. The open mining activities at Drumidera interfered with the centre of the most important part of the feeding fields of *L. curasoae* and to a lesser extent with that of *G. l. elongata*.

Vulnerability of species and habitat:
During frequent searches for almost three years at Canashito and the surroundings or at other places on Aruba not even a single specimen of *P. macrotis* was caught. Given the fact that a vast area of Canashito (and of the cave of Canashito as well) disappeared, this species is regarded as 'extinct'. Bats are extraordinary vulnerable to catastrophes from natural or human causes because individuals are highly concentrated in day roosts in a few caves. *M. m. intermedia* e.g. in the Camber di Leeuw, Quadirikiri and *P. d. davyi* and *N. t. tumidirostris* at Wela W. Therefore these three species are considered as 'critical'. *L. curasoae* is also placed in this category because of the large quantities each time in one roost (> 1000 individuals) and a number of roosts within a restricted area. Furthermore, the former roost of Quadirikiri has been abandoned, while the area of cadushi largo producing cunucu (the main food source of this species) is diminishing. Bats are not equally susceptible to noise, light or other human disturbance. If disturbance afflicts a colony it can cause bats to abandon the cave or cause nonvolant young to drop to the cave floor. If these juveniles are dropped on the cave floor they cannot climb to the roost. On the other hand *G. l. elongata* frequently accepts the neighbourhood of people even deliberately within houses. Moreover *G. l. elongata* may be a little less vulnerable than other bats because it uses a (wide) variety of foraging and roosting habitats and forms large and small colonies as well. *M. molossus* is attracted by the massive light exposure of certain hotels and therefore massive insect-disorientation by human lights may affect bat populations in a positive way. Insect feeding bats are potentially vulnerable to pesticide poisoning and loss of food sources due to pesticides and other pollutions. On Aruba quantitive effects of pesticides on populations of insect-eating bats are not known. Therefore the latter two species are considered as 'endangered'.

Conservation measures proposed
All bats on Aruba can be regarded as endangered or threatened and therefore should be included in the Red List of Mammals of Aruba. Differentiating conservation measures for each bat species according the estimated real danger is not advisable: the public in general cannot be expected to determine each bat species correctly. Primary need is to gain control of important breeding caves and protect them from disturbance by humans. The secondary need is to protect and restore foraging habitat. A routine program to monitor population numbers is needed to measure the effectiveness of the protective efforts. Government agencies together with private conservation groups have to provide information about bats to the public and, in particular, advise people on how to evict unwanted bats from buildings and how to construct artificial roosts. Strategies have to be

developed to remove, rather than destroy, resident 'nuisance' bats. Companies and businesses that promote pesticides and other chemicals to kill bats should be discouraged from this practice. It is necessary to educate local people (schools!) and inform tourists in order to avoid disturbing bats.

C. hummelincki

Correct differentiation between *C. hummelincki* and *M. musculus* (or even small specimens of *R. rattus*) cannot be expected of the public in general. Therefore it makes no sense to make proposals for protection of *C. hummelincki* on an individual level. In stead of that habitat protection is indicated to protect *C. hummelincki* on a population level. The optimal habitat of this species is now known to exist of loamy sandy soils, with a very little slope. The vast majority of these soils is located alongside the north coast and also in some other areas; major protective efforts for this species have to be undertaken on the north coast. Therefore the status of *C. hummelincki* is classified as 'vulnerable'.

S. f. nigronuchalis

Fig. 28 shows the distribution of *S. f. nigronuchalis*: the species is present in almost half (47.7%) of the square kilometre blocks. Besides that sightings of the species during the night are regular. Although from literature (Husson, 1960) the opinion is heard of fewer sightings (and shotings) of this game animal, a considerable decline (>75%), however, could not be demonstrated. Therefore the status of *S. f. nigronuchalis* must classified as ‘low risk’.

Conservation proposals

- Maintenance of the gates and fences should be a regular part of management of the species.
- Old palm fronds have to be kept intact because they provide potential roost sites for potential tree-dwelling bats.
- Because *G. l. elongata* and *M. molossus* so often roost in man-made structures, experiments have to be carried out to investigate whether those species will roost in artificial roosts.
- Closing of the Camber di Leeuw (this is the last chamber of Quadirikiri) with an iron fence.
- Closing of Wela quarry with an iron fence.
- Partial closing of the Tunnel of Love.
- Declaring and preserving the Northcoast as Nature reserve and blocking the sandy-loam areas with boulders of at least one quadruple meter in order to make Safe Area's for *C. hummelincki*.
- Prevention of habitat fragmentation of the important areas of *S. f. nigronuchalis* and construction of linear landscape elements (e.g. trancheru's and stonewalls between these areas in order to prevent roadkillings.

Proposals for additional research

- Determination of kinship (e.g. with DNA-analysis) between the following (sub)species from different places:
    * *M. m. intermedia*, from Aruba, Bonaire and Curaçao;
    * *G. l. elongata*, from Aruba, Bonaire and Curaçao;
    * *L. curasoae*, from Aruba, Bonaire, Curaçao and Paraguana, Venezuela;
    * *M. molossus*, from Aruba, Bonaire, Curaçao and other Caribbean islands;
    * *C. hummelincki*, from Aruba, Curaçao and several parts in Paraguana (Venezuela);
    * *S. f. nigronuchalis*, from Aruba, Curaçao and several parts of Venezuela (around the Lake of Maracaibo).
- Ecological research of mammals of Aruba, especially of *C. hummelincki* and *S. f. nigronuchalis*.

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Appendices

Appendix I

Description of the landscape elements

Aloe-plantation:	Former cultivated area with aloe-plants often gradually transformation into cunucu.
Arroyo:	Descending more or less gutter-formed and, towards the ocean wider, growing structure. The water transport capacity is good; there hardly exists any places with stagnant water. Fast germinating and flowering grasses and herbs can survive. Alongside the higher embankments more permanent vegetation can root.
Baranca:	Area of uniform, sharp coral with clefts and cavities. The vegetation is restricted to low bushes and medium low cactusses. A thick leaf litter layer deposits in the clefts and cavities.
Cave:	Natural excavation in rock (most often in limestone) of at least 2 m depth, 1 m height and 0.5 m width.
Cunucu:	Area with varying densities of cactusses, bushes, thorntrees, sparsely grass and almost absent herbs. Large diorite boulders are widely distributed.
Green isle:	Patch of vegetation within bare country typically structured by some higher trees, bushes or cactusses and surrounded by gradually lower thorn bushes.
Left-over:	Small and almost always isolated areas with vegetation varying from grass, herbs, bushes and a dense canopy of medium-high trees till transition into cunucu.
Mangrove:	Permanent green forest of aerial rooting mangrove-trees alongside salt water, often as a transition of salina.
Quarry:	Manmade horizontal or vertical mineshaft.
Salina:	Loam or sandy plain sometimes submerged by salt water and sparsely covered with herba di coco.
Stonewall:	Provisionally cemented wall of natural stones of approximately 150 cm height.
Tanki:	Basin in the neighbourhood of an arroyo, that can contain rain-water for a long period; grasses and herbs germinate easily while alongside the higher embankments a more permanent vegetation can root.
Trancheru:	Close row of single columns of a columnar-cactus, forming a hedge (originally built as cattle fence).

Appendix II

Definitions of measurements.

Head and body. - Length from tip of snout to the centre of the anus.
Tail, without tuft. - Length from centre of anus to tip of tail.
Free end of tail. - Length from tail after tunnelling the interfemoral membrane to tip of tail.
Forearm. - Length taken externally with folded wings and includes wrist bones and radius.
Hind foot, without nail. - Length from metatarsal to the longest claw.
Ear, from notch. - Greatest length from notch of ear to margin.
First digit. - Length of thumb excluding claw.
Second metacarpal. - Length of second metacarpal.
Third digit. - Length of third metacarpal and finger (including wrist).
Third metacarpal. - Length of metacarpal of third finger (including wrist).
1st phalanx third digit. - Length of first phalanx of third finger.
2nd phalanx third digit. - Length of second phalanx of third finger.
3rd phalanx third digit. - Length of third phalanx of third finger.
Fourth digit. - Length of fourth metacarpal and finger (including wrist).
Fourth metacarpal. - Length of metacarpal of fourth finger (including wrist).
1st phalanx fourth digit. - Length of first phalanx of fourth finger.
2nd phalanx fourth digit. - Length of second phalanx of fourth finger.
Fifth digit. - Length of fifth metacarpal and finger (including wrist).
Fifth metacarpal. - Length of metacarpal of fifth finger (including wrist).
1st phalanx fifth digit. - Length of first phalanx of fifth finger.
2nd phalanx fifth digit. -Length of second phalanx of fifth finger.
Humerus. - Distance from proximal-most end to distal-most end of the humerus bone.
Radius. - Distance from proximal-most end to distal-most end of the radius bone.
Femur. - Distance from proximal-most end to distal-most end of the femur bone.
Tibia. - Distance from proximal-most end to distal-most end of the tibia bone.
Spur. - Distance from the heel to the outermost point of calcar bone.
Occipitalnasal length. - Distance from posterior-most portion of occipital bone to anterior-most portion of skull (also named: greatest length of skull).
Condylobasal length. - Distance from posterior-most portion of occipital condyle to anterior-most margin of alveolar of incisor.
Basal length. - Distance from anterior-most margin of alveolar of incisor to anterior-most margin of foramen magnum.
Palatinal length. - Distance from posterior-most margin of palatum to anterior-most margin of alveolar of incisor.
Foramen incisivum. - Distance from posterior-most margin to anterior-most margin of foramen incisivum.
Nasal length. - Distance from posterior-most margin to anterior-most margin of the nasal bone.
Diastema. - Distance from posterior-most margin of alveolar incisor to anterior-most margin of alveolar first molar.
Zygomatic breadth. - Maximum width of skull at zygomatic arches.
Cranium height. - Distance from basissphenoid to highest portion of parietal.
Interorbital width. - Least interorbital width.
Upper tooth(molar)-row*. - Distance from anterior-most alveolar margin of canine (first molar*) to posterior-most alveolar margin of last molar of upper molar-row.
Lower tooth(molar)-row*. - Distance from anterior-most alveolar margin of canine (first molar*) to posterior-most alveolar margin of last molar of lower molar-row.
C1-C1. - Distance from labial-most alveolar margins of upper canines.
Mandible length. - Distance from anterior-most portion of incisor alveolar to mandibular condyle.
Braincase width. - Width taken at the base of the zygomatic arches.

* in Rodentia, Lagomorpha.

Appendix III

Elements used in a correlation study and results of the test.

LIME	limestone
DIOR	quartz-diorite
DBAS	diabase
ALCO	alluvial-colluvial
OTHR	other
STWL	stonewall
TRCH	trancheru/cactus hedge
GRIS	green-isle
CAVE	cave
ARRO	arroyo
TNKI	tanki
GRBG	garbage
LELI	leaflitter
HOUS	house
HUMS	humus
LOAM	loam-content of soil
SAND	sand
GRAV	gravel
STON	stone
BOLD	boulder
ROCK	rock
FLAT	flat
HILL	hilly
UNDU	undulating
CLIF	cliff
HERB	herbs
GRAS	grasses
MELN	melon cactus
SUCC	succulents
BSHL	low bushes
BSHH	high bushes
TREE	trees
AGVE	agaves
CALH	*Calomys hummelincki*
RATR	*Rattus rattus*
MUSM	*Mus musculus*
SFNI	*Sylvilagus floridanus nigronuchalis*

	C. hummelincki	*R. rattus*	*M. musculus*	*S.f. nigronuchalis*
LIME	-.0025	-.0357*	+.0768**	-.2703**
DIOR	-.0190	+.0516**	-.0359	+.4662**
DBAS	-.0439*	-.0724**	-.0452	-.1055
ALCO	+.1613	+.1188**	-.0136	-.1326
OTHR	-.0380*	-.0312	-.0081	-.1110
STWL	-.0798**	+.0118	-.0309	+.1199
TRCH	-.0424*	-.0418	-.0249	+.3070**
GRIS	+.0936**	+.0513**	-.0362	+.2617**
CAVE	-.0332	+.0375	-.0203	-.1400
ARRO	-.0727**	+.0690**	-.0446*	-.0860
TNKI	+.0768**	+.1823**	+.0127	+.0719
GRBG	-.0622**	-.0349	-.0076	-.0077
LELI	-.1503**	+.1366**	+.0147	-.1527*
HOUS	+.0924**	-.1341**	-.0707**	-.2182**
HUMS	-.0770**	+.0837**	+.0037	-.0313
LOAM	+.0860**	+.0007	-.0327	+.0689
SAND	+.0214	+.0987**	+.0775**	+.1264
GRAV	+.0630**	+.0292	-.0462	+.1387
STON	-.0400*	-.0573**	-.0400*	-.0018
BOLD	-.0602**	-.0625**	-.0497**	+.0848
ROCK	-.0334	-.0900**	-.0471**	-.1786*
FLAT	+.0597**	-.1068**	+.0981**	-.1532*
HILL	-.0361*	-.0421*	-.0422*	+.1557*
UNDU	-.0082	+.1384**	-.0548**	+.0292
CLIF	-.0449*	+.0279	-.0243	-.0223
HERB	-.0414*	+.0195	+.0698**	-.1266
GRAS	+.1306**	+.0136	+.0992**	-.1934*
MELN	-.0356*	-.0643**	-.0770**	+.1560*
SUCC	-.1162**	-.0795**	-.0796**	+.2142**
BSHL	-.1472**	-.0421*	+.0070	-.0426
BSHH	-.1106**	+.0063	+.0107	-.0086
TREE	-.0564**	+.2870**	-.0168	-.0868
AGVE	-.0414*	-.0614**	-.0156	-.0041
CALH	+.8557**	-.0603**	-.0205	+.0319
RATR	-.0534**	+.8489**	-.0238	+.0847
MUSM	-.0475**	-.0042	+.0979**	-.0660
SFNI	-.0411*	-.0119	-.0233	+.3196**

* : $p < 0.05$; **: $p < 0.01$

Appendix IV

Criteria for a Red-list of Mammals adapted for the situation of Aruba.

Extinct on Aruba (EXA)

Species of which no viable population is left on Aruba.

Critical (CR)

Very rare species (presence < 1%), of which the number and/or the distribution since 1960 declined with more than 75%.

Endangered (EN)

Very rare species (presence < 1%), of which the number and/or the distribution since 1960 declined with 50 - 75%.

Vulnerable (VU)

Very rare and rare species (presence < 5%), of which the number and/or the distribution since 1960 declined with 25 - 50%,
and
rather rare species (presence 5 - 25%), of which the number and/or the distribution since 1960 declined with more than 25%.

Susceptible (SU)

Very rare species (presence < 1%), of which the number and/or the distribution since 1960 declined with less than 25%,
and
common species (presence ≥ 25%), of which the number and/or the distribution since 1960 declined with more than 50%,
and
bat species of which a limited number of roosts is known and that are not selected for one of the above mentioned categories.

Low Risk/Safe (LR)

Very rare species (presence 1 - 25%), of which the number and/or the distribution since 1960 declined with more than 50%,
and
common species (presence ≥ 25%), of which the number and/or the distribution since 1960 declined with less than 50%.

Appendix V

Gazetteer

The gazetteer is composed to give a clear indication about the localities on the island and a short description of the area. Each locality used in this paper is recorded in the gazetteer and vice versa. Each locality has block coördinates (fig. 30), but, some localities are so small and specific (e.g. caves) that several localities are located in one block.

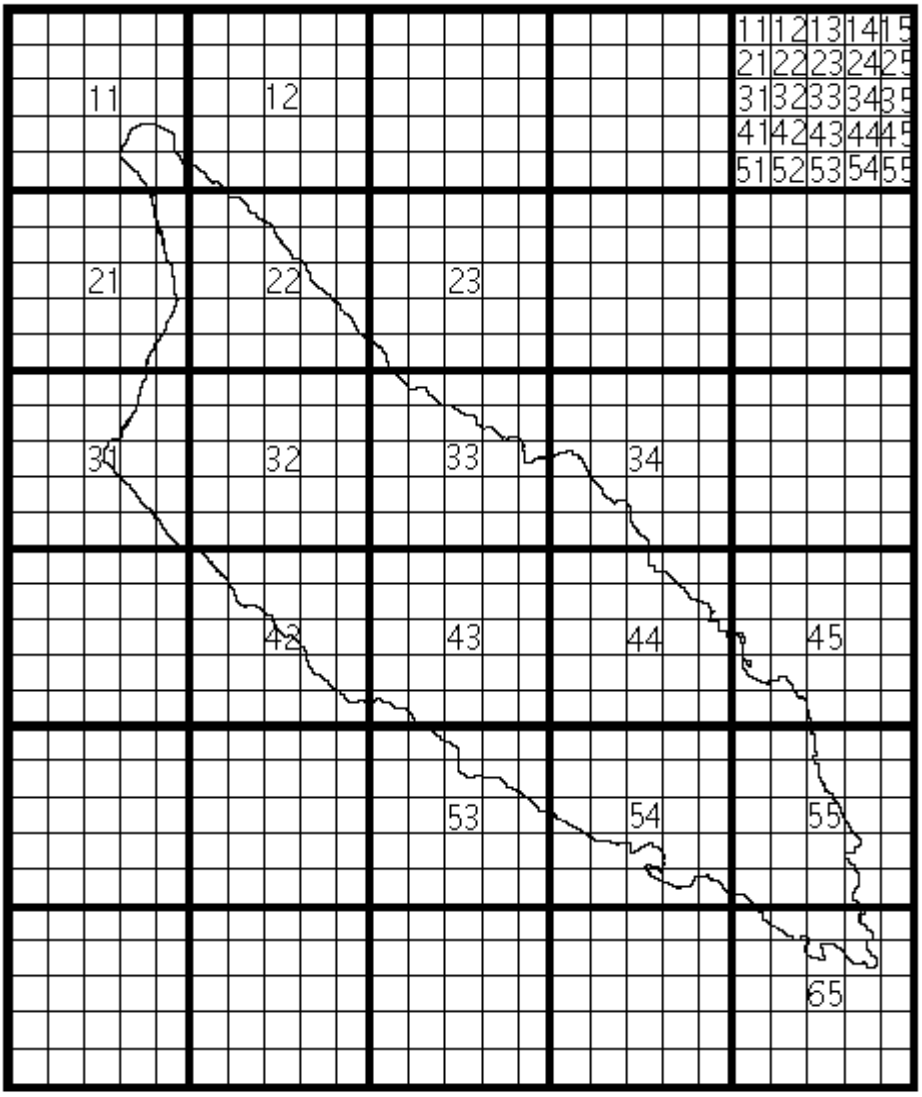

Fig. 30. Map with coördinates of Aruba used in this study.

Certain vaster localities lie in different blocks; for correct indication of the block differentiation is made by addition of N (= north), E (= east), S (= south) and W (= west) or combinations. If (recently) new big buildings (e.g. hotels) dominate blocks the name of that building is used for that block. Although there is a wide variety of the spelling of locality names, the names are used as they were described on the map consequently.

block	locality	description
42-23	Airport E	flat, grassy area nearby firestation;
42-22	Airport W	flat, sparsely grassy area nearby beach;
22-44	Alto Vista N I	light undulating cunucu area predominating with diorite boulders;
22-44	Alto Vista N II	light sloping area with diorite boulders and sparsely grassy in between;
22-53	Alto Vista W	flat cunucu area;
22-11	Anabui	cliff with low thornbushes;
32-35	Anana	open cunucu on hillside;
33-35	Andicuri NE	cliff nearby limestone cave;
33-45	Andicuri SE	cunucu on hill;
33-44	Andicuri SW	cunucu on hill near stonewall;
11-54	Arashi	green isle in arroyo/salina;
44-21	Arikok I	stone wall on hill in thin thornbush;
44-21	Arikok II	dense cunucu on hill with big diabase boulders;
65-23	Baby Beach	green isle in flat area;
43-52	Balashi	left-over next to industrial site;
55-53	Banki Jerome	undulating sandy dunes with low bushes;
44-35	Baranca Cashunti	cliff near baranca;
44-52	Baranca Cora	hilly area with sparsely vegetation;
43-42	Barcadera	arroyo lined with cunucu;
23-51	Block 23	green isle on hilly side;
22-45	Boca di Pos di Nord	flat area with sparsely grass
22-34	Boca Grandi	boulders on slope sparsely grass
33-13	Boca Mahos	sandy area on top of cliff near beach;
43-34	Boton	enclosure;
21-54	Bubali N	mangroves and grassy patches near seawedge drain-pipe;
31-14	Bubali S	seawedge beds surrounded by thick grass and high vegetation;
33-12	Budui	arroyo/salina with densely grass;
42-35	Buena Vista	cunucu;
33-23	Bushiribana	arroyo/salina with densely grass near cliff;
44-55	Butucu E	cunucu;
33-22	Cadushi	cunucu near dry tanki;
11-45	California	flat area with sparsely grass;
33-52	Casheru	arroyo with boulders in cunucu;
32-45	Casibari	cunucu near arroyo;
42-15	Canashito NE	limestone cave;
43-11	Canashito NW	cunucu on hill;
42-25	Canashito S	limestone cave near cunucu on hill;
42-12	Colegio Arubano	South-West wall of Colegio Arubano;
11-11	Cudarebe	rocky coastal area;
32-14	Cudawechi	slope of arroyo with diorite boulders and patches of cunucu;
32-53	Cumana	arroya alongside road with trees;
54-43	Cura Cabai	road in urban area and patches cunucu;
34-42	Daimaru	limestone cavern on sandy beach;
12-51	Druif NO	flat area with sparsely grass;
44-32	Du Chei	cunucu in hilly area;
55-41	Esso Heights	left-over in urban area;
44-35	Fontein	limestone cave;
55-32	Golfclub Road	left-over near chicken farm;
42-15	Hooiberg SW	cunucu at hillside;
43-11	Hooiberg SE	arroyo lined with cunucu;
32-55	Hooiberg NW	cunucu at hillside;
33-51	Hooiberg NE	cunucu in undulating area;
31-34	Hospitaal	thornbush on flat limestone area;
32-15	Hubada	cunucu at slope of hill
11-55	Hudishibana	cunucu limestone cliff;
32-25	Jaburibari	left-over near old chicken farm;

43-33	Jan Flemming	cunucu in undulating area;
44-31	Jamanota N	cunucu at hillside;
43-35	Jamanota NW	arroyo lined by cunucu;
43-45	Jamanota W	cunucu at hillside;
44-31	Jamanota quarry	abandoned goldmine quarry;
43-21	Jucuri	cunucu on hillside;
43-42	Kibaima	former aloe-plantation in transition to cunucu;
65-13	Lago Colony Cave	limestone cave;
65-13	Lago Colony	cunucu on limestone in between urban area;
55-52	Lago Heights	left-over in urban area;
54-45	Lago Ville	left-over in urban area;
55-31	Lourdes Cave	limestone cave;
43-22	Macuarima	left-over in urban area;
31-23	Manshebu	road-verge near drain;
54-23	Mabon	cunucu
31-45	Madiki	left-over in transition to cunucu;
21-14	Malmok	green isle near coast;
55-33	Manzania	limestone caves next to sandy dunes;
21-35	Marriot Hotel	flat area with high bushes and densely grass
43-45	Masiduri	abandoned plantation with tanki's, stonewall and trancheru's surrounded by cunucu;
33-33	Matogerai	area with sparsely grass separated by strips of cunucu;
33-33	Matidiviri	cunucu in between houses;
21-55	Mill	grass covered dyke near seawedge pond;
44-31	Mira Lamar	cunucu in hilly area with diabase boulders;
32-43	Modansa	dry, grassy tanki;
32-12	Montana	enclosure;
22-51	Montserat	arroyo with stagnant water, dense grass and lined by dense cunucu;
32-54	Morgenster	arroyo with dense grass, lined cunucu;
32-12	Noord S	strip of cunucu surrounded by grass near tanki;
32-51	Oranjestad Centre	urban area with houses of two stocks and scattered trees
32-52	Oranjestad E	left-over in urban area;
31-55	Oranjestad haven	grass topped cliff near coast in urban area;
21-45	Palm Beach	flat area with some trees, scattered bushes/cactusses and some patches with grass
32-42	Paramira	left-over in urban area;
65-24	Pet Cemetry	sandy dune with some low bushes and herbs;
33-51	Piedra Plat	cunucu in between urban area;
42-14	Plantersrust	former aloe-plantation in transition to cunucu;
32-32	Ponton	cunucu in urban area;
33-31	Porto Rico	cunucu on hill side;
31-25	Pos Abao	road-verge near cunucu;
53-35	Pos Grandi	sandy patch next to mangrove;
31-44	Punto Brabo	left-over between super markets;
45-41	Quadirikiri	limestone cave;
45-41	Quadirikiri Plains	flat area with sparsely grasses;
55-12	Rincon W	flat area with sparsely grasses;
55-13	Rincon E	flat area with sparsely grasses;
32-34	Roncado	left-over near crossing of road and arroyo;
43-33	Rooi Balashi	road verge next to chicken farm;
54-12	Rooi Cochi	trancheru next to tanki;
43-43	Rooi Franse Pas	arroyo lined with cunucu;
44-42	Rooi Juditi	arroyo on hillside;
32-52	Rooi Lagoen	arroyo edged with cunucu in urban area;
53-15	Rooi Lamoenchi	arroyo in former agricultural field;
44-34	Rooi Prins W	arroyo in former agricultural field;
44-35	Rooi Prins E	arroyo in former agricultural field;
43-54	Rooi Taki	arroyo/salina;

42-13	Sabana Blancu	cunucu;
42-23	Sabana Berde	cunucu in urban area;
43-43	Salina Balashi	arroyo/salina;
22-41	Salina Balashi	salina lined with mangroves;
43-12	San Cruz	left-over in urban area;
43-25	San Fuego	stonewall in cunucu in undulating area;
31-15	San Miguel	left-over near chickenfarm;
54-31	Savaneta W	left-over near playground;
54-32	Savaneta E	urban area with two-stock buildings;
54-41	Savaneta S	cunucu;
55-43	Seagrape Grove	sandy area next to limestone cliff with dense trees;
54-31	Seroe Alejandro	cunucu left-over in urban near house;
42-15	Seroe Bientu	former aloe-plantation on slope of hill with boulders;
44-32	Seroe Cabai	cunucu on hillside;
65-13	Seroe Colorado	cunucu on limestone;
33-32	Seroe Corobori	green isle on hillside;
22-12	Seroe Muskita	green isle on hillside;
54-21	Seroe Oliva	cunucu on hillside;
32-43	Seroe Patrichi	left-over in transition to cunucu;
22-54	Seroe di Pos di Noord	green isle in arroyo/salina;
54-11	Seroe Pretu	cunucu on hillside with boulders;
43-31	Seroe Tishi	former aloe-plantation in transition to cunucu;
32-54	Simonslust	green isle in arroyo;
55-42	Sabana Lodo	cunucu;
43-53	Spaans Lagoen	mangroves next to salina;
22-11	Tanki Cebuju	tanki in undulating cunucu;
32-21	Tanki Flip	grassy left-over in road-verge;
32-33	Tanki Lender	former plantation in transition to cunucu;
32-23	Tanki Salina	large tanki with undulating level;
22-22	Tanki Tres Cabes	dry tanki in cunucu;
21-15	Terra del Sol	green isle in cunucu;
22-21	Tibushi	green isles in cunucu;
45-51	Tunnel of Love	limestone cave;
45-52	Vader Piet NE	tanki in cunucu;
45-51	Vader Piet NW	cunucu near cliff;
55-12	Vader Piet SE	green isle in cunucu;
54-55	Village	green isle in urban area;
32-11	Washington	cunucu;
42-24	Wajaca	green isle in industrial site;
33-11	Warirurí	hillside without vegetation;
22-55	Wiriwari	green isle on slope of hill;
43-23	Wara Wara	cunucu on slope of hill dominated with boulders;
43-44	Wela W	cunucu in undulating area;
43-45	Wela quarry	abandoned quarry of goldmine;
21-25	Westpunt	left-over next to bungalows;
55-22	Zwarte Mangel W	stonewall in cunucu in undulating area;
55-23	Zwarte Mangel E	green isle on flat area with sparsely grass.