PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

The Soils of Aldabra

S. T. Trudgill

Phil. Trans. R. Soc. Lond. B 1979 **286**, 67-77
doi: 10.1098/rstb.1979.0016

Phil. Trans. R. Soc. Lond. B. **286**, 67–77 (1979) [67]
Printed in Great Britain

The soils of Aldabra

By S. T. Trudgill

*Department of Geography, University of Sheffield, Sheffield S*10 2*TN, U.K.*

The soils of Aldabra are of patchy distribution, consisting of pockets of either accumulated organic matter or of biogenic mineral detritus. The soils are shallow (10–20 cm) but locally deeper and more extensive soil covers do occur. Organic covers occur under well established *Casuarina* stands and mineral soil covers occur on the floors of rock basins or where sands are present. The organic soils originate from leaf litter, with local increments of faecal material and bird remains. The mineral soils are primarily carbonate and are derived mechanically from carbonate rocks, from windblown bioclastic carbonate grains or from terrestrial sediments. Solution residues and phosphatic particles also contribute to these soils.

Attempts are made to cross-correlate existing soil information, and several organic and carbonate soil types can be recognized. These are: shallow organic (including litter, pellet and guano varieties); deep organic; calcarenaceous bioclastic soils; brown (silt or silt loam) carbonate soils (including a phosphatic variety) and a widespread organic brown carbonate soil.

The soils may be slightly acid but are mostly circumneutral or alkaline; high salinity may occur in coastal locations. Phosphate levels are usually low.

Insufficient profile data are available at present to define soil type in any rigorous way and the spatial distribution of soil types is only scantily known.

Introduction

The purpose of this paper is to review and consolidate the existing work on Aldabra soils. Of particular interest are (1) the establishment of a classificatory framework which may be of use to other research workers, (2) the origin of the soils and (3) their ecological significance. The paper considers terrestrial soils. Marine (mangrove) soils are not discussed. The formation of palaeosols and other terrestrial sediments is discussed by Braithwaite (1975). These are not discussed here, except where they influence present day soils.

The extent of well developed soils on Aldabra is limited. The soils are often little more than leaf litter mixed with fragments of carbonate rock and show only rudimentary horizonation. As such they may be viewed as immature. They have a discontinuous distribution and are often shallow (of the order of 10–20 cm and frequently as low as 1–2 cm in thickness).

The carbonate rocks which are the commonest soil parent materials are relatively pure, insoluble residues, commonly being in the region of 1–2 % by mass, only locally rising to 10–20 %. Carbonate dissolution thus leads to only slow formation of residual soils. Often only unaggregated and unconsolidated carbonate sediments or phosphatic sediments form the skeletal grains of the soil material. The soils are generally carbonate rich and mostly alkaline or circumneutral, though slightly acid soils do occur.

Variations in the types and amounts of organic and mineral matter can be used to differentiate soil types. At the present state of knowledge it is not possible to ascribe the soils to soil series in any consistent manner. A soil series can be defined as a group of profiles with similar successions of horizons developed in lithologically similar parent materials. Assignation to a series thus involves an extensive study of complete soil profiles to ascertain whether they have similar characteristics. A type profile should be described so that the series can be consistently recognized in the field. This type of information is not yet available for many parts of the island. Much of the area would be classified as 'rock dominant' in terms of many soil mapping

TABLE 1. ANALYTICAL METHODS USED

(1) Carbonates: Collins calcimeter.
(2) Loss on ignition on carbonate free sample (acid washed); percentage given as of whole sample.
(3) pH: laboratory pH meter, 1:2.5, in distilled water.
(4) Phosphate: colour comparator with the use of ammonium molybdate on an $NaHCO_3$ extract of fresh soil, results as PO_4 (extractable, not total, phosphate).
(5) Colour: Munsell Colour, soil colour chart.

TABLE 2. HORIZON NOMENCLATURE USED IN PROFILE DESCRIPTION

L	Litter layer. Plant remains recognizable.
F	Fermentation layer. Plant remains partly decomposed.
H	Humus layer. Plant remains mostly unrecognizable.
A	Mixed mineral–organic horizon.
Ah	A horizon with large proportion of humus material.
B	Mineral horizon, altered by weathering/pedogenesis.
B(ca)	Calcareous B horizon.
C	Parent material, unconsolidated material.
R	Parent material, bedrock.

TABLE 3. SELECTED DATA FOR SOIL TYPES

	soil type†	location	vegetation	rock type‡	soil depth cm	soil colour	pH§	carbonates	percentage organic	phosphate mg/g
1	OS	Takamaka	*Ficus*	Takamaka Lst.	10	10 YR 3/3	7.2	11.5	36.7	0.0
2	OS	Middle Camp	*Casuarina* and shrubs	Aldabra Lst.	10	10 YR 5/2	7.5	17.0	56.4	0.1
3	OS	Middle Camp	*Casuarina* and shrubs	Aldabra Lst.	10	10 YR 4/2	6.5	3.5	73.6	0.01
4	OSP	Takamaka	*Thespesia*	Takamaka Lst.	10	10 YR 3/3	7.4	2.0	48.5	0.0
5	OSG	Gionnet	—	Aldabra Lst.	10	2.5 YR 6/2	7.0	19.0	76.0	1–5
6	OD	Middle Camp	*Casuarina*	Aldabra Lst.	20	10 YR 5/2	7.4	19.0	77.0	0.5–1.0
7	OD	Picard	*Casuarina*	Aldabra Lst.	20	5 YR 3/2	6.4	0.3	99.7	0.8–0.9
8	OD	Picard	*Casuarina*	Aldabra Lst.	20	5 YR 2/2	7.1	0.7	90.3	0.8–0.9
9	OD	Middle Camp	*Casuarina*	Aldabra Lst.	20	7.5 YR 4/2	7.5	27.5	76.9	< 0.1
10	OD	Picard	*Casuarina*	Aldabra Lst.	25	7.5 YR 3/2	7.6	8.0	49.5	0.1
11	CA	Dune Jean-Louis	—	dune sand	10	7.5 YR 8/0	7.9	82.0	0.9	tr.
12	CB	Middle Camp	*Casuarina* and shrubs	Aldabra Lst.	5	10 YR 7/1	7.2	50.5	15.1	1.0
13	CB	Gionnet Camp	sparse shrubs	Aldabra Lst.	10	2.5 YR 6/2	8.0	14.0	29.1	1.0–0.5
14	CB	Dune Jean-Louis	sparse shrubs	Takamaka Lst.	10	10 YR 3/3	8.0	93.0	4.0	0.4
15	CP	Picard	—	Aldabra Lst.	20	5 YR 3/3	8.0	41.0	0.0	1–5
16	CO	Middle Camp	*Casuarina* and shrubs	Aldabra Lst.	10	10 YR 6/3	8.2	22.5	36.2	0.0
17	CO	Dune Jean-Louis	shrubs	Takamaka Lst.	15	10 YR 6/3	7.5	4.0	20.8	0.0
18	CO	Dune Jean-Louis	shrubs	Takamaka Lst.	15	10 YR 5/3	7.9	16.0	41.1	0.5
19	CO	Dune Jean-Louis	shrubs	Takamaka Lst.	15	10 YR 2/2	7.6	8.0	54.8	0.1–0.5

† For notation, see text, pp. 69–70.
‡ Lst. = Limestone.
§ Analysis for horizon 5–10 cm above bedrock.

procedures since it is often the case that over 50 % of any given area is a bare rock surface. This approach is, however, not particularly helpful and in current definitional terms the soils which do exist fall into the rendzina (or U.S.D.A. Rendoll) category. This is a shallow soil, dominantly of one mixed mineral–organic horizon and occurring over calcareous bedrock. The horizon is of high base status. A broader definition is currently in use in Britain which allows for the presence of a B horizon. Typically, however, the soil has an A/C or A/R profile (the horizon nomenclature used is given in table 2). A broad soil survey approach would not be particularly helpful unless conducted at a large scale mapping level. It is only possible to use the existing works and attempt to cross-reference their partial observations. Baker (1963) has identified soil groups, as has Piggott (1968), with reference to soils in the Seychelles. Hnatiuk (Hnatiuk & Merton 1979, this volume, and personal communication) has undertaken a description of soil types in a botanical context as do Merton *et al.* (1976, and Merton's field notes). Trudgill (1972) has suggested a grouping of soil types, based on pedological and geomorphological observations.

Existing soils information is based on surface observations and sampling of profiles for a variety of purposes. The field work of Merton was based on the collection of soil profile data and samples under contrasting vegetation types. The sample data are discussed below and summarized in the tables. Hnatiuk (Hnatiuk & Merton 1979, this volume, and personal communication) discusses the existence of the soil series recognized by Piggott, namely (1) the Farquhar series (a soil formed on windblown sand, with or without a shallow organic horizon, overlying a slightly lighter colour sand and underlain by a transitional zone merging into unaltered sand); (2) the Shioya series (a soil formed on water-lain sand with an A horizon merging into lighter coloured sand) and (3) the Desnoeufs series (a phosphatic humus soil formed from bird excreta, fish waste and bird remains). Saline soils are seen in the bottoms of summer flooded basins. Trudgill (1972) recognized a shallow organic soil (0–10 cm) and a deep organic soil (10–30 cm) and calcareous mineral soils, with or without organic horizons. A proposed scheme of soil types is outlined below, by amalgamating all the existing work. It should be stressed that this is an interim scheme, based on a limited number of examples of soils. It is emphasized that cross-correlations can only be reliably checked by further field work. Moreover, care should be taken not to confuse terrestrial sediments and palaeosols (Braithwaite 1975) with the more recently formed soils under discussion here. The groupings suggested below are based on field observations of profile nature and upon laboratory analysis. They are not based on any speculations as to the origin of the soils. The analytical techniques are listed in table 1, the horizon nomenclature is given in table 2, and selected profile and analytical details are given in table 3. The occurrences of the soils on the island are given in a section after the profile descriptions, though this information is partial.

Aldabra soils – an interim identification of types

The main types are as follows (with shorthand notation):

(1) *Organic soils* (O)
- (i) shallow (0–10 cm) (OS)
  - + pellet variety (OSP)
  - + guano variety (OSG)
- (ii) deep (10–30 cm) (OD)

(2) *Carbonate soils* (C) (i) calcarenaceous (CA)
(ii) brown carbonate (CB)
+ (humic) phosphatic variety (CP)
+ cavity fill variety (CF)
(iii) organic brown carbonate (CO)

3. Other sedimentary (S) types with little or no pedological organization or plant growth:
– organic (algal) sediments (SA)
– carbonate sediments in enclosed basins (SM).

The details of each soil type are given below. The ranges of data given are not necessarily exclusive limits, but represent commonly found ranges in the samples studied.

(1) *Organic soils*

These are accumulations of litter on rock surfaces. The litter may show varying degrees of decomposition. If the bedrock is not well consolidated, lithoclastic and bioclastic fragments of rock (1–10 mm in size) may be mixed in the lower layers of the soil, but not as a distinct horizon. Other than rock fragments or gastropod shells, no substantial mineral matter is present. The profile commonly consists simply of decomposing litter passing abruptly to case hardened bedrock, or in the case of deeper, more acid soils, merging distinctly into soft, non-case hardened limestone. Subdivisions can be made according to the depth of the soils and the origin of the organic matter:

(i) *Shallow organic soil*

Depth of up to 10 cm. Typically occurring under stands of mixed scrub in pockets and small patches, but occasionally more extensive. Accumulations of gastropod shells may be present.

General profile:

depth/cm	horizon†	description and analytical data‡
0–5	L	Litter from shrubs. pH 6.5–7.0
5–10	F	Merging to partly decomposed leaves. Some humus; pH 7.0–8.0; colour, 10 YR 3/3–5/2; carbonates, 15–20 %; organic matter, 50–80 %§; phosphate, 0.1–0.5 mg/g. Sharp boundary.
10 +	R	Limestone (usually case hardened).

Pellet variety. The soil is of faecal pellets of millepedes/orthopterans.

General profile:

depth/cm	horizon	description and analytical data
0–5	L	Invertebrate faecal pellets. pH: 6.5–7.0.
5–10	F	Merging to partly decomposed pellets. pH 7.0–7.5; colour, 10 YR 3/3; carbonates, 0–10 %; organic matter, 40–60 %; phosphate, (no data available). Sharp boundary.
10 +	R	Limestone (usually case hardened).

† Horizon nomenclature is given in table 2.
‡ Methods are given in table 1.
§ Any balance is soluble non-carbonate plus acid insoluble residue.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Guano variety. Present-day accumulation of guano, fish and bird remains. Usually confined to nesting colonies on lagoon islands; (see also under brown carbonate soils, (humic), phosphatic variety (CP), but more organic and fresher than this).

(ii) *Deep organic soils*

A rather more well developed soil, usually of depth 10–30 cm and possessing a well marked humified layer. Occurring in pockets and also in blankets, especially under stands of *Casuarina*; also under *Ficus*. Mostly over non-case hardened rock, occasionally over sand.

General profile:

depth/cm	horizon	description and analytical data
0–2(5)	L	Needles and cones of Casuarina. Merging to
2(5)–10	F	decomposing needles and cones of *Casuarina*.
10–30	Ah	Merging to mixed humus and limestone particles in varying proportions. pH 6.5–7.5; colour, 5YR 3/2 (more calcareous) to 7.5 YR 4/2 (more humic); carbonates, 0.5–30 %; organic matter, 50–90 %; phosphate, 0.1 mg/g. Variability in data due to differing proportions of humus and limestone particles. Distinct boundary.
30+	C	Unconsolidated bedrock, not case hardened, or if so then not to the extent of subaerially exposed surfaces. Brown stained (by humus and/or iron); for 1–5 cm merging into soft bedrock limestone,
	R	no brown staining.

(2) *Carbonate soils*

These soils are dominantly composed of carbonate particles, though some organic matter may be present, either as a discrete surface horizon and/or as an intimate fraction within the soil. Most profiles have an horizon of unconsolidated mineral matter passing to bedrock. The soils can be subdivided according to texture, the presence or absence of surface organic horizons and of reddish (phosphatic, humic) material.

(i) *Calcarenaceous carbonate soils*

Present on uncemented carbonate sand (calcarenite) and is differentiated from unaltered sand by the presence of a humus stained layer next to the surface.

General profile:

depth/cm	horizon	description and analytical data
0–1	L	Litter (of grasses or shrubs). Merging to
1–2	H	decomposed humus (with root mat if under grass vegetation). pH 6.0–6.5. Distinct boundary.
2–4	A/Ah	Humus stained carbonate sand, whitish/humus and some sand, grey. pH 8.0/7.0–7.5; colour, 7.5 YR 8/0; carbonates, 80–95 %; organic matter, 2–10 %; phosphate, trace. Texture, coarse – fine sand. Distinct boundary.
4+	C	Unaltered sand.

Two important erosional/vegetational situations can be distinguished:

(*a*) *Grassland*. *Fimbristylis* and *Sclerodactylon* present. Relatively stable and not prone to erosion while vegetation root mat is intact.

(*b*) *Shrub*. *Tournefortia*, *Scaevola*, *Guettarda* (occasionally some *Casuarina*, *Cocos*) present. Relatively unstable, often only loose litter on sand surface. Prone to erosion unless H and A layers are well developed, but, lacking a root mat, is more sensitive than above.

(ii) *Brown carbonate soils*

These soils possess dominantly brown (brown, 10YR 5/3; reddish brown, 2.5YR 5/4–4/4 or greyish brown, 10YR 5/2) carbonate horizons. The texture is predominantly silty (sandy silt, silt and silt loam). There is little or no organic matter present, unless it is a minor proportion of intimate humus.

General profile:

depth/cm	horizon	description and analytical data
0–20	B	Brown silt or silt loam, occasionally laminated, mostly apedal. pH 7.5–8.0; colour, 10YR 5/3–5/2; carbonates, 50–95 %; organic matter, 0–5 %; phosphate, 0.2–0.8 mg/g. Sharp boundary.
20+	R	Case hardened rock, often with layered deposition (whether layers pre-date soil formation or are consequent upon soil formation is not evident).

Humic phosphate variety. These soils have a relatively high phosphate content and are often reddish brown (2.5YR 5/4–4/4). There is little or no discrete surface humus but the soils may have a relatively high content of intimate humus (but still having the appearance of a dominantly mineral soil). This is probably analogous to the Desnoeufs series of Piggott (together with the fresher, guano variety of the shallow organic soil).

General profile:

depth/cm	horizon	description and analytical data
0–10(20)	B(ca)	Reddish brown or brown silt or silt loam. Apedal. pH 7.5–8.0; colour, 2.5YR 5/4–4/4; carbonates, 10–60 %; organic matter, 15–30 %; phosphate, 1–2 mg/g (merging locally with terrestrial sediment of greater age of 5–20 % phosphate; latter present in fills in solution pipes but often, in practice, difficult to distinguish). Distinct boundary.
10(20)	R	Case hardened bedrock, often stained reddish brown and often with layered deposition (whether layers pre-date soil formation or are consequent upon soil formation is not necessarily evident).

Cavity fill variety. Coincident with unlaminated soils and cavity fills recognized by Braithwaite (1975). This is a deep (1–2 m) sedimentary deposit in solution pits, not a surface soil. *Cardisoma* crabs may be present. Little or no horizonation evident (but may support vegetation and therefore of interest). pH 8.0; colour, 5YR 7/3; carbonates, 40 %, organic matter, 0.0; phosphate, 5–20 %.

(iii) *Organic brown carbonate*

The most developed soil on Aldabra in terms of horizonation. Possesses a discrete surface organic horizon and a discrete mineral horizon together with a mixed A horizon. Widely occurring, possibly in need of further differentiation.

General profile:

depth/cm	horizon	description and analytical data
0–2	L	Litter. Merging to
2–10	F/H	decomposing litter (H usually very small). Merging to
10–12	A	mixed humus and carbonates. pH 7.5–8.0; colour, 10YR 6/3; carbonates, 5–20 %; organic matter, 20–40 %; phosphate, 0.1–0.5 mg/g. Distinct/merging boundary.
12–20	B(ca)	Silt or silt loam mineral soil, mostly apedal. pH 7.5–8.0; colour, 10YR 3/3; carbonate, 75–95 %; organic matter, 0–5 % or 10 %; phosphate, 0.2–0.8 mg/g. Sharp boundary.
20+	R	Case hardened limestone.

(3) *Other sedimentary types*

These are materials showing little or no pedological organization and are usually simply sedimentary accumulations in flat or gently concave areas often seasonally or temporarily filled with water. They may comprise organic (usually algal) remains (pH 7.5; colour, 5YR 4/2; carbonates, 10–20 %; organic matter, 70–80 %; phosphate, 0.1 mg/g), or they may be mineral (pH 7.0–7.5; colour, 10YR 7/1; carbonates, 50 %; organic matter, 15 %; phosphate, 1 mg/g). These latter probably merge to Hnatiuk's saline soils. Here, further field work is needed to clarify the distinction between possible terrestrial saline soils and semi-tidal saline soils (such as occur in the southeast of the island inland from the lagoon).

The occurrence of the soil types

(1) *Organic soils*

(i) *Shallow organic*

Widespread, but often occurs in scattered patches in the localities where present. Largely under mixed scrub and also under *Pemphis*. Mostly on champignon but also on other surfaces.

Pellet variety. Local scattered occurrence, open or closed scrub.

Guano variety. Mostly on lagoon islands.

(ii) *Deep organic*

Largely confined to *Casuarina* stands (north and west coast); also under *Ficus* (Takamaka).

(2) *Carbonate soil*

(i) *Calcarenaceous*

Largely coastal locations (south, west and east coast) (also on Michel and other pocket beaches facing the lagoon); shrub/eroded form on unstable dunes.

(ii) *Brown carbonate*

Widespread in location but patchy in occurrence; most common on platin areas and also in some shallow basins elsewhere.

(*Humic*) *phosphatic variety*. Mostly confined to lagoon islands.

Cavity fill variety. Confined to larger solution pits in champignon.

(iii) *Organic brown carbonate*

Most widespread of all, especially on pavé (but also on other surfaces) and under mixed scrub. Often patchy but sometimes relatively continuous covers with only a few rock outcrops appearing through the soil cover.

(3) *Other* (*sedimentary*) *soil types*

Organic confined to pool floor, many localities.

Mineral mostly common on SE platin area.

Also in SE (Cinq Cases) semi-tidal area merging to marine saline sites (mangrove soils occur on lagoon fringes; see MacNae (1971)).

Table 4. Acid (HCl) insoluble residues of examples of Aldabra soil parent materials

site	parent material	percentage
Dune Jean-Louis	solution pipe sediment	18.34
Middle Camp	solution pipe sediment	9.86
Anse Var	*Platygyra* coral (Aldabra Limestone)	8.31
Picard	Calcarenite	4.97
Anse Var	*Goniastrea* coral (Aldabra Limestone)	4.73
Passe Gionnet	Aldabra Limestone, shelly	3.20
Dune Jean-Louis	*Halimeda*, Aldabra Limestone	2.97
Sylvestre	bioclastic phosphate	2.83
Esprit	Esprit phosphorite	2.38
Picard	Aldabra Limestone, coralline	2.37
Cinq Cases	laminated terrestrial sediment	2.21
Esprit	Esprit phosphorite	2.11
Dune Jean-Louis	Aldabra Limestone, shelly	1.99
Anse Var	Aldabra Limestone, calcarenite	1.70
Cinq Cases	laminated terrestrial sediment	1.45
Picard	solution pipe sediment	1.16
Passe Houareau	Takamaka Limestone, algal	0.83
Anse Var	Aldabra Limestone, calcarenite	0.71
Anse Var	Aldabra Limestone	0.58
Dune Jean-Louis	Aldabra Limestone	0.42
West Channels	Calcarenite	0.19

The origins of Aldabra soils

There are six possible sources of soil constituents, four mineral and two organic.

(1) Chemical rock weathering, yielding an insoluble residue.

(2) Mechanical weathering/erosion and deposition, yielding either sand grains or larger rock fragments.

(3) Terrestrial sediments (other than carbonate rocks from marine sources) as described by Braithwaite (1975).

(4) Extra-island sources: atmospheric dry fallout (such as volcanic dust) and solutes.

(5) Leaf litter.

(6) Animal faecal and detrital material (bodies, feathers).

While the proportions of these constituents will vary with locality, some generalizations can be made about their relative importance for the whole island. Data for the acid insoluble residues of examples of Aldabra rock types (table 4) suggest that the rocks and terrestrial sediments fall into three broad categories: (1) very pure (less than 1 % acid insoluble residue); (2) moderately pure (1–5 %) and those with significant proportions of insoluble residue (5–20 %). The data can be summarized as follows with reference to rock types:

(1) 0.1–1.0 %. Calcarenites. Takamaka limestone (algal micrite).

(2) 1–5 %. Some solution pipe sediments; calcarenite pockets, some shell and coral rich portions of Aldabra Limestone; Esprit phosphorites.

TABLE 5. CALCULATION OF THE PRODUCTION OF ALDABRA SOILS BY THE ACCUMULATION OF SOLUTION RESIDUE

limestone	acid insoluble residue (%)	erosion rate mm/a	centimetres of residual soil produced in 1000 a	10000 a
Aldabra Limestone	0.83	0.10	0.83	8.3
Picard	4.97 (max.)	0.39	1.94	19.4
Calcarenite	0.19 (min.)	0.39	0.07	0.7
generalized figures				
(1)	0.1	0.05	0.01	0.1
	2.0	0.05	0.10	1.0
(2)	0.1	0.26	0.03	0.3
	2.0	0.26	0.52	5.2

(1) Estimated erosion rate (Stoddart *et al.* 1971).
(2) Mean erosion rate (Trudgill 1976).

(3) 5–20 %. Some solution pipe and phosphatic sediments. Assuming that the dissolution of rock material in acid is pertinent to natural soil-forming processes it can be suggested that the solution pipe sediment (which is of spatially limited distribution) is liable to produce thick soils but that most of the limestones will make a much smaller contribution to soil formation. In the latter case a very long time would have to elapse before a distinctive residual soil could be built up. Given the measured erosion rates of subaerially exposed Aldabra limestones (Trudgill 1976; 1979, this volume), surface lowering rates per 1000 years can be estimated. Assuming the weathering of a cube of rock, and the formation of residue *in situ*, then the percentage residues can be used to calculate probable depths of residual soil formation (table 5).

It can be seen from table 5 that in terms of the conservative estimates of erosion rates and time periods and of the lowest insoluble residues, only a thin skin of residual soil can be expected to have formed. However, the time scale involved since the last emersion is probably longer than 10000 a and possibly as long as 27000 a B.P. (Braithwaite *et al.* 1973). Given this possible time, and taking the higher figure for insoluble residue, it would appear possible for a residual soil of a few centimetres thick to have accumulated *in situ*. Given the possible focusing effects of runoff waters, sedimentary accumulations could be much thicker locally in basins. Since emergence appears to have been periodic it is possible that the ages of different emerged surfaces could be reflected in the depths of accumulation of residual soil.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

The organic soils are essentially derived from leaf litter *in situ*. The thickness of the organic horizons is related to the decomposition rates of the litter. The presence of calcium tends to stabilize humus decomposition. This gives rise to a nutrient rich mull humus, the stable calcium humates aggregates accumulating to give the thickness of the soil. Sand grains, rock fragments and terrestrial sediments form dominant mineral sources. Extra-island sources, such as volcanic dust are, as yet, undetected sources of soil constituents. Animal faecal and detrital material are only of local importance and not a widespread dominant soil constituent.

TABLE 6. SOME ASPECTS OF VEGETATION–SOIL RELATIONS, SELECTED DATA
(from data and samples of L. F. Merton)

sample	vegetation	pH, A horizon	depth of litter/cm	depth of A horizon/cm	A horizon $CaCO_3$(%)	A horizon K/(mg/g)	Na mg/g	NaCl equivalent mg/g
1	*Casuarina*	7.2	1.0	5.0	9.8	0.65	4.3	10.6
2	*Casuarina*	7.6	1.0	5.0	59.0	0.30	51.8	132.0
3	*Guettarda*	7.7	2.5	6.5	35.0	0.70	2.1	5.4
4	*Guettarda*	8.7	1.0	2.0	43.0	0.50	2.6	6.5
5	*Pemphis*	6.6	1.0	3.0	8.0	0.10	0.1	0.3
6	*Pemphis*	7.6	4.5	3.0	14.0	3.05	77.5	197.4
7	*Pemphis*	8.3	1.0	5.0	22.0	0.42	0.8	2.0
8	*Pemphis*	6.6	2.0	12.0	8.0	0.38	1.8	4.6
9	*Euphorbia*, *Acalypha*, *Pemphis*	7.9	2.0	7.0	30.0	0.35	11.0	28.0
10	*Acalypha*, *Cyperus*	7.1	1.0	3.0	4.5	0.39	0.7	1.7
11	*Pandanus*, *Ficus*	7.8	1.0	3.0	5.0	0.35	1.1	2.8
12	*Ficus*	8.0	0.0	0.5	19.0	0.35	1.0	2.6
13	*Thespesia*	7.9	1.0	2.0	38.8	0.38	2.1	5.2
14	open ground	7.7	1.0	2.0	8.5	0.40	2.9	7.4
15	'coastal scrub'	8.6	1.0	2.0	42.0	0.60	2.9	7.4

ECOLOGICAL INTERRELATIONS

The soils of Aldabra are important as a rooting medium for herbaceous ground flora and for a proportion, but not all, of the shrubs and trees. Some of the woody vegetation is actually rooted in the rock stratum and not in the surface soil. Their roots penetrate through solutionally opened crevices and cavities into terrestrial or marine sediments. Nevertheless, the chemical and physical properties of the surface soils which have been described will be edaphic considerations relevant to all the herbaceous and to a proportion of the tree and shrub vegetation. Furthermore, it may be observed that many of the soils do not bear much relation to underlying geology. The nature of the vegetation cover is just as important a factor in determining the nature of the soil.

Some data on some aspects of vegetation–soil relations are presented in table 6. The salinity (NaCl) data are calculated from sodium data.

Since only the dominant shrub vegetation is given in table 6 then the influence of shrub vegetation on soil type is more apparent than the influence of soil type on herbaceous vegetation. The thickest organic horizons occur where *Casuarina* and also, to a lesser extent, *Pemphis* occur. The *Pemphis* litter appears to be more acid than that of other plants. Some soils appear to be relatively highly saline. These appear to be largely related to proximity to pocket beaches (e.g. Anse Var) or to location on the exposed southeast coast.

In addition, the highly alkaline soils (pH 8 and above) may present some nutritional problems in terms of elements which are less soluble at high pH (such as iron, manganese, zinc and phosphate). Moreover, in the shallow soils of open structure, water retention is likely to be low. It should be possible to specify these limiting factors more precisely in the light of further analyses.

Conclusions

Three primary sources account for the bulk of Aldabran soils: (1) mechanically derived carbonate fragments (lithoclastic grains of cemented limestones and bioclastic grains of organic skeletal material), (2) chemically derived solution residues and (3) leaf litter. Phosphates, faecal material and terrestrial sediments are of local importance as soil parent materials. The nature of the tree and shrub vegetation has considerable influence upon the nature of the organic soils. Estimates of weathering rates and data on acid insoluble residues suggest that it is possible for a residual soil of the order of 2–10 cm thickness to have been formed during the latest emergence time of Aldabra which has lasted to the present day. The presence of deeper organic soils tends to be coincident with a lack of case hardening of the subsoil rock surface, but case hardening appears to be present under all other soil studied. The degree of mixing of organic and carbonate mineral matter varies considerably. The relative amounts and dispositions of organic and mineral matter can be used as a basis for the grouping of soil profiles into organic, carbonate and intermediate soil types, but further work is necessary over the whole atoll before the full nature and extent of the soils can be determined.

The assistance of the Royal Society and the N.E.R.C. made the field work possible. The help in the field of Dr C. J. R. Braithwaite, Dr J. D. Taylor and Dr W. J. Kennedy are gratefully acknowledged. The British Geomorphological Research Group made a grant towards the cost of the soil analyses which were undertaken by Mr G. Ulmanis and Miss J. Crosland. Dr D. J. Briggs, Dr D. R. Stoddart, Dr R. J. Hnatiuk and Dr C. J. R. Braithwaite are thanked for criticism of the manuscript. Some of the data have been derived from the soil samples and field notes of Dr L. F. H. Merton (deceased).

References (Trudgill)

Baker, B. H. 1963 Geology and mineral resources of the Seychelles Archipelago. *Geol. Surv. Kenya Mem.* **3**, 106–110; 126–127.

Braithwaite, C. J. R. 1975 Petrology of palaeosols and other terrestrial sediments on Aldabra, Indian Ocean. *Phil. Trans. R. Soc. Lond.* B **273**, 1–32.

Braithwaite, C. J. R., Taylor, J. D. & Kennedy, W. J. 1973 The evolution of an atoll: the depositional and erosional history of Aldabra. *Phil. Trans. R. Soc. Lond.* B **266**, 307–340.

Hnatiuk, R. J. & Merton, L. F. H. 1979 A perspective of the vegetation of Aldabra. *Phil. Trans. R. Soc. Lond.* B **286**, 79–84 (this volume).

Merton, L. F., Bourn, D. M. & Hnatiuk, R. J. 1976 Giant tortoise and vegetation interactions on Aldabra Atoll, I. *Biol. Conserv.* **9**, 293–304.

Piggott, C. J. 1968 A soil survey of the Seychelles. *Tech. Bull. Land Resources Division, Dir. Overseas Surv., no.* 2. Tolworth, Surrey.

Stoddart, D. R., Taylor, J. D., Fosberg, F. R. & Farrow, G. E. 1971 The geomorphology of Aldabra Atoll. *Phil. Trans. R. Soc. Lond.* B **260**, 31–65.

Trudgill, S. T. 1972 Process studies of limestone erosion in littoral and terrestrial environments, with special reference to Aldabra Atoll. Ph.D. thesis, University of Bristol.

Trudgill, S. T. 1976 The subaerial and subsoil erosion of limestones on Aldabra Atoll, Indian Ocean. *Z. Geomorph.*, suppl. **26**, 201–210.

Trudgill, S. T. 1979 Surface lowering and landform evolution on Aldabra. *Phil. Trans. R. Soc. Lond.* B **286**, 35–45 (this volume).