Observations on the habitat and ecology of the Hispaniolan Solenodon (*Solenodon paradoxus*) in the Dominican Republic

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The habitat of the Hispaniolan Solenodon (*Solenodon paradoxus*) was investigated in the Dominican Republic in relation to particular environmental parameters (geomorphology, geological structure, soil type, elevation, life zone, vegetation, rainfall, and temperature). Results are discussed in relation to relevant species-environment interactions, particularly habitat preferences and life history patterns of the species. Comparisons on the habitat, ecology and life history are made between *S. paradoxus* and the Cuban Solenodon (*S. cubanus*), the only other living member of the genus.

Keywords: Solenodon, Caribbean, Antilles, Ecology, Conservation Biology.

Observaciones sobre el hábitat y ecología del Solenodon de la Hispaniola (Solenodon paradoxus) en la República Dominicana.

El hábitat del Solenodon de la Hispaniola (*Solenodon paradoxus*) fue estudiado en la República Dominicana en relación a una serie de parámetros ambientales (geomorfología, estructura geológica, tipo de suelo, elevación, zona de vida, formación vegetal, precipitación, y temperatura). Las relaciones especie-hábitat son analizadas usando un modelo empírico descriptivo. Las observaciones sobre interacciones especie-medio ambiente resultantes son discutidas particularmente en relación a preferencias aparentes de habitat y a los patrones de historia natural de la especie. Se ofrecen comparaciones entre el habitat, ecologia y patrones de historia natural de *S. paradoxus* y el Solenodon Cubano (*S. cubanus*), el único otro miembro viviente del genero.

Palabras clave: *Solenodon*, Caribe, Antillas, Ecología, Biología de la Conservación.

Observacions sobre l'ecologia i l'hàbitat del Solenodon de la Hispaniola (Solenodon paradoxus) a la República Dominicana).

Es va estudiar l'hàbitat del Solenodon de la Hispaniola (*Solenodon paradoxus*) a la República Dominicana en relació a tota una sèrie de paràmetres ambientals (geomorfologia, estructura geològica, tipus de sòl, elevació, zona de vida, formació vegetal, precipitació i temperatura). S'analitzen les relacions espècie-hàbitat mitjançant un model descriptiu empíric. Es discuteixen les observacions sobre les interaccions espècie-ambient resultants particularment en relació a preferències aparents d'hàbitat i als patrons d'història natural de l'espècie. S'ofereixen comparacions entre l'hàbitat, l'ecologia i els patrons d'història natural del *S. paradoxus* i del Solenodon cubà (*Solenodon cubanus*), l'única altra espècie vivent del gènere.

Paraules clau: *Solenodon*, Carib, Antilles, Ecologia, Biologia de la Conservació.

Introduction

The Greater Antillean insectivores constitute the oldest assemblage among the known mammal fauna of the West Indies (MacPhee and Grimaldi, 1996; Hedges, 1996). The group once reached an extensive radiation in the region, that have been compared to that of the tenrecoid insectivores on the island of Madagascar (Patterson, 1962; Morgan et al., 1980; Eisenberg and Gonzalez, 1985), and their members are present in the recent fossil record of Cuba, Hispaniola, Puerto Rico and the Cayman Islands. Their radiation in the region includes two recognized families, Nesophontidae and Solenodontidae (Wilson and Reeder, 1993). The former comprises several extinct forms in a single genus, *Nesophontes*, and was the most widely distributed. The Solenodontidae contains four species in one genus, *Solenodon*, the only extant member of the Insectivora in the region, and perhaps the most peculiar of all West Indian mammalian genera. Two are extinct, *S. marcanoi* from Hispaniola and the much larger *S. arredondoi* from Cuba (Patterson, 1962; Ottenwalder, 1991; Morgan and Ottenwalder, 1993), whereas two living species, *S. cubanus* in Cuba and *S. paradoxus* in Hispaniola, are represented by relictual populations in Cuba, Dominican Republic and Haiti. Both species were apparently widely distributed in Cuba and Hispaniola during the Pleistocene and precolumbian Holocene. Today, the Cuban and Hispaniolan solenodons are critically endangered (IUCN, 1996; Ottenwalder, 1985, 1991), and have been included among the mammalian species with higher priorities for needed action to prevent their extinction (Thornback, 1983). They are permanently protected by law in the Dominican Republic and Cuba.

Little is known about the natural history and ecology of these two species, because of their rarity and secretive habits. First described by Brandt (1833), our present knowledge of the biology of *S. paradoxus* is still scanty. Published information about the habitat and distribution of *S. paradoxus* generally follows Miller (1929b) and Allen (1942), in describing these as "areas of stony forest" in the northeastern portion of the Dominican Republic (Westermann, 1953; Hall and Kelson, 1959; Pena, 1977; Hall 1981). Perhaps the most meaningful interpretation of the habitat of *S. paradoxus* from earlier reports is probably given by Findley (1967): "caves, burrows, and hollow trees, in rocky, wooded, hilly country". Similar data on the Cuban solenodon is equally scanty. Other than a paper by Eisenberg and González (1985) providing useful observations on the habitat and ecology of S. *cubanus*, from one mountainous site west of Baracoa in eastern Cuba, little information is available in the published literature.

The observations presented in this paper are part of broader studies conducted over a series of years on the systematics, ecology, and conservation biology of the genus *Solenodon* (Ottenwalder, 1985, 1991; Woods and Ottenwalder, 1992; Morgan and Ottenwalder, 1993; Ottenwalder and Woods, ms.; Ottenwalder and Rupp, ms; unpublished data). Furthermore, since no undisturbed populations could be located, no reliable estimates of natural densities are available to allow for correlation of relative abundance to particular habitat characteristics, and no attempt is made to claim definition of optimal and marginal habitats, but an approximation. The complexity of the habitat is important as a comprehensive environmental parameter in ecological studies but is difficult to reduce to a simplified meaningful index. Therefore, it is important to point out that for the purposes of this paper, species-habitat relationships are analyzed and discussed following a descriptive empirical approach. A more detailed paper, providing a larger sample size of sites and data sets as well as statistical testing of the findings, conclusions and speculations and their proposed implications as presented here, is under preparation.

The primary objective of this paper is to provide general information otherwise unavailable on the habitat and ecology of the Hispaniolan Solenodon, an insular endemic becoming increasingly endangered by development activities in the Dominican Republic, and on the brink of extinction in Haiti. Additional objectives are, to identify which habitat characteristics and environmental conditions seem more favorable considering morphological and ecological adaptations of Hispaniolan and Cuban Solenodons, and, to discuss ecological species-environment interactions and their implications to the natural history patterns, and expected responses to environmental constrains of their natural habitats.

Methods

The study of the habitat of *Solenodon* was primarily conducted on localities supporting extant populations throughout the Dominican Republic. Selection of these sites is supported by specimens, and direct observations of animals and/or their borrows and foraging tracks. Also included, although discussed separately, are localities where we obtained reliable reports with substantial evidence of their presence of Solenodons sighted, captured, or killed by people or dogs. Localities were identified primarily during countrywide field surveys conducted at irregular intervals since the mid-1970's, to search for extant populations, establish their conservation status and distribution, and gather observations on their ecology and natural history. A few historical localities were also included, when specific sites were accurately described and located from published reports and concluding evidence of the recent or past presence of the animal was unequivocal (e.g., museum specimens). In the later case, sites were included only if present day habitat conditions were not seriously disturbed.

Topographic maps (1:250,000) were used to pinpoint the areas and specific localities studied. Although surveys were concentrated in the areas determined to have high potential, interviews and search efforts were conducted during field trips to any other areas of the country whenever the natural vegetation and topography were appropriate. Areas were surveyed during the day to establish the extent and quality of the habitat and to search for *Solenodon* signs, such as foraging excavations on the soil surface; burrow entrances on the ground, at the base of stumps, fallen trees or crevices in rocks; tracks or trails around the base of rocky outcrops; fecal pellets; and remains of recently dead animals. During the night, direct observations were attempted whenever possible to verify the existence of presumed or persisting populations.

For each locality, we analyzed several sets of geological and ecological parameters. Localities were grouped by geomorphological region, geological structure, soil type, elevation, life zone, vegetation type, rainfall, and temperature. Edaphic factors, particularly soils characteristics, were examined in detail, considering their importance in relation to the food substrate and foraging methods of *Solenodon*. The soil resource inventory adopted is based on RPUs (Resource Production Unit), defined as a load unit sufficiently homogeneous with respect to agroecological factors of soil, climate, and water resources to be a reliable planning unit for resource policy analysis. It is based on two main components, soil resources and plant life zones. This system provides a hierarchy of classes that can be grouped to permit the most precise predictions possible about responses to management and manipulation (CRIES, 1978). Soil types in *Solenodon* localities were identified using a soil taxonomy map to subgroup level superimposed on a general topographic map (1:500,000).

In addition to data gathered in the field, the following information sources of were used in the development of the baseline data for analysis: a) site location and topography: panchromatic photo-maps 1:50,000 and 1:250,000 (U.S. Army Topographic Command, 1966-1970); b) geology and geomorphology: Mapa Geomorfológico, 1:500,000 (OEA, 1967), Mapa Geológico Preliminar, 1:250,000 (OEA, 1967), Bowin (1975); c) soils: Mapa de Asociaciones de Suelo, 1:250,000 (OEA, 1967), Soil Survey Staff (1975), CRIES (1977), Soil Taxonomy Map, 1:500,000 (Siedra, 1977); d) life zones: Mapa Ecológico (Holdridge classification), 1:250,000 (OEA, 1967); vegetation: Land Use and Vegetation, 1:250,000 (OEA, 1967), Forest Resources Technical Maps, 1:100,000 and 1:200,000 (FAO, 1973); e) temperature and rainfall: Mapa de Isoyetas, 1:500,000 (OEA, 1967), Oficina Nacional de Estadística (1979), Reyna and Paulet (1979); f) database modeling: OEA (1967, 1984), Hartshorn et al. (1981), Conant et al. (1983).

In designing the data sets of environmental parameters, and to standardize the compilation of data from localities throughout the country, we followed the geomorphological classification proposed in OEA (1967), which defines 20 bioregions, 27 subregions, and 132 well defined zones in the Dominican Republic. Under this hierarchical scheme, mountain chains, deposition basins, and coastal lowlands represent by themselves geomorphic regions with their own characteristics. These regions were classified under the four main physiographical divisions recognized for the Dominican Republic. Regions discussed will be restricted to those that are relevant to localities where *Solenodon* is known to be found (see Study Areas and Field Surveys). Results of the habitat survey are discussed in the following section, in clockwise direction, beginning with the northern division of the country.

Study areas and Field Surveys

The Dominican Republic (Fig. 1) shares with Haiti the island of Hispaniola, the second largest (77,914 km^2) of the Greater Antilles. Occupying the eastern portion, the Dominican Republic covers 48,442 km^2 (approx. two-thirds of the total area of the island), with 1,575 km of coastline and maximum distances of 390 km east-west and approximately 265 km north-south (Hartshorn et al., 1981). Despite its relatively small extension, the physiographic complexity of the Dominican Republic exhibits considerable heterogeneity and variability in local climatic regimes. This allows a variety of life zones and plant communities to exist, ranging from dry thorn scrub to mountain pine forest. The country lies in the subtropical hurricane belt, with geographical coordinates 1736'-1958' N and 6819'-7201' W. Its insularity and relative small area permit a strong marine influence to control the general climatic patterns. The subtropical environments range from extreme aridity in the valleys and coastal areas of the southwestern portion to the pluvial forest in the mountains and the lowlands of the northeast, an area exposed to the northeast trade winds. Annual rainfall is variable, ranging from 500 to 2700 mm, with two regular rainy seasons (April-June and September-November) and one dry season (December-March). Average annual temperature at sea level is 25°C.

The topography of the Dominican Republic is the highest of the Antilles. In marked contrast to the other West Indian islands, much of its physiography is characterized by

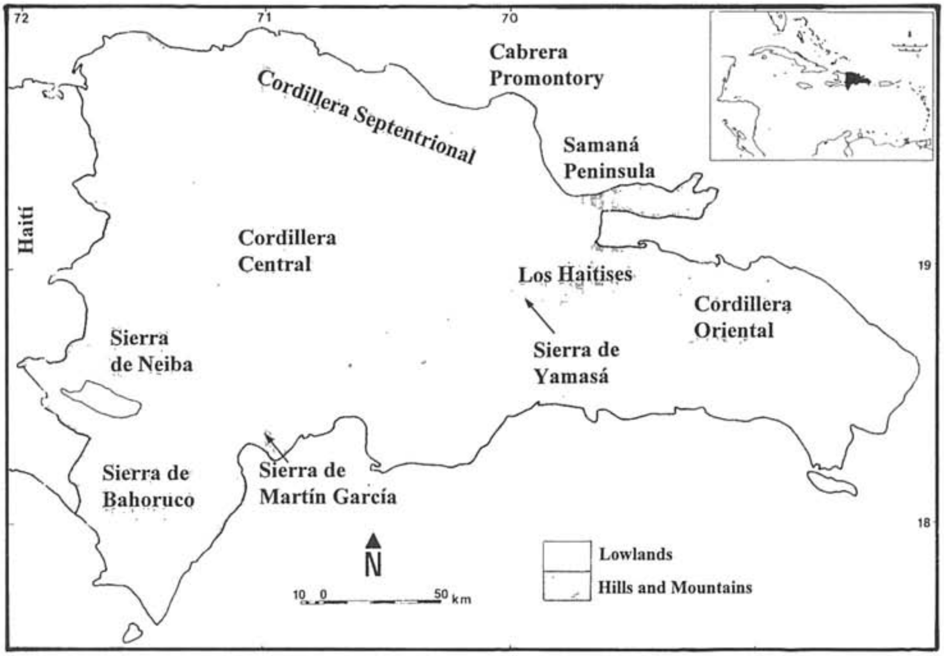

Figure 1. Relevant topographic features of the Dominican Republic. (Shown in inset location of country).
Figura 1. Trets topogràfics rellevants a la República Dominicana. A la casella es mostra la localització del país.

alternating valleys and mountain ranges. The general relief ranges from 35 m below sea level in the Enriquillo Basin to 3087 m above sea level in the Cordillera Central. The coastline of the Dominican Republic varies from sandy beaches to raised coral terraces with undercut cliffs facing the sea, and to steep mountainous slopes disappearing beneath the water. Inland, the terrain varies from wide nearly flat valleys to high rugged mountain ranges. Mountain systems and valleys show a marked parallelism as a result of strong faults and dislocations, a reflection of the island's complex geological history (Bowin, 1975; Draper, 1994, 1996, 1997). Hispaniola is particularly intriguing geologically because of four structural trends that converge upon it: (1) the main axis of the Caribbean island arc; (2) the southeastern part of the Bahamas; (3) the swell (Nicaragua Rise) extending from Central America to southwestern Hispaniola; and (4) the Beata Ridge

Physiographically, the country is characterized by four major mountain ranges: (a) the Cordillera Septentrional; (b) the Cordillera Central, the Sierra de Yamasa, and the Cordillera Oriental in the same axis; (c) the Sierra de Bahoruco; and (d) the Sierra de Neiba (Fig. 1). These ranges lie in a more or less parallel northwest-southeast trend. The four mountain chain system is intercalated with six main deposition basins and lowlands of which three, the Caribbean Coastal Plain, the South Peninsula of Barahona, and the occidental portion of the Cibao Valley, are the most important for this study.

Northern division

This division comprises the north portion of the country. Except for the Atlantic Coastal Plain, *Solenodon* habitat is found in the following regions of this division; the Promontorio de Cabrera, the Cordillera Septentrional, the Peninsula de Samaná, and in the Valle del Cibao.

A. Cordillera Septentrional (CS)

The northernmost Cordillera Septentrional extends parallel to the Atlantic coast from Montecristi to Nagua, approximately 200 km long and 40 km wide. Exposure to northeasterly tradewinds for more than half of the year causes abundant orographic rainfall over the north flank. The three highest elevations in the Cordillera Septentrional are, the central and eastern sections, Diego de Ocampo (1253 m), Monte Aguacate (1098 m), and Loma Quita Espuela (942 m). Recent specimens are known from Quita Espuela, and reports were obtained from lower elevations (ca. 300 m) north of San Francisco de Macorís. The geology of the Cordillera is characterized by tuffs and sedimentary rocks slightly faulted and folded. Also present are calcareous rocks, and some Miocene, Oligocene, and Eocene shales. A remarkable feature is represented by several highly elevated karst terraces in the central section, and near the coast are at least two hills of peridotite partially serpentinized. Also present are hills of rugged terrain formed by tuffs and calcareous rocks, with other volcanic and metamorphic rocks, mainly from the upper Cretaceous. No significant blocks of undisturbed forest remain on this cordillera due to widespread deforestation, although reduced natural forest fragments persist in some areas.

B. Cibao Occidental Valley (COV)

The Cibao Occidental Valley (approx. 110 x 40 km), lies between the Cordillera Septentrional and the Cordillera Central. It is characterized by alluvial deposits and hilly terrain with a slope average of 1.5 m/100 m. *Solenodon* distribution seems restricted to the southern boundaries of the valley, an elongated rocky zone dominated by hills and plateaus. Actual localities are known from south of the adjacent northern limits of the Cordillera Central in high hills formed by limestone, Miocene conglomerates, and schist. These elevations range from 450 m near Monción to 600 m around San José de las Matas, the best known *Solenodon* areas in the region. There are also historical records of animals captured in the northwesternmost end of the valley, an area of foothills southeast of Montecristi reaching 300-400 m elevation, located between upper Miocene rocks north of the Yaque del Norte River, and the Cordillera Septentrional. The geology of these hills consists of clay schist, limestone, and Miocene conglomerates.

C. Samaná Peninsula (SP)

The Samaná Peninsula (62 x 14 km) is an isolated low mountain range, separated from the Cordillera Septentrional by the alluvial deposits of the Rio Yuna, and one of the wettest areas in the country. Its western portion consists primarily of a Miocene karst limestone platform with maximum elevations of ca. 200-300 m. A limestone and conglomerate mountain ridge with elevations of up to 500 m is found to the south of the platform. The central part shows lower elevations conformed primarily by Cretaceous schists and marble. The northeast and southeast portions of Samaná consist of Cretaceous mountains of marble, that reach elevations of up to 564 m in the hill Laguna Salada. The lower parts usually consist of coastal reef limestone.

D. Promontorio de Cabrera (CP)

The Promontorio de Cabrera is a region of reef limestone characterized by somewhat horizontal strata on karst terrain, with a maximum elevation of 409 m in Loma de los Cocos. It is rectangular-shaped with a total area of 320 km^2.

Eastern division

The eastern portion of the country includes the regions of Los Haitíses, the

Coastal Plain of Miches and Sabana de la Mar, the Cordillera Oriental or Sierra del Seibo, Pie de Monte de la Cordillera Oriental, and the Caribbean Coastal Plain. Relative to the other major divisions, a larger number of *Solenodon* localities were detected in the eastern Dominican Republic, suggesting a more continuous distribution. This spatial pattern is more obvious throughout Los Haitises, Sierra del Seibo, and Pie de Monte de la Cordillera Oriental, which appear separated, although not necessarily isolated, from known existing populations in the Boca de Yuma area. Specimen samples per locality are comparable, ranging from 1 to 4 individuals, and reflect casual collecting.

E. Los Haitises (LH)

Los Haitises is the most striking geological region of the country due to its extensive karst topography (1600 km²) of more than 80 km long. Differential weathering of Oligocene-Miocene limestone have produced the characteristic "cockpit" or Kegelkarst (cone karst) limestone. Maximum elevations are usually from 200 m to 250 m. For the most part, the physiographic structure of the region consists in mature tropical karst, although some lowlands showing advanced karstic erosion can be found in its periphery. In addition to the specimens known from this region, fresh tracks have been found in several localities. The species is well known to the peasants living in the area, and their reports are numerous and consistent.

F. Coastal Plain of Miches and Sabana de la Mar (CPM)

The lowlands of the Coastal Plain of Miches and Sabana de la Mar are primarily lacustrine deposits of non-calcareous clay, including lagoons and marshes. The only records of solenodons in this region have come from areas southeast of Nisibon, which are characterized by coastal reef limestone and apparently more related geologically to Sierra del Seibo. Peasants and farm owners have reported, over a period of time, a number of animals captured during clear-cutting of the stony forest found at the ecotone of these two habitats.

G. Sierra del Seibo (SS)

Also known as Cordillera Oriental, the Sierra del Seibo (approx. 80 km) is found at the east end of the island. Its geology is characterized by folded and faulted volcanic tuffs, and by other volcanic rocks and limestone, presumably of upper Cretaceous age. Its maximum elevation reaches 879 m. To the east of the mountain ridge the formation is primarily composed of tuffs and other volcanic elements, the west portion of tuffs and limestone, and a third, smaller zone formed mainly by limestone. Some areas of serpentine are present east of El Seibo.

H. Pie de Monte de la Sierra del Seibo (PMSS)

This region extends along the south slopes of Sierra del Seibo for approximately 80 km, and varies from 8 km to 24 km wide. It presents a hilly terrain formed by volcanic tuffs in the higher parts, and some alluvial gravel with emerging tuffs in the valleys. *Solenodon* populations are found in several hills around the El Seibo area.

I. Caribbean Coastal Plain (CCP)

This region extends for approximately 240 km across seven different provinces along the southern coast of the country. *Solenodon* localities, however, are only known from La Altagracia Province in the easternmost portion of this region. The elevation gradient ranges from sea level to 70-100 m in its northern boundaries. At San Rafael de Yuma, the elevation is approximately 54 m. For the most part it is characterized by a series of terraces formed by coastal reef limestone and varies in width from 10 m to 40 m. *Solenodon* habitat remains within the limits of the Parque Nacional del Este, which includes within its boundaries the only undisturbed natural forest of this region.

Central division

This division comprises the massif of the Cordillera Central, its prolongation in the

Sierra de Yamasa, and the intramontane valleys of the Cordillera Central. The dominant feature of this division is its imposing and extensive topography, the highest in the Antilles.

J. Cordillera Central (CC)

The Cordillera Central is the cardinal mountainous system of the Dominican Republic and the whole of Hispaniola, occupying a significant superficial extension on central portion of the island. In addition to the Pico Duarte, the highest elevation in the West Indies (3087m), two additional peaks exceed 3000 m, and 22 others have altitudes over 2000 m. The geology of this mountain range is very complex. *Solenodon* is presumably present in many areas and there are a number of reports of solenodons in the range. Survey coverage was conservative, and most reports still await verification. The fact that only four recent specimens have been detected from the whole region is somewhat unexpected, and extensive surveys are required to locate presumed persisting populations. A number of recent *Solenodon* sites are known from the region. Two of these are of concern to this study. The area of El Mogote is characterized by plutonic igneous rocks, including peridotite partially serpentinized. In the lower slopes of Monte Nalga de Maco and foothills near Rio Limpio the dominant structure is represented by volcanic rocks and a metamorphic base. We examined photographs of two additional specimens recently taken in the Cordillera Central between Bonao and La Vega, but since the precise location was not available, it is not included in the analysis. Historically, a large number of specimens originated from the mountains surrounding the La Vega valley area. At present, the valley represents the region of major agricultural development in the country; however, observations made during aerial surveys suggest the possibility that small populations of *Solenodon* might still survive in isolated patches of forest scattered around La Vega.

K. Intramontane Valleys of the Cordillera Central (IVCC)

Four major valleys, Bonao, Altagracia, Constanza, and Jarabacoa, are confined to the elevations of the Cordillera Central. Of these, Jarabacoa (529 m) and Constanza (1190 m), are high mountain valleys. Jarabacoa is of structural, probable faulted origin, filled by deposition and alluvials, while Bonao and Villa Altagracia resulted from rapid erosion of the grano-diorite. In both, the soils are alluvial, with low hills of highly meteorized grano-diorite. There are historical records, including specimens, of the existence of *Solenodon* in the vicinity of the valleys. The natural forests of the slopes surrounding the valleys have been pointed out as the source of historical and recent *Solenodon* reports. No specimens are known to have originated from any of the valleys in recent years. The closest record being the specimen from El Mogote (Cordillera Central region), an elevation between La Vega and Jarabocoa.

L. Sierra de Yamasa (SY)

The Sierra de Yamasa is formed in its highest elevation (ca. 800 m) by volcanic rocks with some diorite, whereas its lower areas are characterized by faulted calcareous rocks with small areas of karst. The hills of this mountain range, which appear as a northeastern extension of the Cordillera Central, were inhabited by *Solenodon* in the past, but no recent records were obtained from this region. The Sierra represents the most important mining region of the country. Its topography and natural vegetation have undergone considerable modifications after decades of extensive open mining operations for ferronickel and gold.

Southwest Division

This division includes four major regions, the San Juan Valley and the Sierra de Neiba located north of the Valle de Neiba-Cul de Sac depression (north island), and south of the same depression, the Sierra de Bahoruco and the South Peninsula of Barahona (south

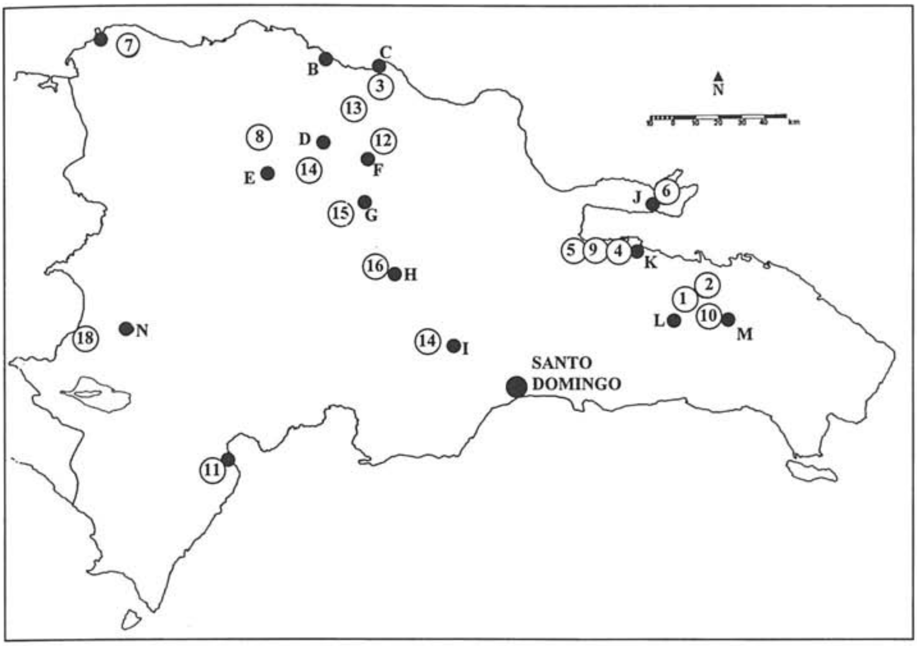

Figure 2. Historical records of *Solenodon* in the Dominican Republic (**open circles** with numbers - locality name and/or nearest approximation of record and source are given for each site). **Key:** 1= El Cajón (Allen, 1908); 2= La Honda (Allen, 1908); 3= near Sosua (Bridges, 1936); 4= Railroad cave, south coast of Samaná Bay (Miller 1929; indian kitchen middens); 5= Río Naranjo Abajo, south coast of Samaná Bay (Miller 1929; indian kitchen middens); 6= Río San Juan, Samaná Peninsula (Miller 1929; indian kitchen middens); 7= "foothills southeast of Montecristi (Miller 1929; indian kitchen middens); 8= La Cuesta [=Jaiqui Picado], between San Jose de Las Matas and Santiago (Mohr, 1936-38); 9= "neighborhood of Sabana de la Mar (Mohr, 1936-38); 10= "area of El Seibo" (Mohr, 1936-38); 11= "surroundings of Barahona" (Mohr, 1936-38); 12= Moca, Prov. Espaillat (Mohr, 1936-38); 13= Yásica, Prov. Puerto Plata (Mohr, 1936-38); 14= "southwest Sabana, Santiago area" (Wislocki, 1940); 15= "near la Vega" (Allen, 1942); 16= "foothills near Bonao" (E. de los Santos, J.M. Moronta, and other local collectors, pers. comm.); 17= "foothills near Villa Altagracia" (E. de los Santos, J.M. Moronta, and other local collectors, pers. comm.); 18= Rancho La Guardia, Hondo Valle (Patterson, 1962; fossil record, type locality for the extinct *S. marcanoi*). Major cities and towns in the proximity of historical records are indicated by solid circles. **Key:** A= Montecristi, B= Puerto Plata, C= Sosua, D= Santiago, E= San José de las Matas, F= Moca, G= La Vega, H= Bonao, I= Villa Altagracia, J= Samaná, K= Sabana de la Mar, L= Hato Mayor, M= El Seibo, N= El Cercado, O= Barahona.

Figure 2. Registres històrics de Solenodon *a la República Dominicana (cercles oberts amb nombres - per a cada indret es donen el noms de locaclitat i/o aproximació més propera del registre i la seva font). Clau: 1= El Cajón (Allen, 1908); 2= La Honda (Allen, 1908); 3= aprop de Sosua (Bridges, 1936); 4= Cova a la carretera, costa sud de la Badia de Samanà (Miller, 1929; femers d'indis); 5= Rio Naranjo, Abajo, costa sud de la Badia de Samanà (Miller, 1929; femers d'indis); 6= Rio San Juan, Samanà Peninsula (Miller, 1929; femers d'indis); 7= coster de colina al sudest de Montecristi (Miller, 1929; femers d'indis); 8= La Cuesta [= Jaiqui*

Picado], sentre San José de Las Matas i Santiago (Mohr, 1936-38); 9= proximitats de Sabana de la Mar (Mohr, 1936-38); 10= àrea de El Seibo (Mohr, 1936-38); 11= voltants de Barahona (Mohr, 1936-38); 12= Moca, prov. Espaillat (Mohr, 1936-38); 13= Yásica, Prov. Puerto Plata (Mohr, 1936-38); 14= sudoest de Sabana, àrea de Santiago (Wislocki, 1940). 15= aprop de La Vega (Allen, 1942); 16= coster de colina aprop de Bonao (E. de los Santos, J.M. Moronta, i altres recol·lectors locals, com. pers.); 17= coster de colina aprop de Villa Altagracia (E. de los Santos, J.M. Moronta, i altres recol·lectors locals, com. pers.); 18= Rancho La Guardia, Hondo Valle (Patterson, 1962; registre fòssil, localitat típica de l'extint S. marcanoi*). Les ciutats principals properes als registres històrics s'indiquen amb cercles sòlids. Clau: A= Montecristi, B= Puerto Plata, C= Sosua, D= Santiago, E= San José de Las Matas, F= Moca, G= La Vega, H= Bonao, I= Villa Altagracia, J= Samaná, K= Sabana de la Mar, L= Hato Mayor, M= El Seibo, N= El Cercado, O= Barahona.*

island). Probably because of their remoteness, the latter two might support some of the few remaining undisturbed populations of *Solenodon* in Hispaniola. However, it should be noted that these two regions have been more intensively surveyed.

M. San Juan Valley (SJV)

The San Juan Valley lies between the Cordillera Central and the Sierra de Neiba. Physiographically, it is similar to the Cibao Valley and has an extension of approximately 100 x 200 km. The bottom of the valley is found, in general, at 400-450 m. Volcanic structures and some limestone are found in slopes north of Las Matas de Farfan. Although actual specimens were not examined, consistent reports suggest the existence of small populations in the foothills of the Cordillera Central north of Las Matas de Farfan.

N. Sierra de Neiba (SN)

This region includes some peaks over 2,000 m of elevation. The geology of Hondo Valle, Loma El Hoyazo, and Angel Féliz is characterized by volcanic basaltic flow, sedimentary rocks, and limestone. Shifting agriculture for annual crops and massive replacement of the natural forest for plantations (coffee), has resulted in widespread environmental degradation of the region. This mountain range includes the type locality of the extinct Hispaniolan solenodontid *Solenodon marcanoi* (Patterson 1962). More frequent reports come from the north slopes of the range. We obtained fewer reports on the opposite side, where *Solenodon* appears to occur associated with remote patches of forest near the ridges.

O. Sierra de Bahoruco (SB)

The Sierra de Bahoruco (approx. 70 x 40 km) is a prominent mountain range, which continues in Haiti as the Massif de La Selle. Three peaks exceed elevations of 2000 m. It is characterized by an irregular geomorphology, with numerous blocks of faults on the north flank and wide marine terraces bordering the Caribbean coast. An ancient fossil lake is located in the elevations of the range, which is primarily formed by folded and faulted Eocene limestone. The underlying parent material in *Solenodon* localities is dominated by limestone with some sedimentary rocks. The species seem well distributed, though scattered, throughout the mountain range where favorable conditions exist, and particularly associated with patches of dense vegetation.

P. South Peninsula of Barahona (SPB)

The South Peninsula of Barahona is essentially a region of coastal reef limestone, formed between the Oligocene and Miocene,

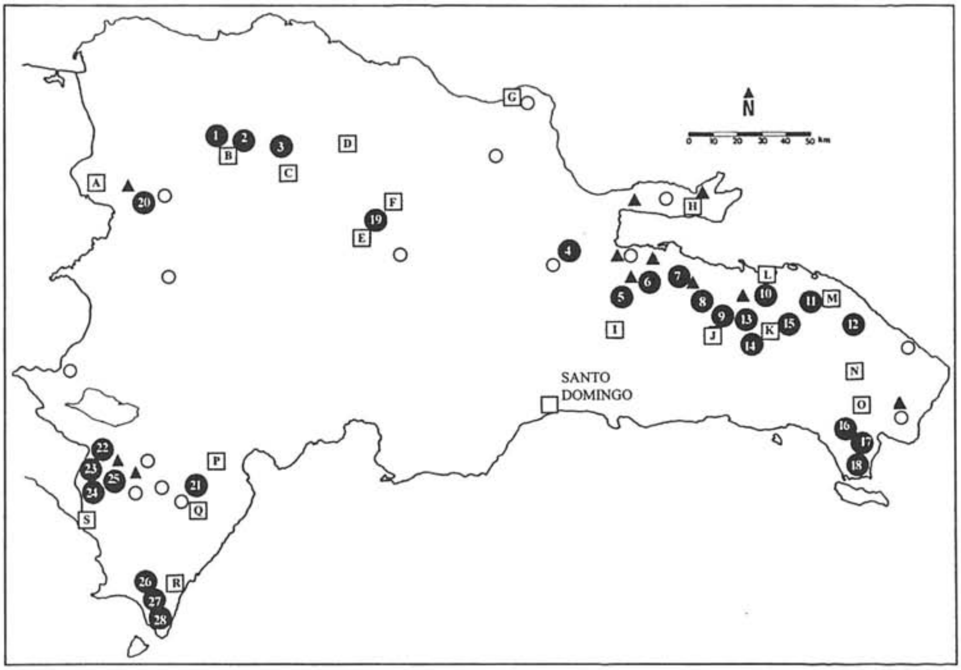

Figure 3. Geographic coverage of *Solenodon* localities sampled in the habitat analysis, indicating localities from where recent specimens were known and examined (**solid circles** - numbers refer to locality names listed in Table 5), localities with confirmed reports of existing populations at the time of the study (**open circles**), and localities where fresh tracks and other evidence were recorded (**solid triangles**). Major cities and towns in the vicinity or general area of study sites (**open squares**): A= Restauración, B= Monción, C= San José de las Matas, D= Santiago, E= Jarabaoca, F= La Vega, G= Río San Juan, H= Samaná, I= Bayaguana, J= Hato Mayor, K= El Seibo, L= Miches, M= Nisibon, N= Higuey, O= San Rafael de Yuma, P= Cabral, Q= Polo, R= Oviedo, S= Pedernales.

Figura 3. Situació geogràfica de les localitats de Solenodon *mostrejades en l'anàlisi hàbitats, indicant les localitats d'on es coneixen i s'han examinat especímens recents (cercles sòlids - els nombres es refereixen als noms de localitats llistats a la Taula 5), localitats amb registres confirmats de poblacions vivents en el temps d'aquest estudi (cercles buits) i localitats on s'han registrat traces recents i altres evidències (triangles sòlids). Ciutats i pobles principals en la proximitat o àrea general dels indrets d'estudi (quadrats buits): A= Restauración, B= Monción, C= San José de las Matas, D= Santiago, E= Jarabaoca, F= La Vega, G= Rio San Juan, H= Samaná, I= Bayaguana, J= Hato Mayor, K= El Seibo, L= Miches, M= Nisibon, N= Higuey, O= San Rafael de Yuma, P= Cabral, Q= Polo, R= Oviedo, S= Pedernales.*

characterized by a series of terraces shaped by the waves. An elongated band of low coastal reef limestone extends along most of the eastern coast of the Peninsula east of Oviedo. *Solenodon* sites appear more concentrated in areas of low hills and plateaux, with a maximum elevation of 200 m. These characteristics describe the dominant topography of the Peninsula, extending south and west of Oviedo.

Table 1. *Solenodon* distribution in Dominican Republic: number of localities visited and specimens examined per region.
Taula 1. Distribució de Solenodon *a la República Dominicana: nombres de localitats visitades i especimens examinats per regió.*

Major geographical division Geomorphologivcal region	Region code	No. of Localities	No.of Specimens	Other evidence
NORTH				
A. Cordillera Septentrional	CS	2	-	R
B. Cibao Occidental Valley	COV	3	29	R/T
C. Samana Peninsula	SP	3	-	R/T
D. Cabrera Promontory	CP	5	6	R/T
EAST				
E. Los Haitises	LH	4	3	R/T
F. Coastal Plain of Miches	CPM	-	-	R
G. Sierra del Seibo	SS	6	15	R/T
H. Pie de Monte de la Sierra del Seibo	PMSS	3	3	R
I. Caribbean Coastal Plain	CCP	4	4	R/T
CENTRAL				
J. Cordillera Central	CC	3	2	T/R
K. Intramontane Valleys Cordillera Central	IVCC	-	-	R
L. Sierra de Yamasa	SY	-	-	R
SOUTHWEST				
M. San Juan Valley	SJV	1	-	R
N. Sierra de Neiba	SN	1	-	R/T
O. Sierra de Bahoruco	SB	13	16	R/T
P. South Peninsula of Barahona	SPB	4	18	R/T

Other evidence: R -reports, T -tracks

Results

Field surveys results and geographic coverage of sites sampled for habitat analysis are presented both for historical (Fig. 2) and for recent records (Fig. 3). Historical records, all but two general areas identified through interviews with old collectors during our surveys, were obtained from published reports. With few exceptions, these records were not useful for habitat evaluations because of the lack of precision concerning the location of sites. In addition, kitchen middens and cave fossil material were also among these records, which might possibly involve transportation of specimens as food by Indians and owls. Therefore, historical sites were not included in habitat assessments. A total sample of 53 specific sites, supported by irrefutable evidence of recently extant populations (specimens examined, tracks recorded, and/or reliable reports), were investigated in habitat analysis. The number of sample sites for each environmental parameter weighed varied with data availability.

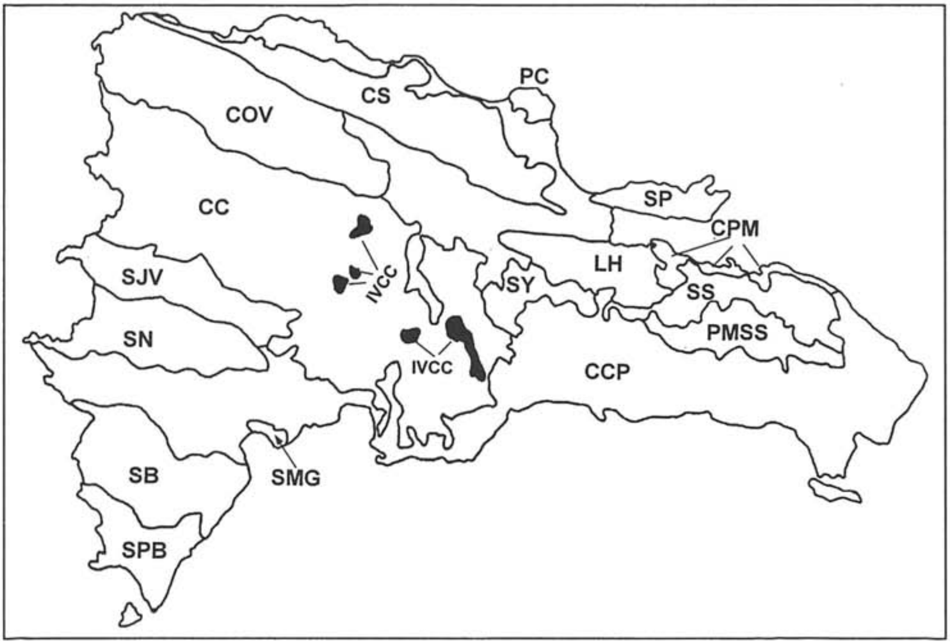

Figure 4. Biogeographic and physiographic regions relevant to *Solenodon* distribution in the Dominican Republic. **Key:** COV= Cibao Occidental Valley; CS= Cordillera Septentrional; CP= Cabrera Promontory; SP= Samaná Peninsula; LH= Los Haitíses; CPM= Coastal Plain of Miches and Sabana de la Mar; SS= Sierra del Seibo; PMSS= Pie de Monte de Sierra del Seibo; CCP= Caribbean Coastal Plain; CC= Cordillera Central; IVCC= Intramontane Valleys of the Cordillera Central; SY= Sierra de Yamasá; SJV= San Juan Valley; SN= Sierra de Neiba; SMG= Sierra Martín García; SB= Sierra de Bahoruco; SPB= South Peninsula of Barahona.

Figure 4. Regions biogeogràfiques i fisiogràfiques rellevants per a la distribució de Solenodon *a la República Dominicana. Clau: COV= Cibao Occidental Valley; CS= Cordillera Septentrional; CP= Promontori de Cabrera; SP= Península de Samaná; LH= Los Haitises; CPM= Plana Costanera de Miches i Sabana de la Mar; SS= Serra del Seibo; PMSS= Raiguer de la Serra del Seibo; CCP= Plana Costanera del Carib; CC= Serralada Central; IVCC= Valls intramuntanes de la Serralada Central; SY= Serra de Yamasá; SJV= Vall de San Juan; SN= Serra de Neiba; SMG= Serra Martín García; SB= Serra de Bahoruco; SPB= Península meridional de Barahona.*

Geomorphology and Geology

The distributional range of the Hispaniolan *Solenodon* appears to be consistently associated with particular geomorphological features. Landform, soil parent material, subsurface structure, topography, soil associations, climatic patterns, and life zones all influence the distribution of *Solenodon*. Geomorphological regions found supporting *Solenodon* populations and habitat are indicated in Figure 4. The distribution of locations, specimen samples, and reports within each physiographic region is shown in Table 1. Geological characteristics of *Solenodon* habitats are summarized in Table 2 (sample of localitites from where specimens are known) and Table 3 (sample of localities from where tracks and confirmed reports of the animal were recorded).

Table 2. Geologic features in a sample of *Solenodon* localities (specimen-supported data)
Taula 2. Tres geològics d'una mostra de localitats amb Solenodon *(documentades sobre especimens).*

Geologic structure(a)	Geomorphic region	Number of localities	Percent of total
Limestone, metamorphic volcanic rocks	COV	2	7.1
Acid metamorphic rocks, limestone	COV	1	3.6
Karstic limestone (UT)	LH	3	10.7
Undifferentiated limestone (C), and volcanic rocks	SS	4	14.3
Volcanic tuffs (C), and serpentine	SS, PMSS	5	17.8
Rocks (Q), coastal reef limestone, gradual inland transition to clastic deposits	CCP	3	10.7
Plutonic igneous rocks, peridotite partially serpentinized	CC	1	3.6
Volcanic rocks, metamorphic base	CC	1	3.6
Sedimentary rocks and limestone (LT)	SB	4	14.3
Undifferentiated limestone (UT)	SB	1	3.6
Coastal reef limestone (UT), and sedimentary rocks (E)	SPB	3	10.7

Sources: a - Bowin (1975), OEA (1967). Geologic structure: C - Cretaceous, E - Eocene, Q - Quaternary, T - Tertiary, L - Lower, U - Upper. Geomorphic region: same as Table 1.

Elevation

General topographic features for all physiographical regions relevant to the historical or recent distribution of *Solenodon* are presented in Table 4. Of all 14 regions, only five have maximum elevations over 1000 m, and recent specimens have been obtained in only two. The maximum elevation among the nine remaining regions is 879 m. Recent specimens are known from at least eleven of these regions. Data from 27 site-specific localities from where specimens have originated (Table 5), indicate an estimated average elevation of 271.8 m with a range of 20-800 m. The elevation sample data suggests that the majority of known *Solenodon* populations occur at moderate elevations. This might be related both to the fact that surveys were conducted more frequently below 1000 m, and by the massive human intervention of the natural habitats at mid-elevations, which are more favorable for agriculture. The single most important source of known recent *Solenodon* specimens are of animals that were found dead (killed by dogs or peasants) or alive in the proximity of human settlements. Chances are indeed much higher for the secretive *Solenodon* to be detected, identified and even kept, near human habitation by people aware of the rarity of the animal. Although no specimens from higher elevations were examined, we obtained reliable reports of the presence of solenodons up to 1500 m, and according to some informants, their vertical range might reach 2000 m (Table 6). The lowest elevation at a particular locality was 5 m.

Table 3. Geologic features of *Solenodon* localities (based on reliable reports and tracks)
Taula 3. Trets geològics de localitats amb Solenodon *(basades en informes verosimils i traces).*

Geologic structure(a)	Geomorphic region	Number of localities	Percent of total
Volcanic rocks, tuffs periodite, serpentine (C)	CS	1	5.5
Karst limestone	SP, LH	4	22.2
Metamorphic limestone	SP	1	5.5
Volcanic tuffs (C)	SS	1	5.5
Coastal reef limestone (Q)	CCD	1	5.5
Volcanic rock, metamorphic base	CC	1	5.5
Volcanic basaltic flow	SN	1	5.5
Sedimentary rocks and limestone (LT)	SN, SB	5	27.8
Undifferentiated limestone (T)	SB	2	11.1
Sedimentary rocks and coastal reef limestone (UT)	SPB	1	5.5

Sources: a - Bowin (1975), OEA (1967). Geologic structure: C - Cretaceous, E - Eocene, Q - Quaternary, T - Tertiary, L - Lower, U - Upper. Geomorphic region: same as Table 1.

Table 4. Topographic features of major physiographical regions.
Taula 4. Trets topogràfics de les principals regions fisiogràfiques.

Geomorphic region	Elevation (m) Average	Maximum	Recent specimens
CS	600	1249	
COV	80	563	*
SP	400	605	
LH	200	485	*
SS	450	879	*
PMCS	-	500	*
CCP	60	138	*
CC	1800	3087	
IMVCC	767	1164	
SY	-	856	
SJV	350	460	
SN	1000	2279	
SB	1100	2367	*
SPB	60	400	*

Geomorphic region: same as in Table 1.

Table 5. Localities from where *Solenodon* specimens examined in the study have been obtained, indicating elevation of collecting site and number of specimens salvaged.
Taula 5. Localitats d'on procedeixen especimens de Solenodon. *S'indica l'altitud de l'indret de recol·lecció i el nombre d'especimens obtinguts.*

Site Number on map	Region and locality	Estimated elevation (m)	Number of specimens
	CIBAO OCCIDENTAL VALLEY (COV)		
1	Loma el Cacique, Moncion	330	1
2	Arroyo de Agua, Moncion	360	4
3	Jaiqui Picado, S.J. Matas	520	24
	LOS HAITISES (LH)		
4	5 km S Guaraguao	130	1
5	Hidalgo, Bayaguana	250	1
6	Monte Bonito, El Valle	361	1
	SIERRA DEL SEIBO(SS)		
7	Loma El Cabao, El Cabao	100	1
8	Guamira, Hato Mayor	190	2
9	Manchado, Hato Mayor	190	4
10	near head Rio La Piedra, 13 km S. Miches	150-300	4
11	La Cibita, Nisibon	100	1
12	Las Canas, Nisibon	≤100	3
	PIE DE MONTE DE SIERRA DEL SEIBO (PMSS)		
13	Magarin, El Seibo	150	1
14	Candelaria, El Seibo	≥100	1
15	Monte near El Seibo	-	1
	CARIBBEAN COASTAL PLAIN (CCP)		
16	San Rafael de Yuma	70	1
17	Boca de Yuma	60	1
18	near Punta Caleton Hondo	20	1
	CORDILLERA CENTRAL (CC)		
19	El Mogote, La Vega	575	1
20	Pico Nalga de Maco, Rio Limpio	≥800	1
	SIERRA DE BAORUCO (SB)		
21	Los Naranjos, 4 km SO Cabral	400	1
22	Las Cruces - Aguacate	700	1
23	Mencia, Pedernales	500	5
24	Azucena - Avila, Pedernales	300-420	6
25	Las Mercedes, Cabo Rojo	420	3
	SOUTH PENINSULA OF BARAHONA (SPB)		
26	Fondos de Ansamona, Oviedo	≥100	1
27	La Plena, Oviedo	160	4
28	Bucan de Tui-Bucan Isidro	60-80	13

Table 6. Frequency distribution of collected specimens and collecting localities by elevation range.
Taula 6. Freqüència de distribució dels especímens recol·lectats i de les localitats de recol·lecció segons l'altitud.

Elevation range (m)	Speciments collected	Number of localities With specimens	Number of localities Other evidence
<100	16	4	*
100-200	18	10	*
200-300	7	2	*
300-400	10	4	*
400-500	5	2	*
500-600	30	3	*
600-700	-	-	*
700-800	1	1	*
800-900	1	1	*
900-1000	-	-	*
1000-2000	-	-	*
>2000	-	-	-

Table 7. Soil taxonomy in *Solenodon* localities analized
Taula 7. Taxonomia dels sòls a les localitats amb Solenodon *analitzades.*

ORDER	Soil subgroup (a)	Symbol	No. of localities Total	Spec	Other
INCEPTISOLS	Lithic Eutropets	ITEg K/LS	6	3	3
	Lithic Eutropets	ITEs M/LSS	6	2	4
	Lithic Ustropepts	ITUa RH/LSS	5	3	2
	Lithic Ustropepts	ITUs RH/T	4	4	-
	Lithic Dystropepts	ITYf S/T	4	3	1
	Lithic Ustropepts	ITUs M/LSS	3	1	2
	Lithic Dystropepts	ITYs M/RB	2	1	1
	Lithic Dystropepts	ITYs S/RB	1	-	1
	Lithic Eutropepts	ITEs RH/LSS	1	-	1
ENTISOLS	Skeletal Lithic Torriorthents	EOHck UR/LS	7	5	2
	Lithic Udorthents	EOUdk UR/LS	4	3	1
ULTISOLS	Typic Tropudults	UDTa RH/T-ITYf S/T	2	2	-
VERTISOLS	Typic Pellusterts	VUPa L/LS	1	1	-
ARIDISOLS	Typic Camborthids	DOAa RH/LSS	1	1	-

Sources: a - CRIES (1977), USDA (1975).
Note: Spec - Specimens, Other - Other Evidence

Table 8. Features and properties of soils in *Solenodon* localities sampled.
Taula 8. Trets i propietats dels sòls a les localitats amb Solenodon *mostrejades.*

Soil Subgroup	No.	GR	Soil parent material	Slope (%)	Depth to bedrock (m)	Soil texture	Coarse fragment	Permeability	Reaction/ salinity	Water capacity	Flooding risk	Drainage	% Base saturation
DOAa Rh/LSS	1	SB	LS, and other C, Si	8-30	0.5-1.0	Mod. fine	Stony	Mod. slow	Mod-ALK Non-SAL	Low	None	Excess drained	calcareous
ITYs S/RB	1	SP	RB	>30	0.2-0.5	?	Stony	Mod. slow	Strong AC Non-SAL	Very low	None	Well drained	<50
ITYf S/T	4	SS CC	VT	>30	0.2-0.5	Mod. fine	Stony	Mod. slow	Strong AC Non-SAL	Very low	None	Well drained	<50
ITYs M/RB	2	CC	RB, some SE[d]	>30	0.1-0.5	Mod. fine	Stony	Mod. slow	Strong AC Non-SAL	Very low	None	Well drained	<50
ITUs M/LSS	3	SB	LS*, some C, Sd, Sh	>30	0.2-0.5	Mod. fine	Stony	Mod. slow	Mod-ALK Non-SAL	Very low	None	Excess drained	Calcareus
EOHck UR/LS	7	SB PSB	LS coastal reef	3-15	0.1-0.5	Mod. fine	Extremely stony	Slow	Mod-ALK Non-SAL	Very low	None	Excess drained	Calcareus
ITUs RH/T	4	CC PMSS	VT	8-30	0.2-0.5	Mod. fine	Stony	Mod. slow	Med-AC Non-SAL	Low	None	Well drained	>50
ITEg K/LS	6	PS LH	LS[b]	30->100	0.1-0.5	Mod. fine	Non stony	Mod. slow	Mild-ALK Non-SAL	Very low	None	Excess drained	>50
ITUa RH/LSS	5	COV SN	LS*, some Sh, Sd, T, St	15->30	0.2-0.5	Mod. fine	Stony	Mod. slow	Mod-ALK Non-SAL	Very low	None	Poorly drained	Calcareus
EOUdk UR/LS	4	CCP	LS: coastal reef	3-15	0.1-0.5	Fine	Extremely stony	slow	Mod-ALK Non-SAL	Very low	None	Excess drained	>50
ITEs M/LSS	6	CN SNsb	LS*c	>30	0.1-0.5	Fine	Stony	Mod. slow	Mod-ALK Non-SAL	Very low	None	Well drained	Calcareus
UDTa RH/T-ITYf S/T	2	SS	VT	>30	0.2-0.5	Fine	Stony	Mod. slow	Strong AC Non-SAL	Very low	None	Well drained	<50
VUPa L/LS	1	CCP	LS, coastal reef	3-15	0.2-0.5	Fine	Non stony	Slow	Mild ALK Non-SAL	Very low	None	Well drained	>50
ITEs RH/LSS	1	SP	LS*, other C, SE[e]	8-30	0.2-0.5	Mod. fine	Stony	Mod. slow	Mod-ALK Non-SAL	Very low	None	Well drained	Calcareus

Sources: CRIES (1967) DEA (1967), Bowin (1975). Soil Subgroup: symbols as in Table 7. Location: No.- number of localities, GR, - geomorphic Region, same as in Tables 3, 4, and 5. Soil parent material: (C) calcareous rocks; (LS) limestone; (SE) serpentine; (Sd) sandstone; (Sh) shale; (St) schist; (Si) sedimentary rocks; (RB); mixed acid and basic igneus and metamorphic rocks; (T) tuff; (TV) volcanic tuff. b - marble east and north of Samana, also some serpentine; c - with lesser armounts of calcareous sandstone and shale, shist and tuff; d - minor areas of serpentine near Bonao and Cabrera; * - dominant structure. Soil texture: mod-moderately. Permeability: mod-moderately. Reaction/salinity: (ALK) alkaline; (AC) acid; (SAL) saline; mod-moderately; med-medium; strong-strongly. Soil drainage: excess-excessively.

Table 9. Available temperature and precipitation data in the proximity of *Solenodon* areas.
Taula 9. Dades disponibles de temperatura i precipitació a les proximitats de les àrees amb Solenodon.

			Temperature (°C)[a]					Rainfall (mm)[a]			
			Annual average			Absolute		Annual total rainfall			
Location	Elevation (m)	Years of data	Mean	Max	Min	Max	Min	Mean	Max	Min	Rain days/ year
Hondo valle	890	18	21.2	29.1	13.5	35.0	0.0	2,299.2	4,241.6	1,166.4	147.5
El Cercado	732	22	21.6	27.5	15.8	37.2	6.0	1,069.0	1,603.9	782.0	84.3
Polo	703	27	23.1	30.3	16.0	40.0	5.0	2,269.2	4,241.6	1,166.4	147.5
Restauración	594	30	25.1	31.7	18.7	39.5	7.2	1,890.2	4,469.2	715.9	94.9
Jarabacoa	529	9	22.0	27.8	16.3	36.0	7.0	1,466.1	2,217.3	877.4	132.4
S. J. Matas	523	9	24.1	30.3	18.5	38.8	18.8	1,253.4	1,928.7	750.2	104.1
Moncion	366	39	23.8	29.8	17.8	40.0	8.0	1,268.1	2,026.8	752.9	93.1
El Seibo	107	9	26.7	32.8	20.6	40.6	11.5	1,307.7	1,944.2	647.0	120.6
Higuey	106	8	26.3	30.3	22.3	39.0	13.0	1,328.9	1,877.0	704.1	128.0
Hato Mayor	102	21	26.7	32.8	20.5	39.0	10.4	1,542.0	2,118.6	990.4	97.0
La Vega	100	39	26.3	31.1	21.5	40.5	12.0	1,457.4	2,625.8	728.6	108.3
S. R. Yuma	54	12	27.1	32.3	21.8	38.5	14.0	1,344.3	2,015.3	769.6	152.3
Samaná	7	38	26.5	31.0	21.9	39.2	12.0	2,249.8	-	-	171.7
R. S. Juan	4	21	26.3	38.8	21.8	38.4	15.0	1,684.5	2,355.0	830.7	145.2
Oviedo	3	5	25.4	29.6	21.2	38.8	13.8	855.1	1,040.0	597.1	72.4
Mean			24.8	31.0	19.2	38.7	9.6	1,520.8	2,388.5	796.1	117.1

Source: Reyna y Paulet (1979)

Soils

The Dominican Republic has a great variety of soils. CRIES (1979) has identified 37 soil units, using USDA (Soil Survey Staff, 1975) soil taxonomy denominations. We found 14 soil units or subgroups (Table 7) represented in a sample of 47 *Solenodon* localities (29 with known specimens, plus 18 additional sites based on reports and/or tracks). At the order level, soils from 32 localities and 64.3 percent of all soil subgroups proved to be Inceptisols. Other soil orders represented are, in order of importance, Entisols. Ultisols, Vertisols, and Aridisols. A data set matrix scrutinizing the 47 localities sampled in relation to soil types, properties, and features is presented in Table 8.

Limestone was the dominant underlying soil parent material in nine (65%) of the 14 subgroups identified. The slope of the terrain is predominantly steep, averaging 25.1 percent, with a range varying from 3 percent in the coastal plain to >100 percent (very steep) in high mountain ranges. Soil depth is consistently shallow, with bedrock close to the surface. Average depth was 0.35 m, with a

Table 10. Frequency distribution of *Solenodon* localities sampled according to life zones.
Taula 10. Distribució de frequències de les localitats amb Solenodon *mostrejades segons les zones vitals.*

Region	SDF	(D/M)	SMF	(M/W)	SWF	SLMMF	SLMWF
	Life zone						
CS					1		
COV	2	1			1		
SP			3		2		
LH							
SS			2		3		
PMSS			3				
CCP	1	2	4				
CC					2	1	
SN					2		
SB		1	5	1	1	1	1
SPB		2					
Total percent	7.1	14.3	40.5	2.4	28.6	2.4	4.8

Region: Region names as in Table 1. Life zones: SDF - Subtropical dry forest; D/M - Transition between Subtropical dry to moist forest; SMF - Subtropical wet forest; M/W - Transition between Subtropical moist to wet forest; SWF - Subtropical wet forest; SLMMF - Subtropical lower montane moist forest; SLMWF - Subtropical lower montane dry forest.

range of 0.1 to 1.0 m. Notably, 11 (78%) soil units fall among the lithic (truncated by hard rock, shallow, or intermittent between rock outcrops) subgroups. It is obvious in the field how bare rocks are frequently exposed for extensive areas on the surface, and the soil is usually accumulated in solution holes of varying depths. The texture of the soil is almost invariably moderately fine and in a few cases fine. With the exception of two subgroups, involving seven localities, stoniness was the rule, and coarse fragments were extremely stony in some localities. Permeability is low to moderately slow. The reaction of the soils ranged through varying degrees of acidity and alkalinity, while all soil units are invariable non-saline. The available water capacity is predominately low or very low. Because of the steep topography, rainfall runoff in *Solenodon* areas is fairly rapid and flooding risk is low in all sites analyzed. With the exception of one subgroup, all soils are considered well to excessively drain.

Temperature

Data from 15 selected meteorological stations, the closest in each area to *Solenodon* localities, are shown in Table 9. Elevation of these stations ranged from 3 to 890 m. Annual average mean recorded temperature varied from 21.2°C at 890 m to 27.1°C at 54 m, with a total mean of 24.8 °C. Annual average maximum ranged from 27.5°C to 38.8°C, with a mean temperature for all stations of 31.0°C. The mean of the minimum annual averages in these localities is 19.2°C, with the lowest in Hondo Valle (13.5°C) and the highest in Higüey (27.3°C). An absolute maximum of 40.6°C has been recorded in El Seibo, with a mean of 38.7°C for all stations. Absolute

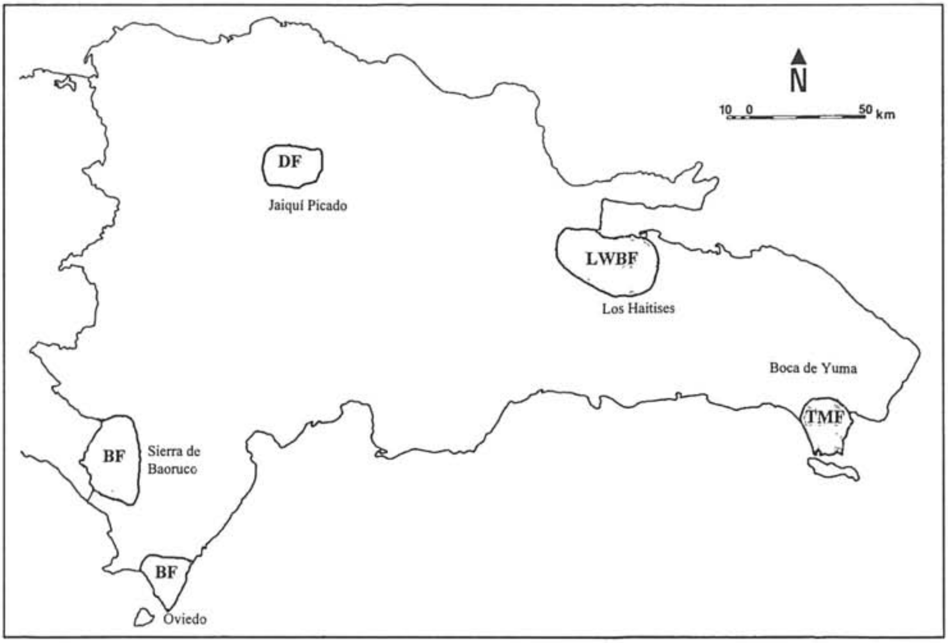

Figure 5. Representative sample of forest types in selected *Solenodon* areas. **Key:** DF= dry forest (Jaiquí Picado, San José de las Matas); BF= *Bursera* forest (Oviedo, Pedernales); TMF= transitional moist forest (Boca de Yuma, Altagracia Prov.); LWBF= Wet broadleaf forest at low elevation (Los Haitíses); BF= broadleaf forest formations along an elevational gradient (Sierra de Bahoruco).

Figura 5. Mostra representativa de tipus de boscs a àrees seleccionades amb Solenodon. *Clau: DF= Bosc sec (Jaiquí Picado, San José de Las Matas); BF= Bosc de* Bursera *(Oviedo, Pedernales); TMF= Bosc transicional humid (Boca de Yuma, Prov. Altagracia); LWBF= Bosc humid de fulla ampla a baixes altituds (Los Haitíses); BF= Formacions boscoses de fulla ampla al llarg d'un gradient altitudinal (Sierra de Bahoruco).*

minimum temperatures varied from zero degrees in Hondo Valle (890 m) to 18.8°C in San Jose de las Matas (523 m), with a mean of 9.6°C.

Precipitation

Rainfall follows a predictable pattern in most localities analyzed (Table 9). Mean annual precipitation records from 15 stations ranged from 2349.8 mm in Samaná (5 m elevation on the northeast coast) to 855.1 mm in Oviedo (3 m elevation on the southwestern coast), with a total mean of 1520.8 mm. Maximum and minimum annual rainfall records for the localities are respectively 4469.2 mm in Restauración at 594 m (records from Samaná are not available, but are probably higher) and 597.1 mm in Oviedo. Average maximum and minimum annual total rainfall in these stations are 2388.5 mm and 796.1 mm respectively. The number of days with rain per year fluctuated from 171 to 72.4 days. Samaná is the area with most frequent precipitation, while Oviedo has the lowest

Table 11. Frequency of dominant vegetational formations in *Solenodon* localities sampled (n= 25).
Taula 11. Freqüència de les formacions vegetals dominants a les localitats amb Solenodon *mostrejades (n= 25).*

Number of Locations	Vegetation type
2	Mixed pine-broadleaf
7	Broadleaf, mild-elevation (500-900 m)
10	Broadleaf, lower elevation (0-500 m)
4	Bursera forest
2	Dry forest

periodicity. The mean number of rainy days per year in these localities is about 117.1 days, and only four areas have less than 100 days with rainfall annually: Restauracion (94.9), Hato Mayor (97), Monción (93.1), and Oviedo (72.4).

The clinal distribution of *Solenodon* in Sierra de Bahoruco, across a gradient from Pedernales at the base of the south slopes and Duverge on the north side and at the edge of the desertic Valley of Nieba, appears to be closely associated with the amount of annual rainfall. The isohyet of 750 mm is below the lowest elevation (195 m) at which any specimen of *Solenodon* has been captured on the south slope of Sierra de Bahoruco. At higher elevations, particularly in mountain ridges above 1500 m, the habitat quality decreases (i.e. extremely shallow soils and extreme humidity and temperature), and the cost of survival probably becomes increasingly expensive. On the north slope of Bahoruco, the specimen obtained at the lowest elevation (about 700 m) was found between Aguacate and Puerto Escondido, again above the 750-mm isohyet. In general, the rainfall regime of most *Solenodon* areas is between 1000 mm and 2000 mm with the exception of the localities in the South Peninsula of Barahona, (under 1000 mm).

Life zones

Populations of Hispaniolan solenodon were found utilizing at least five different life zones regions (Table 10), from subtropical dry forest to subtropical lower montane wet forest. About 86 percent of the localities is in transitional moist forest (14.3%), subtropical moist forest (40.5%) and subtropical wet forest (28.6%).

Subtropical dry forest. This is the second most extensive life zone in the Dominican Republic occurring up to 800 m in elevation and corresponds with the distribution of *Solenodon* in the Cibao Occidental Valley. Total annual rainfall is about 500-1000 mm. Characteristic species of this life zone are *Acacia, Guaiacum, Prosopis, Bursera, Phyllostillon, Plumeria, Sabal,* and *Swietenia.* Two of the *Solenodon* areas included in this study, Boca de Yuma in the Caribbean Coastal Plain, and the block of forest south of Oviedo in the South Peninsula of Barahona, are found in large transitional extensions of subtropical dry to moist forest. Small transitional areas of subtropical moist forest occur also on the lower foothills of the Sierra de Bahoruco due to orographic rainfall and slightly cooler temperatures.

Subtropical moist forest. This life zone covers almost half of the country, including areas in the Caribbean Coastal Plain, foothills of the Cordillera Central below 850 m, and on the low foothills of the Sierra de Bahoruco. Rainfall (mean annual of 1000-2000 mm) generally occurs in two peaks over a 9-month period. The natural vegetation is a well-developed heterogeneous broadleaf forest. Since this life zone is the most suitable for agriculture, including many of the best soils, its extent has been drastically reduced by clearing.

Subtropical wet forest. The subtropical wet forest characterizes many of the *Solenodon* localities, particularly in Sierra del Seibo, Samaná Peninsula, Los Haitíses, and the Cordillera Central. The mean annual rainfall is about 2000-4000 mm. The natural vegetation in this life zone is a heterogeneous multispatial forest usually dominated by broadleaf tree species. Pine is dominant on lateritic soils.

Subtropical lower montane moist forest. Solenodon localities in this life zone occur at least in Sierra de Bahoruco. Mean annual rainfall is between 1000 mm and 2000 mm, and elevation is usually above 800 m. The natural vegetation is primarily an open pine forest of the only native species, *Pinus occidentalis.*

Subtropical lower montane wet forest. This forest is found in *Solenodon* localities of mid-elevations (>850 m) of the Cordillera Central and Sierra de Bahoruco. The natural vegetation of this life zone is characterized by a complex mixture of broadleaf and pine. Broadleaf vegetation occurs in depressions and lower slopes, grading to pine forests on the ridges and upper slopes.

Vegetation

Broadleaf forests at lower (0-500 m) and mid (500-900 m) elevations were found to represent the most dominant formations in a sample of sites examined for vegetations types (Table 11). Mature forest or communities presumably reaching complete regeneration seem to be preferred by solenodons, although they were observed to persist under varying stages of succession. Man-caused disturbances are no doubt the main source of environmental change and population mortality. Most, if not all, existing *Solenodon* specimens collected and examined during the past 25 years, have originated from areas of marginal agriculture or patchily distributed forest habitat surrounded by intensively exploited countryside. Hurricanes are a major successional force, and their impact has been particularly felt several times in the past by the forest of the South Peninsula of Barahona. In broadleaf-pine forest at higher elevations pine regenerates well following disturbances, particularly fire, but broadleaf is usually dominant on deeper, moister soils.

Representative samples of forest types characteristic of the habitat and ecology of *Solenodon* are discussed below. Descriptions correspond to dominant formations in a given locality or group of localities (Fig. 5).

Dry Forest (Jaiqui Picado, COV). The natural vegetation is a single stratum forest characterized by a dense stand of trees, dense undergrowth, and an abundance of schlerophyll-leafed species. Canopy height is about 7-10 m. Trunks reach a maximum DBH of 25 cm and a length of 2-4 m. Tree species are characterized by slow growth and high density. An list of the most frequent species is given in Table 12. The soil is shallow and rocky, but rich due to the large amount of decaying plant material and soil nutrients as a result of slow decomposition and lower leaching because of reduced rainfall. Mean annual rainfall is 1253.4 mm with 104.1 days of rain per year. The topography at this locality (523 m) is best described as rough and hilly terrain. Limestone formations are common, and fossil reef is evident in many areas. The surrounding lowlands are mostly occupied by an agricultural landscape, and forest habitats in the small elevations are subject to exploitation for wood poles and charcoal.

Bursera Forest (Oviedo, SPB). The Almácigo (*Bursera simaruba*) forest represents a typical forest formation for the Dominican Republic. Ecologically, it is in transition between the dry and the moist

Table 12. Frequent plant species in the dry forest of Jaiqui Picado
Taula 12. Espècies vegetals freqüents al bosc sec de Jaiqui Picado.

Acacia farnesiana
Acacia macracantha
Acacia scleroxyla
Agave brevispina
Amyris balsamifera
Bumelia salicifolia
Bunchosia glandulosa
Bursera simaruba
Capparis ferruginea
Cassia crista
Cassia emarginata
Cassia siamea
Catalpa longissima
Cecropia peltata
Cestrum daphnoides
Chrysophyllum angustifolium
Clusia rosea
Coccoloba diversifolia
Comocladia glabra
Cordia collococca
Croton barahonensis
Cuscuta americana
Eugenia foetida
Euphorbia lactea
Ficus aurea
Guazuma ulmifolia
Heteropteirs laurifolia
Hura crepitans
Krugiodendrom ferreum
Licaria jamaicensis
Mastichodendron foetidissimum
Nectandra coriacea
Piper amalago
Prosopis juliflora
Rauvolfia nitida
Rochefortia acanthophora
Sabal umbraculifera
Serjania polyphylla
Sterculia apetala
Swietenia mahagoni
Tamarindus indica
Tragia volubilis
Zanthosylum flavum

Sources: Pena (1977), Varner (pers. comm.).

Table 13. Most frequent tree species in the *Bursera* forest of Oviedo.
Taula 13. Espècies arbòries mès freqüents al bosc de Bursera *d'Oviedo.*

Species	Macimum height (m)[a]	No. adult trees/ha dbh > 20 cm)[b]
Bursera simaruba 15	56,3	
Mastichodendron foetidissimum	-	13.1
Metopium brownei -	6.2	
Coccoloba diversifolia	12	5.1
Antirhea lucida	13	4.1
Spondias mombin	-	2.9
Piper aduncum	6	2.3
Guaiacum officinale	10	1.6
Manilkara jaimiqui	10	1.6
Buchenavia capitata	-	1.4
Cupania americana	-	0.9
Krugiodendrom ferreum	10	0.8
Acacia scleroxyla	-	0.7
Casearia arborea	15	0.7
Pauteria sapota	-	0.6
Coccoloba uvifera	15	0.5

Sources: a - Adams (1972), Loigier (1973), Moscoso (1943); b - FAO (1973)

forest (FAO 1973). The area described is located between Oviedo and Cabo Beata, where we have found and studied solenodons at several locations since the mid-1970's. The relief of the Peninsula increases gradually to a level of 200 m. The surface of the ground is rocky and stony, and limestone formations are invariably present. The area receives about 870 mm of rainfall annually. *Bursera* has a broad ecological distribution (up to 900 m), from thorn woodland to moist forest. In thorn scrub, growth is limited to a shrub-size height; however, it might reach 15 m with a DBH of 80 cm under more favorable climatic and edaphic conditions. In this vegetational formation, *Bursera* is not only the most frequent species but also the canopy dominant (Table 13), and it is easily distinguished for the emergent wider crowns protruding above the treetops of other canopy species. Species composition of the different strata of this forest is shown in Table 14. The upper layer (10-14 m) is characterized by tree species of large crowns, dominated by homogeneous stands of *Bursera* or mixed patches with other species. The intermediate layer is dense and reaches a height of about 5-6 m. The transition from the latter to the shrub layer (2-4 m) is not very distinct. This lower level is very dense and entangled with lianas. The density of the ground layer, mostly herbs, depends on the amount of clay available mixed with the rocky soil. Movement through the forest is made difficult by the dense shrubby vegetation. Most of the forest is still intact particularly in the more remote areas towards the coast. Hurricanes are the most important natural disturbances of the *Bursera* forest in the

Table 14. Representative structure of the Bursera forest in Oviedo.
Taula 14. Estructura representativa del bosc de Bursera *d'Oviedo.*

Layer	Height (m)	Frequent species
UPPER	10-14	*Bursera simaruba*
Large crowns		*Spondias mombin*
		Mastichodendron foetidissimum
		Phyllostylon brasiliensis
		Prunus myrtifolia
		Prosopis juliflora
		Manilkara jaimiqui
		Acacia macracantha
		Cassia emarginata
INTERMEDIATE	5-6	*Krugiodendrum ferrem*
dense		*Pera bumelifolia*
		Bunchosia glandulosa
		Guaiacum officinale
		Guaiacum sanctum
		Jatropha gossypifolia
		Celtis trinervia
SHRUB	2-4	*Croton humilis*
very dense		*Cissus intermedia*
		Lantana camara
		Brya ebenus
		Capparis ferruginea
		Acacia farnesiana

Barahona Peninsula. About half of the forest was reported seriously affected by a strong hurricane in 1966 (FAO 1973), and strong tropical storms along the south coast were recorded in 1979 and 1980.

Moist Broadleaf Forest (Boca de Yuma, CCP). This large block of moist broadleaf forest of low elevation is the most important forested zone in the east of the Dominican Republic. It is located in the easternmost end of the Caribbean Coastal Plain around the settlement of Boca de Yuma. It extends for about 100,000 ha. without interruptions along the coast, from Cabo Cuerno in the north, to Boca de Chavón near La Romana. The subsoil consists of reef limestone. The topography is monotonous. The terrain increases gradually from the coast, and there are a few low marine terraces, beyond which a maximum elevation of 130 m is reached. In the major blocks of forest, the soil surface is covered by recent fallen leaves, below which a 1-3 cm layer of humus covers the limestone rocks mixed with smaller rocks, gravel, and roots of trees. Fine soil is not found in a continuous layer, and probably few residuals are left from the chemical decomposition of the limestone rocks for the formation of soil. Most of the reddish brown clay formed slipped between the fissures of the rocks, where it is reached by the

Table 15. Most frequent tree species in the moist subtropical forest of Boca de Yuma.
Taula 15. Espècies arbòries més freqüents al bosc subtropical humid de Boca de Yuma.

Species	Maximum height (m)[a]	No. adult trees/ha dbh > 20 cm)[b]
Bursera simaruba 15	12.4	
Coccoloba diversifolia	10	10.4
Cordisa sp.	-	10.1
Ficus trigonata	10	9.2
Mastichodendrom foetidissimum	25	9.1
Homalium recemosum	10	5.7
Meliosma hebertii	20	4.8
Acacia scleroxyla	17	4.2
Oxandra laurifolia	-	4.3
Krugiodendrom ferreum	10	3.5
Spondias mombin 20	3.4	
Phyllostylon brasiliensis	15	3.0
Catalpa longissima		
*Ateramnus lucidus*10	2.8	
Licaria jamaicensis	20	2.8
Myrcia citrifolia	15	2.0
Lonchocarpus sericeus	15	2.0

Sources: a - Loigier (1973), Moscoso (1943); b - FAO (1973).

roots. Solenodons are primarily found in areas of depressions, where the larger accumulations of soils are available. These soil deposits are also avidly sought after by peasants for shifting agriculture. Here direct competition between solenodons and man for limiting soil and space resources is more obvious. The water retention capacity of this soil is very low, and rainfall is rapidly lost to the deep subsoil. Annual rainfall varies between 1000 mm and 1300 mm.

Among the most common species in this formation are *Bursera simaruba, Spondias mombin, , Mastichodendron foetidissimum, and Ficus trigonata* (Table 15). Average diameter is 10-30 cm and trees with a DBH over 40 cm are rare. The canopy is very dense with small crowns, and fairly homogeneous, interrupted only by pure patches of some of the most frequent species, like *Bursera* and the strangler *Ficus*. Average height is between 12 m and 16 m, with a maximum of 20 m. Emergent species are rare except in areas of depressions with greater accumulation of soils, where trees might reach up to 25 m. Below the canopy the space is densely occupied. The surface vegetation, however, only barely covers the soil and herbs, a cactacea and *Zamia* are frequent. Thick roots of trees are frequently observed extending for relatively great distances above the soil surface, probably in response to the limiting soil resources. The "middle layer" is very dense and consists primarily of tree regeneration and many shrubs. The height is about 6-10 m, above which canopy trees protrude.

The average diameter in this lower level ranges from 1-5 cm. Epiphytes are frequent, and lianas are very abundant. between the ground and the canopy. The extent of natural forest cover has been reduced in some areas due to clearing for charcoal, timber and extraction of other forest products, and for conversion to marginal agriculture and grazing.

Wet Broadleaf Forest (Los Haitises, LH). The wet broadleaf forest of lower elevation (up to 500 m) is characteristically well represented in the karstic platform of Los Haitises, the only large remaining extension of this type of forest. It extends from the south coast of Samaná Bay, between Sabana de la Mar and the Rio Barracote, 20 km inland (ca. 40,000 ha). Some areas are still virgin because of their low accessibility and difficult terrain. The subsoil is karst limestone forming a karstic platform. Landform consists of an endless number of hills, similar in elevation, divided from each other by narrow valleys. Hills rise from the valley floor with almost vertical walls of 30-50 m in height. The base platform is about 100 m in from the coast, and then elevation increases for up to 300 m inland. The red clay soils are not too deep in the top of the hills, but there are large accumulations of alluvial material in the valleys. The soil and subsurface are excessively drained, and the runoff is filtered to freatic levels almost immediately. Therefore, only subterranean rivers are known in Los Haitíses, being superficial freshwater courses mostly the effect of heavy seasonal rains. The region receives between 1900 and 2100 mm annually, and is among the areas of greatest rainfall in the country. In Los Haitíses, tree species are taller (up to 15-20 m), thicker (30-70 cm DBH), and with larger crowns than most other broadleaf forests (FAO 1973). Seventy-five percent of the volume is made up of tree species with more than 30 cm DBH, and 25% is due to tree species with more than 50 cm DBH. The most frequent tree species are listed in Table 16. The structure of this forest is heterogeneous because of differences in site quality, from the base of the valleys to the hilltops. Taller trees are more frequently found in the flatlands and valleys than on the tops of the hills where soil depth is reduced. Feeding tracks of *Solenodon* could be found where the soil and litter layer is deep enough to support a soil macrofauna. However, tracks are more frequently found in depressions or small valleys where the soil tends to accumulate. Daytime resting burrows are apparently located on higher ground or sloping terrain under dense cover.

Broadleaf forests (Sierra de Bahoruco). Along its vertical distribution on the southwest slopes of the Sierra de Bahoruco, *Solenodon* was found associated with several broadleaf vegetation zones: moist broadleaf forest in low elevation (0-500 m), moist broadleaf in medium elevation (500-900 m), wet broadleaf in high elevations (over 800 m), lower montane wet broadleaf (>1000 m), and mixed broadleaf-pine forest. Ecological factors, including rainfall, temperature, soil, and history of disturbance, are related to this vegetational zonation (Fisher-Meero, 1983).

The subsoil of most of the Sierra de Bahoruco consists of limestone with little resistance to weathering resulting in mountains with a moderate curvature. This mountain range is characterized by frequent deep ravines, cliffs, and plateaus interrupted by steep terraces. The highest elevation is 2367 m near the border with Haiti. Rainfall increases with elevation, and annual precipitation ranges widely from 1000 mm to 2000 mm. Percolation rates are high and the impermeable horizon is almost nonexistent in the higher elevations. Soils are derived from reef limestone, pronouncedly rocky, with shallow depths, and clay texture.

The vegetation is influenced by the intensity of fissures and crevices on the subsurface, where the soils are deposited after being washed by rains. Water and nutrients stored in these fissures are available to plant species with deep root systems. The upper layer consists of gravel and small pieces of weathered limestone mixed with red clay and organic materials contributed by leaf litter. On very steep slopes, water deposits are closer to the surface and more readily accessible to

Table 16. Most frequent tree species in the low elevation wet broadleaf forest of Los Hitíses, as indicated by the average number of individuals trees per count, in both flatland and hilltop (mogote) forest (only species with an average count of ≥4 individuals are shown).
Taula 16. Espècies arbòries més freqüents al bosc de fulla ampla humid de baixa altitud de Los Hitises, indicat pel nombre promig d'arbres individuals per recompte, tant a les terres baixes com als mogotes (només s'indiquen les espècies amb un promig de 4 o mes individus).

Species	Forest	Mogote
Alchornia latifolia	-	4.67
Allophylus cominia	-	13.33
Ardisia obovata	-	4.17
Artocarpus altilis	4.00	-
Bombacopsis emarginata	-	70.00
Bursera simaruba	-	5.50
Calophyllum brasiliens	-	23.33
Cinnamodendron ekmanii	-	9.33
Cinnamomum grisebachi	5.00	1.00
Clusia minor	-	16.83
Clusia rosea	-	6.17
Coccolaba diversifolia	-	49.67
Comocladia glabra	-	8.33
Dendropanax arboreus	8.50	35.50
Eugenia domingensi	5.00	-
Exothea paniculata	-	4.50
Ficus maxima	-	8.83
Gesneria viridiflor	-	17.50
Guapira fragans	-	5.33
Guarea guidonea	17.00	0.83
Inga laurina	-	5.33
Inga vera	11.00	5.00
Lonchocarpus latifolius	-	26.50
Ocotea coriacea	7.00	176.67
Ocotea leucoxylon	-	4.83
Ocotea membranacea	15.50	4.50
Pavonia fruticosa	5.00	-
Persea americana	5.50	-
Piper jacquemont	60.00	0.83
Piper laetevirid	92.50	-
Pouteria multiflora	-	4.17
Prunus myrtifolia	-	41.17
Pseudolmedia spuria	8.50	23.33
Psychotria pubescens	57.50	5.83
Sideroxylon cubense	-	4.33
Sideroxylon dominguense	-	8.00
Tetrazygia sp.	-	11.33
Tetreagastris balsamifer	-	4.67
Trichillia pallida	2.50	8.33
Trophis racemosa	2.50	13.67
Turpinia occidental	-	7.00
Urera baccifera	10.00	-
Zanthoxylum martinicensis	4.00	-

Source: Power y Flecker, 1997.

Table 17. Frequent tree species in three vegetational formations of Sierra de Bahoruco.
Taula 17. Espècies arbòries freqüents a tres formacions vegetals de la Serra de Bahoruco.

	No. trees/ha.(dbh > 15 cm)[b]		
Species	MBLE	MBME	WLMB
Carapa guaianensis	-	4.4	3.1
Clusia rosea	0.2	3.1	2.1
Inga vera	0.4	3.1	-
Melia azedarach	-	-	8.3
Prunus occidentalis	-	-	7.0
Cassia grandis	3.8	1.9	-
Bumelia salicifalia	4.4	24.4	-
Eugenia axillaris	13.2	6.2	-
Licaria triandra	1.5	23.7	51.4
Metopium toxiferum	0.5	11.2	-
Nectandra coriacea	10.1	18.1	11.6
Beilschmiedia pendula	-	-	12.0
Bursera simaruba	55.4	23.7	-
Comocladia glabra	3.1	74.9	-
Didymopanax morototoni	-	-	39.9
Rauvolfia nitida	16.1	5.0	0.1
Spondias mombin	11.2	-	0.1
Coccoloba diversifolia	6.2	15.6	-
Dendropanax arboreus	0.4	2.5	31.1
Sloanea amygdalina	2.0	4.4	28.1
Vitex divaricata	20.8	0.6	-
Zanthoxylum fagara	9.3	23.1	-
Prestoea montana	-	-	12.4
Mastichodendrum foetidissimum	6.4	5.0	-
Phithelocobium berteroanum	5.9	4.4	8.3
Canna sp	9.0	20.6	-
Ficus citrifolia	20.3	5.6	-
Cyrotaenia myriocarpa	-	11.9	-

Sources: a - FAO (1973)
Broadleaf vegetation. Types: MBLE - Moist broadleaf at low elevation (0-500 m); MBME - Moist broadleaf at medium elevation (500-900 m); WLMB - Wet lower montane broadleaf (>800 m).

trees, providing favorable conditions for growth. In all types, the canopy is dense, and this is easily noted from aerial surveys. Frequently, taller trees emerge over the rest with pointed or wide crowns. Canopy height is variable, and this is probably associated with soil characteristics. Size and density of the canopy increase with humidity and the space between the medium and ground levels is characterized by close vegetation, with many lianas, shrubs, and saplings. This transition is successive, and no stratification is evident. The number of lianas and epiphytes appear to increase in wetter forests. Most frequent tree species of these forest types are shown in Table 17.

Moist broadleaf forest at low elevation (up to 500 m). This type is found in the lowest slopes of the south side, between Las Mercedes and Mencia. Of the whole south-west slope, this is the area from where more *Solenodon* localities and specimens are known. The lowest *Solenodon* site elevation recorded was 195 m in a locality between La Azucena and El Manguito.

Moist broadleaf forests at mid-elevation (from 500-900 m). This type is a transition to the wet forest at high elevations. The height of the trees and the density and size of the canopy, are similar to the forests at lower elevation. However, there are differences in vegetation, diameter of the trunks, and species composition. We found abundant fresh tracks of *Solenodon* in Los Teleses (560 m), a mature forest about 4 km NE from Los Mercedes.

Wet lower montane broadleaf forest. This broadleaf formation is found between 850 m and 2000 m, and its presence is usually associated with deep, humus-rich soils. This formation has been heavily reduced above Los Arroyos. Extensive areas are now converted to pasture, and pine regeneration is more common. Natural patches of pine are also present inside the broadleaf, on the ridges, and upper slopes where the soil is shallower and drier.

Broadleaf-pine forest. There are only a few patches left of pine trees mixed with broadleaf on the higher elevations of the south-west slopes. One of these areas is Pinalito, west of El Acetillar (1370 m). Solenodons are still found there, and crossing to the pine-dominated side of this ecotone after heavy rains.

Discussion: Species-Environment interacions

Distribution in relation to habitat

The geological features of localities where recent specimens of *Solenodon* have been found represent a diverse but consistent morphology. Ranked from the most frequent to the least, the relief in *Solenodon* areas is characterized by rolling and hilly terrain, steep hills, mountains, undulating and rolling plains, and karst topography. In contrast, the species is usually absent on flood plains, fans at the base of mountains, level and undulating plains or swamps (Table 18). *S. cubanus* is present in areas with a similar geomorphology, particulary on slight to deeply dissected mountains (Baracoa, Sierra Maestra, Sierra del Cristal and Sierra del Escambray). Karst topography (cone and "mogote" types) is locally frequent in Sierra Maestra, Sierra del Escambray, and Sierra de los Organos (Atlas de Cuba, 1979).

The parental material associated with the habitat of the Hispaniolan solenodon is primarily limestone and limestone and shale. Mixed acid and basic igneous and metamorphic rocks are the dominant underlying material in localities at high elevations. Tuff is present on most of the Sierra de Neiba and associated foothills. The species is apparently never present in alluvium, lacustrine deposits, or unconsolidated marine structures. Limestone, including karstic and reef formations, is present in eight of eleven geological characterizations, through the different regions, and in 75% of the total number of localities analyzed.

Metamorphic, volcanic or sedimentary rocks are frequently found associated in the same habitat. Where limestone is absent, the localities are characterized by Cretaceous volcanic tuffs, plutonic igneous rocks, and volcanic rock with a metamorphic base. Serpentinized peridotite seems to be usually associated in this later group of localities. The same conclusion can be drawn from the analysis of localities from where only tracks and reports have been recently recorded (Table 3). Limestone is present in seven of eleven geological characterizations involving 77% of the total number of localities. Volcanic (primarily tuffs and basaltic flow), sedimentary and metamorphic rocks were present in the same habitat with limestone, or

Table 18. Landform and soil parental material in habitat selection by *Solenodon*
Taula 18. Formes terrestres i materials edàfics en la selecció d'hàbitat per Solenodon.

	SOLENODON PRESENT		SOLENODON ABSENT
	LANDFORM		
K	Karst topography	DT	Dissected terrace
M	Mountains	F	Fans at base of mountain
RH	Rolling and hilly terrain	FL	Floodplain
S	Steep hills	L	Level Plain
UR	Ondulating and rolling plain	SW	Swamp
		T	Terraces
	PARENTAL MATERIAL		
LS	Limestone	A	Alluvium
LSS	Limestone and shale	LA	Lacustrine alluvium, unconsolidated
RB	Mixed acid and basic igneous	M	Marine, unconsolidated and Metamorphic rocks
T	Tuff		

represented the dominant structure. Once again serpentine was found where volcanic tuff is the main strata. These characteristics are comparable to those described recently by Eisenberg and Gonzalez (1985) from the habitat of *S. cubanus* they studied in the mountains west of Baracoa. The geology of Sierra Maestra and the various mountain ranges between Holguin and Baracoa, including Sierra del Cristal where populations of *S. cubanus* occurred historically and where presumably they are still found (Varona, 1983), is dominated by rocks of the Domingo Belt (Pardo, 1975), characterized by ultrabasic igneous rocks invariably associated with some sediments and metamorphic rocks. This formation is of tectonic origin and includes among other elements grano diorite, and three types of serpentine derived from peridotites, usually associated with metamorphic rocks.

Serpentinized peridotite occurs at many sites in the Dominican Republic, and possibly defines two parallel belts (Bowin, 1975). One belt occurs in the fault zone that parallels the trend of the Cordillera Central, while the second lies along the Cordillera Septentrional, extending from the Puerto Plata region to the Samaná Peninsula. There is also a small occurrence of serpentinazed peridotite between El Seibo and Higüey that appears as an extension of the same north belt. Peridotite has been found in Haiti only in a valley northeast of Saint-Michel de l'Atalaye, and is dissimilar to those found in the Dominican Republic, with the exception of the serpentines that have been reported from western Dominican Republic (Woodring et al., 1924). The Haitian sample is only slightly serpentinized, while those of the Dominican Republic are highly serpentinized. Consequently, it has been suggested that the Haitian and western Dominican Republic occurrences be not related to the other Dominican localities. Also intriguing, is the contrast in the occurrence of serpentinized periodotite between that of Hispaniola and on the adjacent islands of Cuba and Puerto Rico, reported by Mattson (1973). In Hispaniola, peridotite appears more closely associated with faults as tectonic slivers, whereas in Cuba and Puerto Rico these are more elliptical and might be exposed through the erosion of anticlinal uplifts.

The Hispaniolan Solenodon appears to occur mainly at elevations below 1000 m. All specimens examined in this study and most reports correspond to localities between 5 to

800 m. *Solenodon* certainly can be found up to 1500 m, above which the numbers decrease with elevation. Since presumably fewer populations are found at higher elevations, chances for the development of locally adapted populations should be higher in isolated insular montane conditions, in relation to those inhabiting the lowlands.

Temperature, moisture, and particulary soil quality among other factors seem potential environmental constraints as elevation increases. Thin, less friable soils usually predominate on the higher mountain slopes, while deeper soils occur at lower altitudes. The elevation of 630 m at the study site of *S. cubanus* in Cerra La Iron recorded by Eisenberg and Gonzalez (1985) is within the altitudinal range found for *S. paradoxus* in the Dominican Republic, though, the denser underfur and longer guard hairs forming a more efficient, insulative coat in the Cuban Solenodon suggest that environmental strategies between the two species are apparently not identical.

The Cuban Solenodon, with longer claws than *S. paradoxus*, seems more specialized for burrowing and might spend more time below ground than the Hispaniolan species. Over two hundred museum specimens of *S. paradoxus* are known in collections worldwide, contrasting with less than 30 *S. cubanus* worldwide. The chances for finding *S. paradoxus* would be higher if they spend considerably more time on the surface, and this could account for the difference in the number of specimens. It is also possible that population densities of *S. cubanus* are lower than that of *S. paradoxus*.

The Hispaniolan form is known to remain active through the year, and the same might be true for the Cuban species. The differences in rectal temperatures between *S. paradoxus* and *S. cubanus* are slight and might reflect differences in thermoconductance at similar body sizes, perhaps related to the more efficient insulation of *S. cubanus*. Diel variations, recorded from one specimen each were 30.5 - 33.7°C in *S. paradoxus* (Eisenberg and Gould, 1966), and 33.0 - 35.0°C in *S. cubanus* (J.F. Eisenberg, pers. comm.) which suggest a somewhat narrow range of thermoneutrality and the ability of both species to maintain a relatively constant body temperature in relation with that of the environment. If linked to low basal rates, these low body temperatures may be an adaptation to reduce heat storage and water exchange (McNab, 1979). Under lab conditions a female *S. paradoxus* maintained an average rectal temperature of 6.4°C above the ambient at the same time that 20 *Echinops telfairi* (ca. 180 g.; Tenrecidae) were torpid with rectal temperatures only 0.6 - 1.6°C above Ta (Eisenberg and Gould, 1966). Extreme ambient temperatures during these experiments ranged from 21.0 to 27.3°C, which compares very closely to the mean annual averages (21.2 - 27.1°C) found in this study for 15 field stations (ranging in elevation from 3 to 890 m) in areas occupied by *S. paradoxus*. However, it has been shown that during the year temperatures in different localities fluctuate from 13.5°C to 38.8°C, with an absolute minimum of 0°C above 900 m at selected localities (Table 9). Extreme surface temperatures are likely buffered by the stable microclimate of the burrow.

Although food habits are not well known, *Solenodon* appears to be a food generalist. Although they feed primarily on soil litter invertebrates (i.e. earthworms, land snails, centipedes, millipedes, insects and arachnids), additional preys include crabs, small amphibians and reptiles, and ground birds. In feeding trials in captivity, they also readily pursue, kill and eat mice. With the exception of species with relative small body size, mammals feeding on soil and litter fauna usually have low body temperatures and a reduced capacity to regulate body temperature at low environmental temperatures (McNab, 1983), possibly because of the periodicity in the availability of soil invertebrates. McNab (1979) has also shown that, basal rates of metabolism are lower than expected in fossorial and burrowing mammals weighing more than 80 g; including those species that spend only part of the time in burrows as in the case of *Solenodon*. Therefore, both *S. cubanus*, with a body mass close to that of the Hispaniolan form, and *S. paradoxus* (ca. 800 g., N=10 non-captive individuals) should have low basal rates of metabolism. Although the metabolic rates of *Solenodon* have never been studied in the laboratory, the adaptation to low basal rates under the hypoxic hypercapnic conditions of the burrow might be associated to a reduction in gas exchange (Darden, 1972), and to avoid overheating.

Activity patterns, thermoregulation, and the exploitation of an insectivorous food source under the presumed low productivity conditions of their environments seem closely related. We have observed captive animals basking during early hours, and most daylight observations of *S. paradoxus* by peasants have been reported early in the morning or after rains, which suggest the possibility of behavioral thermoregulation, though the facilitation of digestion might also be involved. Cuban solenodons have been also observed sunning themselves (Eisenberg and Gonzalez, 1985). The Cuban Solenodon seems to occur primarily at higher elevations, and apparently they have not been found on lowland or dry habitats comparable to those described for *S. paradoxus* in this study. This lead to the possibility that ecologically, *S. cubanus* might be more specialized whereas *S. paradoxus* is able to survive under a wider range of conditions. The shorter pelage of the Hispaniolan species, which is known to occur in both mountains and lowlands, might reflect an adaptation, or at least a higher level of tolerance, to drier, warmer environments. Furthermore, the lack of hair on the rump, around the base of the tail and around the anus of both species, probably important for passive heat dissipation, is slightly more pronounced in *S. paradoxus*. Obviously *S. cubanus* also survived the drier conditions that characterized the West Indies during the last glaciation, when arid habitats, (savannas or grasslands) occupied extensive areas of previous forests habitats. As a result of changing climates and sea levels after the Pleistocene, the present distribution of species that are obligate xerophiles have been found to be of restricted, relictual occurrence (Pregill and Olson, 1981), due to the loss or decrease of dry, prairie-like habitat since the late Pleistocene. At present, the distribution of dry habitats in Cuba is reduced, in contrast to the extensive xeric areas that are still found in the Dominican Republic today. Only five areas receive less than 1000 mm of rain every year in all of Cuba, four of which are coastal. Schubert and Medina (1982) have presented data suggesting that the glacial average temperature gradient in the Dominican Republic was higher than today, possibly greater than -1C per 100 m elevation, hence suggesting a drier climate than today. At present, the mean average annual rainfall along the distribution of *S. paradoxus* in the Dominican Republic is about 1500 m, though the minimum annual in their habitats appears to be close to 800 m. The harsher moisture conditions presumably occur in Oviedo, (annual mean of 855.1 mm) where amounts of rainfall as low as 597.1 mm have been recorded.

Habitat Selection

Habitat selection in *Solenodon* seem closely associated to certain edaphic conditions, and further interrelations of the soil with other characteristics of the physical and biotic environment of their habitats (Table 19). Altitude, moisture, topography, forest cover and substrate features combined appear to influence the geographical distribution of *S. paradoxus*, although soils and vegetation cover seem to be primary limiting factors. These two factors seem to further influence, more than any other, the physiological ecology, distribution and abundance of food resources, and presumably the population structure and dynamics of *Solenodon*. The soils found in the habitats of the Hispaniolan Solenodon are characteristically shallow, stony, erosive, non-saline, well drained, fine textured, with slow permeability, no risk of flooding, and usually on very steep topography.

The advantages of a rough topography seem to be varied, and a number of situations might illustrate apparent preferences in habitat use and selection by *S. paradoxus*. In much of the habitat, the soil is extremely shallow, due to frequent emergence of the bedrock, with intermittent depressions caused by weathering or dissolution of the parental material. The depressions represent storage pools for soil deposition, organic matter and litterfall accumulation and moisture retention. Therefore this litter accumulation provides favorable habitat for a diverse soil fauna, thus food sources are seemingly more concentrated in particular areas. Although feeding tracks of *S. paradoxus* can be found anywhere the soil and litter layers are deep enough to support soil fauna, foraging signs seem more commonly found on depressions, small valleys or ravines, and between hills where soil and litter tend to accumulate. While foraging is mostly done in these depressions, burrows and major tunnels are apparently more frequently found at relatively higher levels (i.e. slopes, around limestone outcrops in the immediate vicinity of the foraging grounds).

Eisenberg and Gonzalez (1985) described extensive networks of tunnels made by *S. cubanus* in habitats with thick leaf litter and humus. They also suggested that the Cuban form spend considerable time foraging beneath the surface, and that above ground foraging is regulated by humidity and ambient temperature. Similar behavior is exhibited by *S. paradoxus*, though limiting temperature and humidity might shift to harsher conditions in dry habitats during extreme seasonal conditions. We have found foraging tunnels converging under the base of a Membrillo (*Prunus* sp.) in the dry transitional moist forest of Oviedo. Because the reduced rainfall and the sclerophyll condition of the leaves, decomposition is slow. We have found litter accumulations up to 50 cm deep in some areas of this forest. In the south side of Sierra de Bahoruco, the steep slopes covered with adult forest above 300 m usually have litter-soil layer depths greater than 25 cm in places with foraging tracks.

The selection of dry sites for the location of the nest chamber have been observed in the wild and in captivity in *S. paradoxus*, and has been illustrated for *S. cubanus* by Eisenberg and Gonzalez (1985). The requirement for dry sleeping chambers, hence their location under large rock outcrops, trees or stumps, seem related with the consistent reports suggesting that both *S. paradoxus* and *S. cubanus* are more active above the ground after a rain, when presumably they have been observed foraging or sunning themselves. Several reasons might be involved. In burrowing mammals, hypoxia and hypercapnia conditions increase underground after rains or periods of active digging (Arieli, 1978) because gas diffusion rates are influenced by a moisture gradient. For instance, decreased burrowing rates of *Geomys* have been recorded when the soil is frozen or saturated with water (Andersen and MacMahon, 1981). A wet nest chamber would result in the pelage of *Solenodon* becoming wet with an increase in thermoconductance. The higher heat loss might be energetically costly and might explain observations of animals basking themselves after a rain. The selection of relatively higher places (i.e. steep slopes) for the construction of nest chambers might also be associated with the advantage of a faster water runoff in higher areas, therefore preventing flooding situations. A pair of animals kept in captivity in an outdoor enclosure, drowned inside their nest under a large rock after heavy rains, when the water filled the tunnel causing its collapse. In the wild, *S. paradoxus* occur without exceptions in soil types with reduced or no chance of flooding. We have found remains of *S. paradoxus* several times inside non-active burrows, and bones of adult *S. cubanus* were reported found under similar circumstances (J. Eisenberg, pers. comm.). Whether these are cases of mortality due to older age or disease, rather than losses of animals caused by hypothermia or flooding events, is unknown. In

Table 19. Summary of vegetational, climatic and topographical trends assicated with particular soil types in *Solenodon* localities sampled.
Taula 19. Resum de les tendències vegetatives, climàtiques i topogràfiques associades amb tipus particulars de sòls a les localitats amb Solenodon *mostrejades.*

Soil type	Typical location	Vegetation type	Mean annual precipitation (mm)	Mean annual temperature (°C)	Terrain and landform type	Local relief (m)	Elevation range (m)	Agricultural potential
ITEg K/LS	Los Haitises; Samana Pen.	Mf to Wf (a)	2000-2500 V-mild-ds	25-27	KS: erosional steeper 60%(K)	100	100-400	very low
ITEs M/LSS	Sierra Neiba; Sierra Baoruco	Wf-m in cloud zone (b)	2000-2500 mild-ds	15-22>1200 m 20-25<1200 m	MT: slopes steeper 30%	300-600	100-2000	very low
ITUa RH/LSS	S.J. Matas; P. Santana; Cercado, Moncion	Df, Mf (c)	1000-2000 (g) distinct(1-3)ds	22-25	HL + VY: erosional	50-300	100-1000	mod. low
ITUs RH/T	Sierra Seibo	Mf	1200-1600 distinct-ds	26-27	UD + VY: erosional	50-150	100-400	moderate
ITYf S/T	high elevations thru the country	Mf, Wf, Rf, and Prm	2000-2300 V-mild-ds	24-26	HL: steep erosional	50-300	100-700	very low
ITUs M/LSS	high elevations thru the country	Mf, Wf, Rf, and Prm	900-1300 distinct-ds	20-25	MT: slopes steeper 30%	300-600	200-1200	very low
ITYs M/RB	high elevations thru the country	Mf, Wf, Rf and Prm	1800-2500 mild-ds	15-22>1200 m 20-25<1200 m	MT: slopes steeper 30%	300-800	300->2000	very low
ITYs S/RB	high elevations thru the country	Mf, Wf, Rf, and Prm	1800-2400 mild-ds	25-27	HL: steep erosional	200-300	100-600	very low
ITEs RH/LSS	Samana, Cabrera	Mf, Wf(d)	2000-2500 mild (1-3)-ds(h)	22-25	HL + VY: (1) erosional	50-200	20-500	low
EOHck UR/LS	Oviedo; lower south slope S. Baoruco	Df to Mf(e)	600-1000 erratic (i)	25-28	CP: reef (m)	10-100	5-300	unsuited
EOUdk UR/LS	Boca Yuma	Df to Mf	1000-1400 distinct-ds	26-27	CP: reef (m)	5-40	5-150	very low
UDTa RH/T- ITYf S/T	NE coast S of Miches	Mf with Wf at higher elev.	2000-2200 V-mild-ds	25-26	HL erosional	20-100	50-300	low
DOAa RH/LSS	lower slopes N side S. Baoruco	Mf, Wf, Rf(f)	400-900 (j) 1 or 2 max.	26-28	HL erosional	50-300	200-1000	very low

Sources: CRIES (1977), Vegetation types: D - dry, M - moist, W - wet, R - rainforest, Prm - premontane, m - montane, f forest; a - Wet broaleaf evergreen forest, unique floristic composition; similar to other Antillean Kegelkarst forest; b -Wet montane forest in cloud zone (broadleaf, Mora, palms, somewhat more epihites than the merely moist montane forest, but other similar in vegetational composition; c - Mois forest, most of which now represented by secondary growth, d - Nonseasonal broadleaf moist forest in lower areas; wet forest on higher slopes; endemicity of herbaceous plants; e - Mainly Bursera, but also present legumes such as Acacia, Brya and Calliandra; rubiads as Guettarda and Psychotria; euphorbs as Croton, Jatropa, and Phyllantos, also Phyllostillon, Tabebuia and Prosopis, f - Broadleaf forest ranging from true rain forest, throughout wet forest (tre fens, and occassional Prestoea palms) to moist forest.
Precipitation (Seasonality): distinct-ds: with distinct first-quarter dry season; mild-ds: with mild first-quarter dry season; V-mild-ds: with very mild first-quarter dry season; g - distinet first-quarter dry season, with additional third-quarter dry season; h - mild first or third-quarter dry season; i - with erratic distribution of rains; j - with one or two maxima in the May thoughout October period. Terrain and landform type: CP - Coastal plain, HL - Hill, MT - Mountain, UD - Upland, VY mValley, k - karst with narrow ridges, about 20 sinks/km², and erosional slopes, l - erosional hills with remants of coral reef near Cabrera and Samana, m - coastal plain apparently slightly from original coastal reef.

small burrowing mammals, mortality caused by extreme weather conditions have been documented elsewhere (Ingles, 1952; Nevo, 1961; Williams and Baker, 1976).

Above ground activity is also probably associated with the mobility patterns of the soil fauna in response to soil moisture and temperature gradients. Together with soil and vegetation structure, and the chemical factor of base content and pH, microclimatic gradients exert a considerable direct influence on the horizontal and vertical distribution of the soil fauna (Wallwork, 1970). Soil structure, vegetation type and chemical factors are relatively static features of the soil environment, and their effects determine the presence or absence of a species on a particular place. Microclimatic factors are dynamic, with diurnal and seasonal periodicity. Their effects are both qualitative and quantitative, promoting cyclical shifts horizontally and vertically, in the centers of population densities (Wallwork, 1976). Studies done on the vertical distribution, abundance and population dynamics of the macrofauna of the litter substrate by Gonzalez and Herrera (1983b) in the seasonal evergreen forest of Sierra del Rosario, Cuba, have shown that adults and larvae of major invertebrate groups exhibit a great vertical mobility correlating with humidity. Starting from the more superficial layers of the litter, the 99.9 percent of the biomass of the Coleoptera was found within the first 15 cm of soil; the larva being found until 15 cm depth and the adults until 10 cm. With an increase in humidity, both larvae and adults move up, whereas they move to the deeper horizons during the drier months. The movement of this fauna is also affected by soil temperature, which may account for the apparent reduction of surface foraging between December and March by *S. paradoxus* (pers. obser.). Studies in Cuba (González and Herrera, 1983a; González and Mendizabal, 1983) had shown that the greatest abundance and biomass of all stages and the emergence of adults of the Coleoptera from the litter coincides with the rainy season. When available, the larvae and adult Coleoptera of the large sized genus *Strategus* seem one of the important items in the diet of *S. paradoxus* in the Dominican Republic. *Strategus oblongus* (adult: 35-58.8 mm; instar 3 larvae: 100 mm) and *S. aenobarbus* (adult: 32.0-38.0 mm) are widely distributed in Hispaniola and all stages, except the eggs, have been found in all months of the year (Ratcliffe, 1976). In Grenada, Lesser Antilles, Tanaka and Tanaka (1983) found that the average wet-season abundance of arthropods was 2.3 times greater, and the wet-season biomass was 3.1 times greater than that for the dry season.

The relative abundance of other apparently important invertebrate groups in the diet of *S. paradoxus* also seems closely associated with the dominant geologic structure in the habitat of *Solenodon*. Snails, millipeds and woodlice use calcium carbonate in relatively massive quantities to strengthen the exoskeleton, and these groups flourish where the parental material is limestone or chalk (Wallwork, 1976). The geological substrate of some beetle groups (e.g., Tenebrionidae) in the Antilles is essentially represented by limestone and effusive igneous rocks, particulary volcanic tuffs (Marcuzzi, 1974).

The shading by the canopy influences the microclimate at the surface of the ground and also determines, to some extent, the type and distribution of the ground flora (Longman and Jenik, 1974). The organic material entering the soil is derived from leaf fall and the decay of logs and branches. Decaying logs and stumps, and debris accumulated in holes provides an important series of microhabitats for the soil fauna, however, Bray and Gorham (1964) have suggested that leaf litter constitutes roughly 70 percent of the total litter. The litter on the forest floor affects the moisture and temperature status, runoff pattern and nutrient content (Garg and Vyas, 1975). The combination of favorable conditions that provide food and living space determine the mosaic distribution of the soil fauna (Walkwork, 1976). A large percent of the tree species in *Solenodon* habitats are evergreen and shed their leathery leaves throughout the year. However, their leaf-fall remains in a dry and largely undercomposed state during the dry season. The surface litter breaks down as the wet season progresses, presumably in proportion to the amount of rainfall in the different localities, but decomposition rates decrease with increase in elevation due to lower ambient temperatures. Reduced decay rates due to low temperatures are further influenced by the mountain raising effect (Massenerhebung effect). The subtropical insular conditions of Hispaniola and Cuba exhibit lower temperatures at lower elevations than continental habitats. These conditions suggest that *S. paradoxus* is apparently adapted to reduced secondary productivity as have been noted in the habitat of *S. cubanus* by Eisenberg and Gonzalez (1985).

The reduced plant productivity, and the tendency for evergreen, scleromorphic leaves, are probably influenced by the nutrient-poor, low moisture holding, azonal soils of *Solenodon* habitats. As shown in chapter four, these immature soils (mainly Inceptisols and Entisols), although in most cases developed on limestone, are often above ultrabasic rocks of serpentine. The depauperate appearance of the forests of Sierra del Seibo is probably a reflection of the toxicity and deficiency of nutrients of these soil formations. *Solenodon* seems more associated with older, "undisturbed" forest, which are generally considered of lower productivity than younger successions (Mabberley, 1983). Gonzalez and Herrera (1983c), found 32 times more Diplopoda, and two times more soil organisms in a 7-year-old forest plantation of *Hibiscus elatus* than in a seasonal, evergreen old forest. The same study suggested that the mobility of the litter fauna is low and practically constant throughout the year in the forest, whereas soil organisms are more active and mobile in the plantation situation.

Life history patterns

There appears to be no sharp breeding season in *S. paradoxus*, although some evidence suggests that there might be a peak from September to March. If a peak exist, gestation occurs during the driest season, and the young are born either at the onset or during the rainy season, presumably to maximize growth and survival. The gestation period is at least 84 days, and as a rule, a single young is born. Neonate weight is about 80 - 100 g. Young open their eyes after five days of age, and the first pelage is usually black on the back and sides. Their cryptic coloration might be an adaptation to reduce predator detection during overground foraging activity in company with the mother. During the earlier stages of development, mother-young contact during foraging activity is accomplished by "teat-transport" (Eisenberg, 1975). Presumably, females do not attain sexual maturity until the second year of age. Basic social units are family groups consisting of the adult pair and one young, although a subadult from the pervious litter is frequently present in the same nest chamber or burrow system. Presumably, subadults leave the family group between 10 to 18 months of age. This mechanism might be a response to reduce competition between genetically similar offspring, though how far these subadult individuals, particulary males, disperse from their natal burrow or territory is unknown. Adult survival is more likely favored in the low productivity environments of *Solenodon*. Life expectancy of *S. paradoxus* in the wild is apparently long, and at least one captive individual is known to have survived eleven years (J.F. Eisenberg, pers. comm.).

In addition to *Solenodon* itself, the only known native predators of the Greater Antilles are represented by raptorial birds and snakes. Because of their nocturnal activity and relatively large size, potential natural predators of *paradoxus* are reduced to owls (*Tyto alba* and *Asio stygius*), and the Hispaniolan boa (*Epicrates striatus*). The habitat of other large potential predators, namely, the Short-eared owl (*Asio flammeus*) and snake (*Alsophis anomalus*) do not overlap with that of *paradoxus*. Predation rates are apparently low and probably buffered by the security of the burrow, though it may increase during subadult dispersal. *Solenodon* remains are usually absent in pellet deposits of barn owls, but owls might prey on the young and subadult *Solenodon*. The larger *Asio stygius* occur only in dense mature forest and might prey on adult individuals, but interestingly this owl is as rare or even more rare than *S. paradoxus*. Common Hispaniolan boas, *E. striatus* (up to 2.3 m in SVL length) could be the most potential native predators. One large Hispaniolan boa was reported containing the remains of an adult cat (Ottenwalder, 1980), and C. A. Woods (pers. comm.) examined an adult *E. striatus* containing a fresh carcass of Hispaniolan Hutia (*Plagiodontia aedium*) in its digestive tract (Ottenwalder 1985; Henderson et al., 1987). The larger Cuban boa (*E. angulifer*), with maximum SVL of 4 (Schwartz and Henderson, 1991) meters is certainly capable of entering the burrows and kill an adult *Solenodon*.

At least five species of helminths, including trematodes, cestodes, and nematodes, are known to parasitize *S. paradoxus* and *S. cubanus* (Sandground, 1938; Lorenzo *et al.*, 1981). *Acanthocephala* larvae, presumably *Macracanthorynchus hirudinaceus* (Ricart *et al.*, 1973), are present in a high percentage of adult *paradoxus* but so far not in any of the few young examined (pers. obser.). This is an erratic host-parasite cycle, and the infestation is apparently obtained thru the ingestion of adult and larvae Coleoptera. In particular, coprophagous beetles of the Scarabaeidae are known to be intermediate hosts of this swine parasite. Cruz (1973) reported one host-specific acari parasitizing each of the two extant species of *Solenodon*. In all recorded cases, parasitic loads and their impact on the survivorship of affected individuals are unknown, though Mohr (1936-38) referred the deaths of some captive solenodons due to helminthiasis. In subterranean mammals, mortality factors such as parasites, diseases, and food shortage have been shown to be density-dependant (Jarvis, 1973).

The life history patterns of *S. paradoxus*, (i.e. slow development, relatively large body size compared to other members of the Insectivora, prolonged longevity, low reproductive rates, and presumably, low recruitment and mortality rates) imply an extreme K-selection strategy in both species of Solenodons as suggested by Eisenberg and Gonzalez (1985). This strategy is matched to the adaptive patterns of fossorial ecology, i.e. constancy of microclimates, nocturnality, food generalism, low population densities, effective predator avoidance and subdivided population structure and low vagility due to the discontinuity of favorable habitats. These adaptations might favor high competitive ability and over all individual fitness (Nevo, 1979). The low total biomass is apparently determined by the relatively low productivity of their environment.

Conclusions

Extant populations of the Hispaniolan *Solenodon* occur in remote, relatively undisturbed forest habitats, with relatively low human densities. Their habitats are characterized by steep, hilly terrain in mountain ranges, or undulating and rolling plain in coastal lowlands. The geology of the habitat is dominated by limestone. Mixed acid and basic igneous metamorphic rocks and tuffs are also frequent, particulary in the Cordillera Central, Cordillera Septentrional, and Sierra del Seibo y Neiba. Serpentine in often associated with these outcroppings. The slope of the terrain averages 25.1 percent. Soil depth is shallow (ca. 0.35 m), with the bedrock close to the surface. Lithic subgroups comprise 78 percent of all soil units, so the soil usually accumulates in solution holes. Though soils are of fine texture, slow permeability and low water capacity, the soils are also well drained because of the steep slopes and stony coarse fragments.

Available data indicates that *Solenodon* occurs primarily at moderate elevations, <800 m, and most known populations have been found between sea level and 1000 m. Above that elevation, populations are less frequent, but there is evidence supporting their presence up to 2000 m. *Solenodon* localities receive on the average 1500 mm of rain annually, with a mean annual minimum of about 800-mm in the driest localities. In the sample of *Solenodon* localities analyzed, the average number of days with rain per year was about 117 days, though in one area total rainfall was distributed in 72.4 per year. Mean annual temperature was 24.8C ranging from 21 to 27C in 15 areas analyzed. Average annual extremes ranged from 19.2 to 38.8C, though absolute low temperatures of zero degrees C have been recorded above 900 m locations.

About 86 per cent of the *Solenodon* localities evaluated in the study is in transitional moist forest, moist forest, and wet forest. *S. cubanus* is apparently restricted to these life zones, in contrast with *S. paradoxus*, which also occurs in dry habitats in at least three areas of the country. Low to mid elevation broadleaf forests seems to represent a favored habitat for *S. paradoxus*. Although old, mature forest habitats no doubt represent the optimal habitat for both species of *Solenodon*, the Hispaniolan species was found surviving in secondary, disturbed forest habitats. Though the degree of relative success of *S. paradoxus* in response to particular successional trends can not qualify be assessed on the base of the present data, their persistence in these habitats suggest that the species might survive, at least temporarily, under variable levels of disturbance. However, evidence from populations we discovered in disturbed localities during the mid-1970's, were found locally extirpated 20 years later. In addition, available data from one disturbed population being monitored since the mid-1980's, indicate that *Solenodon* populations surviving and depending from nearby disturbed forest fragments would vanish before 20-30 years if the causes of disturbance do not disappear, and the habitat does not enter a successional recovery (Ottenwalder and Rupp, in press).

Hispaniola is visited by hurricanes at intervals of less than 30 years. According to UNEP (in Hartshorn *et al.*, (1981), an estimated 46 tropical storms and hurricanes passed near or over the Dominican Republic between 1887 and 1975. When exposed to such selective pressures many ecosystems are rejuvenated and become more productive. In addition to hurricanes, the insular forests must overcome other natural disturbances such as drought, floods, fires, landslides, and excessive wind. These perturbations have relatively natural frequencies and therefore predictable in ecological time. Human disturbances are also involved in this changing process. In Sierra de Bahoruco, *Solenodon* has been found in forest patches, usually in the proximity of older stands, and often recovering from serious agricultural exploitation.

The chances of a population to survive under disturbed conditions are probably determined by the resilience of the habitat and the extent of the disturbance. Rapid growth and regeneration of the forest canopy and the persistence of the soil seem important conditions for the habitat to recover its original productivity, and for *Solenodon* to recover its former population density, or to re-colonize a given area.

The food habits of the species determine the amount of resources available, which in turn influence the carrying capacity of the habitat. *Solenodon* occupy an insectivore-fossorial niche, hence could be considered narrow habitat specialists adapted to the greater stability and predictability of the burrow environment (i.e. microclimate, low predation, food supply). Their environment is presumably poor in productivity and carrying capacity, apparently discontinuous in structure, and with resources unequally distributed. *Solenodon* is certainly a K-selected species with a large body size among the Insectivora. Their life history patterns suggest that equilibrium between numbers and carrying capacity are achieved a) maximizing breeding age and duration of breeding season, and b) minimizing litter size, mortality rate, and predation.

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