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VIII — THE PLANT FORMATIONS OF WESTERN  
BRITISH SOMALILAND AND THE HARAR PROVINCE  
OF ABYSSINIA.

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When the boundary between British Somaliland and Ethiopia was being demarcated in 1931, Kew was invited by the Colonial Office to send a botanist to be attached to the Boundary Commission. Thanks to the existence at that time of the Empire Marketing Board's Grant to Kew, it was possible to take advantage of this valuable invitation, and Mr. J. B. Gillett, then a scholar of King's College, Cambridge, was appointed botanist with the Commission (see Kew Bull. Annual Review, 1932, p. 4, and 1933, p. 4).

Unfortunately, there has been a long delay in working out the extensive collections made by Mr. Gillett, which he was unable to do himself owing to other duties; the work, therefore, had to be carried out by members of the African Section of the Herbarium Staff, when time could be spared from their normal work on the numerous collections then being received from West Tropical Africa. With the conclusion of the "Flora of West Tropical Africa" in 1936, it was possible to complete the identification and enumeration of Mr. Gillett's collection and to write the full account.

Owing to the outbreak of the war and Government restrictions on printing, the publication of the paper has suffered further delay, but now with the recovery of British Somaliland and the restoration of Ethiopian sovereignty, we are fortunate in being able to publish Mr. Gillett's valuable contribution to the Flora of Somaliland and the adjacent regions of Abyssinia.

A. W. H.

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SETTING AND PHYSIOGRAPHY.

The area dealt with lies between  $41^{\circ} 30'$  and  $45^{\circ} 30'$  E. and  $8^{\circ} 30'$  and  $11^{\circ} 30'$  N. It includes five topographic regions:— (1) the Gulf of Aden coastal plain, or Guban, 40 to 110 kilometres in width, broken in places by hills and small mountains, usually representing faulted-down blocks of the plateau; (2) the mountains forming the margin of the plateau from 1,200 to 1,800 m. high. These are much broken up by river valleys running down from the watershed, some 40 to 80 kilometres behind the edge of the plateau; (3) the high part of the plateau including the watershed and the area between this and the edge of the plateau, known in parts as Ogo; (4) the great plains sloping gently down to the south of the



and Eocene in the east. In the Haud the limestone is continuous. In places in the Guban and along the edge of the plateau lava-flows occur. Many parts of the Guban are covered by alluvium.

#### CLIMATE.

There is a double rainy season over the greater part of the area, one rainy period being about May and another about August. In addition in the Guban and the coastal mountains a more or less regular winter rainfall occurs. The rainfall is scanty everywhere except in the Harar massif and a few small parts of the coastal mountains. Such weather records as are available are referred to in more detail in the accounts of the different plant formations.

#### THE PLANT FORMATIONS.

The following seven plant formations, in Clements' sense of the word, occur :—(1) Subdesert ; (2) Commiphora—bush Acacia open deciduous scrub ; (3) Tree Acacia open woodland ; (4) Tree Commiphora—Acacia—Combretaceae deciduous scrub ; (5) Evergreen scrub ; (6) Evergreen forest ; and (7) Erica thickets. The areas occupied by these formations so far as they were ascertained are shown on the accompanying map.

#### I. THE SUBDESERT.

The vegetation is composed of scattered, dwarf, woody plants less than half a metre high with small, usually hairy leaves, and scattered, tufted, grasses. Trees and bushes are found only beside watercourses, or where there is underground drainage water. The plants, although very openly spaced above ground, form a closed network of roots below and no such complete absence of vegetation occurs as in a true desert.

This formation seems comparable with the vegetation of the coastal plain in eastern British Somaliland, and perhaps with that of sandy soil in the Hormo district ( $10^{\circ} 33' N.$  by  $48^{\circ} 59' E.$ ) described by Collenette (31).

The area occupied lies along the coast up to an altitude of about 150 m. and on the 900 m. plateau crossed by the railway from Diredowa to Jibuti.

*Environment.*—Rainfall : records for two stations, Berbera and Zeilah, are available. At Berbera the average rainfall over 11 years was 51.7 mm. and at Zeilah over 7 years, 127.75 mm. In this period the minimum annual rainfall was 9.3 mm. at Berbera and 16.6 mm. at Zeilah. One year in three has a rainfall of under 25.4 mm. at Berbera and under 50.8 mm. at Zeilah. Most of the rain falls in winter or early spring in showers. On an average there are 6 months in the year at Berbera without a trace of rain and at Zeilah 5, while in some years there may be 8 or 9 months

without rain. Probably of very great importance for the establishment of seedlings are occasional unusually rainy years. In 1926, for instance, 166 mm. of rain fell at Berbera and 273.5 mm. at Zeilah, only 3 months being without rain at Berbera and 2 at Zeilah.

Temperatures: The absolute annual shade maxima are between 41° C. and 49° C. and the minima from 10° C. to 16° C. The average mean monthly maximum is about 33.5° C. Of course in the more elevated parts of this formation lower temperatures may be expected.

The soils here are either pale sands or grey and powdery. The six samples examined were all rich in lime and strongly alkaline. In many places accumulations of chlorides or of gypsum and sodium salts occur. The presence of these salts certainly exerts a strong influence on the vegetation and accounts for some strange phenomena. For instance at Berbera imported trees grown under irrigation sometimes die after the rare heavy rainstorms. This is probably because the storm raises the level of the saline ground water so that it kills the roots of the trees.

*Communities within the subdesert formation.*—These may be distinguished according to the following habitats:—(1) eluvial soil, not deep sand; (2) deep sand; (3) places where ground water is available; (4) places where salts accumulate — Halosere; (5) Hydrosere.\*

(1) On eluvial soil other than deep sand, the dominant plants are woody herbs usually between 10 and 50 cm. tall, with smallish hairy leaves, and scattered at intervals of a metre or more. Such are *Aerva tomentosa* Forssk.\*, *Jatropha glandulosa* Vahl. and *Farselia longisiliqua* Decne. Between these are scattered tufted grasses and small woody dicotyledons. The absence or great scarcity of succulents is noteworthy. Among the grasses and sedges are *Aristida* sp. (4664)†, *Enneapogon* sp. (4665), *Aristida abnormis* Chiov., *Aristida mutabilis* Trin. and Rupr., *Aristida* sp. (4750) and *Cyperus conglomeratus* Rottb.

(2) On deep sand occur almost pure societies of the chamaephytic grasses, *Eragrostis hararensis* Chiov.\* or *Panicum turgidum* Forssk.\* Sometimes the two occur together. They are from 10 to 40 cm. tall and occur at intervals of 40 cm. or more. Their numerous fine roots, which spread in all directions for 50–90 cm., bind the sand.

In slight depressions, whether on sand or other soil, where storm water collects and runs off, suffruticose *Indigoferae* and other plants with deep tap roots are very prominent; such are *Indigofera Ruspoli* Bak. f.\*, *Cucumis prophetarum* L., *Crotalaria dumosa* Franch., *Indigofera arabica* Jaub. & Spach, *Indigofera spinosa* Forssk., *Crotalaria aegyptiaca* Benth., *Pavonia Sennii* Chiov.,

\* An asterisk indicates the species has a native name; to save space and repetition these have been listed at the end with the scientific names to which they belong (see p. 74); for the same reason the botanical authority is given only once.

† The numbers in brackets are the author's collecting numbers.

*Dipterygium glaucum* Decne, *Tephrosia purpurea* Pers., *T. uniflora* Pers., and *Convolvulus Hystrix* Vahl. In the dry season these deeply-rooted species are conspicuously greener than the grasses around them.

(3) A feature of the subdesert are the alluvial fans in which the "tugs"† from the interior spread out and disappear. In these and in adjacent deep-soiled plains ground-water is within reach of deeply-rooted species, at any rate at certain seasons. *Balanites orbicularis* Sprague\* and *Maerua somalensis* Pax\* in the west, and *Zygophyllum Hildebrandtii* Engl.\* in the east are the principal of these. These three species are all evergreen and deeply rooted. The roots of a 2.75 m. bush of *Dobera glabra* Juss.\* in the subdesert were seen penetrating 12 m. of soft lava and reaching a sandy river bed where they were still over 5 cm. in diameter. In between the very scattered individuals of these species the herbaceous vegetation is usually much the same as where ground-water is lacking. In parts where ground-water is more plentiful Acacias occur as well as these evergreen trees. *Acacia spirocarpa* Hochst.\* and *A. sp.* near *Bussei* Harms\* are the chief. Here the herbaceous vegetation is usually richer; geophytes such as *Littonia obscura* Baker, *Scilla carunculifera* Chiov. and *Steinheilila radians* (Forssk.) Decne, are especially common, though they may also be found elsewhere.

If it is to be supposed that these trees depend on underground water, the problem of how their seedlings become established must be solved. The exceptional rainy years which occur in this formation probably play a part, and it is not unlikely that the burrowing rodents, which abound in these parts, may carry the fruits down into their burrows, where those which escaped being eaten would start life in a much more favourable position than the arid surface soil. Phillips (29) mentions that the seeds of *Balanites* are dispersed by fruit-eating mammals. A small thicket of young *B. orbicularis*\* trees which was observed near Elmis might have sprung from an abandoned cache of the fruits made by some burrowing rodent.

The diverse effects of wind erosion on the grasses and the *Indigoferae* in this community are worth mention. The grasses rarely have the sand blown away beneath them, as their numerous fibrous surface roots bind it, and they form low hillocks. The tap roots of the *Indigoferae* afford no such protection, and nothing is more common than to see a length of 10, 20 or 30 cm. exposed by the wind. A certain amount of exposure however does not seem to do much damage to the *Indigoferae*, while it kills the grasses.

(4) The Halosere. Owing to its being next to the sea, and to the fact that evaporation very greatly predominates over rainfall, salty places are frequent in the subdesert. On sheltered shores of deep mud, as at Berbera harbour, the shrub *Suaeda fruticosa* Forssk\* is dominant. On deep moist sand the two grasses

† Dry river beds

*Sporobolus spicatus* Kunth and *Aeluropus lagopoides* (L.) Chiov. form a close sward. On shallow sand above coral rock *Cyperus conglomeratus* grows in scattered tufts, while on dry deep earth occur scattered shrublets of *Salsola foetida* Del.\*

(5) The hydrosere of the subdesert formation may be seen at Biyo anod., 42° 40' E., 10° 35' N., where there is a large tug with permanently running water. The sand of the tug bank is fixed by *Panicum turgidum*\* and *Tamarix nilotica* Ehrenb.\*, the latter forming dense groves in which occurs the creeper, *Pentatropis cynanchoides* R. Br.; where these groves are broken up by heavy grazing, *Calotropis procera* Ait.\* is prominent. On ground further above the water and barely flooded, *Acacia spirocarpa* Hochst.\*, *Salvadora persica* L.\*, *Maerua somalensis*\*, *Dobera glabra*\* and *Euphorbia nubica* N.E. Br.\* are dominant, forming dense thickets; creepers are *Cissus rotundifolia* Vahl\* and *C. quadrangularis* (L.) Planch.\*, while *Sansevieria Ehrenbergii* Schweinf. ex Bak.\* is dominant on the ground. The abundance of evergreen and succulent species is noteworthy, also the absence or paucity of any mesophytic ground flora such as is to be seen in similar situations within other formations.

Large tugs at Elmis, 44° 15' E., 10° 20' N., without water near the surface during the dry season, were fringed by thickets of *Acacia spirocarpa*\*, *Ziziphus mauritiana* Lam.\*, *Z. Hamur* Engl.\*, *Balanites orbicularis*\*, *Leptadenia Spartum* Wight\* and *Acacia Senegal* Willd.\* with *Cissus quadrangularis*\* and *Combretum aculeatum* Vent. as climbers. An absence of mesophytic herbaceous forms was noticeable here also.

As shade temperatures of 43° C. are by no means uncommon in parts of the subdesert, the question of the maximum temperatures which plant tissues can endure is sharply raised in it. Some of the animals inhabiting this area are living dangerously near their upper limit of temperature; for instance lizards are said often to die of heat upon being confined in a closed space.

*Economics.*—The subdesert provides a certain amount of grazing for sheep, goats and camels at times when rain has recently fallen.

## 2. THE COMMIPHORA—BUSH ACACIA OPEN DECIDUOUS SCRUB.

The dominant woody plants (except where water is available) are deciduous shrubs, without well-defined trunks and branching from within 1 m. of the ground. They do not exceed 4 m. in height, have small leaves, are usually thorny and resin- or gum-bearing, and often aromatic. The shrubs are spaced well apart so that it is easy to walk between them. Larger trees may occur, scattered at considerable intervals. Between the larger shrubs small ones about 1 m. high occur and the ground vegetation consists of scattered tufts of grass and other plants. On eluvial soils the dominant shrubs are usually species of *Commiphora* and *Acacia*, and on alluvial soils the *Acacia* spp. alone occur.

This formation differs from the *Commiphora*—other species deciduous scrub described by Phillips in Tanganyika Territory in being much more open, in consisting of bushes rather than small trees and in the open scattered nature of the ground vegetation. It seems to be the same as the *Commiphora* community described by Collenette (31) on the northern slopes of the Al hills in eastern British Somaliland, between 300 and 900 m.

The area occupied lies firstly in the south-eastern Haud below about 1,000 m., and secondly in the coastal plain and the lower slopes of the coastal mountains above the subdesert and below about 850 m. This second area becomes very narrow in the extreme west owing to the great extent of the subdesert here.

*Environment.*—No meteorological data are available. It seems clear that the rainfall is less in total amount and less regular than that of the tree *Acacia* open woodland, while greater than that of the subdesert. On the other hand the dry season, certainly in the northern area, and probably in the south-east, is interrupted by occasional rains in January and December. The average temperature is certainly higher than in the tree *Acacia* open woodland so that there will be an even greater preponderance of evaporation over precipitation.

Soils are red, fawn, whitish or light grey and usually contain a high proportion of sand. Deep soils only develop on flat ground as the vegetation is insufficient to prevent their being washed away on slopes, which are therefore always stony or rocky with mere pockets of soil; ten samples were all strongly alkaline even though some were developed from rocks containing no lime. Travertine is usually much less developed than in the tree *Acacia* open woodland but is very prominent where there is ground-water. Organic carbon contents of .088 per cent. and .296 per cent. were found.

The distinction between limestone and non-calcareous rocks seems to make little or no difference to the vegetation in this formation, no doubt because of the absence of leaching and the fact that drainage is always adequate. Salts may accumulate locally in the same way as in the subdesert formation, but less frequently.

*Communities within the Commiphora—bush Acacia open scrub formation.*—The chief communities are:—(1) the climax on eluvial soils; (2) the climax on alluvial soils; (3) hydroseral; (4) overgrazed sub-climax areas; (5) *Rhigozum somalense* Hall. f.\* scrub; (6) a type occurring in the least arid part of the formation on the slopes of the coastal mountains.

(1) *The climax open scrub on eluvial soils.*—The most prominent plants are species of *Commiphora* with their thick, smooth-barked, sappy, strangely contorted branches. Acacias are usually more numerous than the *Commiphoras* though often less conspicuous. In one area of 500 sq. m. there were 45 of the larger bushes 1–3 m.

tall, of which 7 belonged to 3 species of *Commiphora*, 17 to 3 species of *Acacia*, and 20 to 2 other species. These shaded (of course very lightly) approximately  $\frac{1}{4}$  of the area. This seems to be about the average proportion shaded. In the same area there were 76 shrublets under 1 m. high, about  $\frac{1}{3}$ th of them being small individuals of the species already mentioned and the others belonging to 9 other species. Here there were, in 1 sq. m., 4 tufts of grass and 8 other herbaceous plants. The bushes possess an extensive superficial root system so that rain falling on the open ground between them can be utilised. For instance a small individual of *Commiphora cuspidata* Chiov.\*, 1.2 m. high, was found to have roots spreading, between 15 and 35 cm. from the surface, to 8.5 m. distance. The components of the climax scrub differ widely from place to place and in particular those in the Haud are different from those in the north.

The few real trees, which occur widely scattered, are *Acacia spirocarpa*\*, *Balanites aegyptiaca* Del.\* and *Delonix elata* (L.) Gamble\*, the latter alone occurring in the Haud. In the north the chief larger bushes are *Commiphora cuspidata* Chiov.\* and *C. myrrha* var. *molmol* Engl., *Acacia Asak* Willd.\* and *A. somalensis* Vatke\*, *Premna resinosa* Schauer, *Rhigozum somalense*\*, *Euphorbia cuneata* Vahl; and *Euphorbia Thi* Schweinf., the largest succulent in the association. Other bushes are *Commiphora Opobalsamum* var. *induta* Sprague, *Commiphora crenulata* (A. Ven.) Chiov., *C. Gowlello* Sprague, *C. tubuk* Sprague, *C. rostrata* Engl., *C. erythraea* Engl.\*, *Acacia mellifera* Benth.\*, *Caesalpinia erianthera* Chiov., *Jatropha spinosa* var. *somalensis* Pax, *Cadaba longifolia* DC.

In the Haud the chief bushes are *Commiphora erythraea*, *C. samharensis* Sprague, *C. obovata* Chiov., *C. Playfairii* Hook., *C. crenulata*, *C. crenato-lobata* Chiov., *C. Gowlello*, *C. resiniflua* Martelli, *C. ancistrophora* Chiov., *C. flaviflora* Engl., *Lannea triphylla* Engl., *Iphiaona rotundifolia* Oliv., *Sesamothamnus Smithii* Baker, *Dalbergia commiphoroides* Bak. f., *Caesalpinia Gillettii* Hutch. & E. A. Bruce, *Sarcostemma viminale* R. Br., *Boswellia Bricchettii* Chiov., *Grewia* sp. (4215).

Of the small shrubs, in the north the chief are *Grewia tenax* (Forssk.) Fiori\*, *Iphiaona rotundifolia*\*, *Croton Cliffordii* Hutch. et Bruce\* and *C. somalensis* Vatke & Pax, *Tephrosia obbiadensis* Chiov. Others are *Adenia venenata* Forssk.\*, *Adenium somalense* Balf. f. (not common but very conspicuous), *Cadaba glandulosa* Forssk.\*, *Solanum* sp. (4279), *Jatropha spinosa* var. *somalensis* Pax, *Farsetia longisiliqua* Decne, *Cienfuegosia Ellenbeckii* Gurke.

In the Haud the main shrublets are the tall grass *Andropogon cyrtocladus* Stapf\*, *Jatropha parvifolia* Chiov., *Ipomoea Donaldsonii* Rendle, *Adenium somalense* var. *crispum* Chiov., *Lycium europeum* L., *Hildebrandtia somalensis* Engl., *Blepharispernum fruticosum* Klatt, *Cephalocroton cordofanus* Hochst., *Adenia venenata* Forssk., *Iphiaona rotundifolia*.

Some of the chief herbs in the north are:—*Cymbopogon Schoenanthus* Spreng.\*, *Blepharis edulis* (Forssk.) Pers., *Oldenlandia rotata* Baker, *Boerhaavia elegans* Choisy, *Indigofera Ruspoli*\*; others are:—*Sericostoma albidum* Franch., *Boerhaavia repens* L., *Neuracanthus* sp. (4477), *Chrysopogon Aucheri* Stapf var. *quinqueplumis* Stapf\*, *Barleria acanthoides* Vahl, and the succulents:—*Aloe trichosantha* Berger\*, *Portulaca Wightiana* Wall., *Caralluma Edithae* N.E. Br., *Euphorbia longeluberculosa* Hochst., *E. nigripina* N.E. Br., *E. triaculeata* Forssk. In the Haud, *Sporobolus Ruspolianus* Chiov., *Ceropegia subaphylla* K. Schum., *Raphanocarpus Stefaninii* Chiov., *Sarcostemma viminalis*, *Indigofera Ruspoli*\*, *Dorstenia crispa* Engl. and *Vernonia cinerascens* Sch. Bip. are some of the more important herbs.

(2) *The climax bush Acacia community on alluvial soils.*—In the Haud this community occurs in the very slight depressions which alternate on the surface of the plain with equally slight ridges, the latter being covered by the *Commiphora*-bush *Acacia* open scrub. The alternation between the two communities is very striking, as the plain seems as nearly uniform as it is possible to imagine. In the north scattered *Balanites orbicularis*\* and *B. aegyptiaca*\* occur; in the Haud trees are wholly absent. The *Acacia* bushes are dense, 1–2 m. high, and flat-topped. In the north the dominants are *Acacia Sieberiana* DC\* on sand and *A. sp.?* nr. *Bussei*\* (4172 and 4742) on other soils. In the Haud *A. misera* Vatke\* is dominant, *A. Senegal*\*, *A. sp.?* nr. *Bussei*\* (4172), *A. Sieberiana*\*, and *A. mellifera*\* also occur, but much less often. Frequently large areas are covered by unbroken stretches of one or other of these *Acacias*. An occasional larger bush is *Boscia minimifolia* Chiov.\* Other shrubs are *Cadaba farinosa* Forssk.\*, *Grewia tenax*\*, *Lycium europeum* in the north, and *Grewia tenax*\*, *Cordia Gharaf* Ehrenb.\*, *Caucanthus edulis* Forssk., *Ehretia obtusifolia* Hochst.? (4168), *Grewia erythraea* Schweinf., *Maerua sessiliflora* Gilg\* in the Haud. In the north *Indigofera Ruspoli*\* and *Iphiaea rotundifolia*\* are abundant as small woody plants between the *Acacias*. Grasses and sedges which may be locally dominant among the herbs in the north are *Eragrostis hararensis*\*, *Cyperus* sp. (4434), *Lasiurus hirsutus* Boiss. forma, *Chrysopogon Aucheri* var. *quinqueplumis*\*, *Sporobolus variegatus* Stapf\*, *Chaetostichium minimum* (Hochst.) C. E. Hubbard, *Dignanthia villosa* C. E. Hubbard, *Enteropogon barbatus* C. E. Hubbard and *Chloris myriostachya* Hochst. Other herbs are *Crinum ornatum* (L. f.) Bury, *Euphorbia nigripina*, *Ceropegia nuda* Hutch. & E. A. Bruce, *Blepharis edulis*, *Barleria Hochstetteri* Nees, *Corchorus cinerascens* N.E. Br., *Hibiscus micranthus* L., *Indigofera intricata* Boiss., *Eremopogon foveolatus* Stapf, and *Tricholaena teneriffae* Parl. in the north, and *Craterostigma plantaginea* Hochst., *Abrutylon molle* Baker, *Cyclocheilon somalense* Oliv., *Sarcostemma viminalis*, *Scilla somaliensis* Baker, *Commelina albescens* Hausskn., *Coccinea laevigata* Chiov., *Melhania muricata* Balf. f., and *Sarcocornus pallida* Schinz in the Haud.

(3) *The Hydrosere*.—By large tugs having water at or near the surface throughout the year a number of hydrosereal communities may be distinguished. In pools are found *Algae* and *Characeae* such as *Chara vulgaris* L. On the moist sandy floors of tugs an annual vegetation consisting of seedlings of *Tamarix nilotica*\* and such herbs as *Sporobolus spicatus*, *Mollugo Cerviana* Seringe, *Gynandropsis gynandra* (L.) Briq., *Dactyloctenium aegyptium* Beauv., *Datura Metel* L., *Echinochloa colonum* Link, *Farsetia longistyla* Bak., and *Ammannia baccifera* L. springs up. At the margins sand is fixed by grasses less than 1 m. high, of which the most important are *Panicum turgidum*\*, *Pennisetum dichotomum* Delile and *Sporobolus robustus* Kunth; other plants such as *Indigofera articulata* Gouan, *Chrozophora oblongifolia* (Del.) A. Juss. and *Ricinus communis* L., spring up among the grasses; following these come tall reeds such as *Pergularia Daemia* (Forssk.) Chiov. var. *macrantha* Chiov., *Typha angustifolia* L., *Phragmites communis* Trin. and *Saccharum Ravennae* Murr. One of these species may form a pure associates, or two or three may form a consocieties. These give way to thickets dominated by *Tamarix nilotica*\* in which grasses such as *Coelachyrum stoloniferum* C. E. Hubbard, *Cenchrus setigerus* Vahl, *Sporobolus spicatus* and *S. robustus* form a ground flora; *Phoenix* sp. and *Suaeda fruticosa*\*, *Sesbania Sesban* (L.) Merrill, and *Cleome scaposa* DC. also occur.

These *Tamarix* thickets give way to a wood dominated by *Acacia spirocarpa*\*, *Salvadora persica*\*, *Ziziphus mauritiana*\*, and in which *Tamarindus indica* L.\*, *Ficus Sycomorus* L.\*, *Lawsonia inermis* L.\* and *Dobera glabra*\* also occur. This is followed by *Balanites*-bush *Acacia* scrub in which, besides the *Balanites orbicularis*\* and *Acacia* sp. ? nr. *Bussei*\* (4172), *Balanites aegyptiaca*\* and *Acacia Senegal*\* occur.

A different course of events is followed where blown sand occurs. Here, after the pioneer grass stage, a scrub of *Maerua somalensis*\* and *Salvadora persica*\* is formed, with the grass *Eleusine flagellifera* Nees abundant in open places; this gives way to the *Acacia-Salvadora* wood. Where the earlier communities are opened up by grazing a grass community with abundant *Calotropis procera*\* is produced.

Beside tugs which are thoroughly dry for a large part of the year occur tree communities of *Ziziphus mauritiana*\*, *Acacia spirocarpa*\* and *Balanites aegyptiaca*\*, and less commonly *Ziziphus Hamur*\*, and the shrubs *Lepladenia Spartum*\* and *Acacia Senegal*\*.

(4) *Overgrazed Areas*.—Owing to the long dry season and the sporadicity of the rainfall, the *Commiphora*-bush *Acacia* formation is usually not heavily grazed throughout the year, and even after the rains some time must elapse before the Somalis can move their flocks and herds to the area affected. However, by large caravan routes and watering places, severe overgrazing takes place and here the shrubs may be eliminated and the herbaceous flora also much

reduced. In this way extensive bare areas are produced, superficially similar to the sub-desert. Grazed-down bushes of *Grewia tenax*\* especially near gullies, are usually the chief vestiges of the woody vegetation.

(5) *The Rhigozum scrub.* In the lowest parts of the *Commiphora* are other species of open scrub near Mount Elmis, and west of this a very much impoverished scrub occurs, in which *Rhigozum somalense*\* is dominant, and sometimes the only shrub present; the ground flora is also much reduced. Besides various members of the *Commiphora cuspidata*\* scrub a few plants were found here which were not seen elsewhere. These were: shrubs, *Caesalpinia* sp. and *Moringa aptera* Gaertn., and the herb *Convolvulus sericophyllus* Anders. This *Rhigozum* scrub might perhaps be treated as part of a distinct association within this formation, adapted to more xerophytic conditions than the other associations. The Binin was not seen east of Berbera, though *Caesalpinia* sp. (4489) and the *Moringa* occur here also.

(6) *The Commiphora erythraea*\*—*Acacia Asak*\*—*Croton open scrub.* On the lower north-facing slopes of the escarpment at altitudes of from 600–900 m. between the typical *Commiphora cuspidata*\* and shrub *Acacia* communities and the tree *Acacia* formation there occurs, especially on non-calcareous rocks, a special type of the *Commiphora* open scrub in which most of the species typical of the *Commiphora cuspidata*\* scrub are absent, the dominants being *Commiphora erythraea*\*, *Acacia Asak*\*, and *A. mellifera*\* among the shrubs, and *Croton Cliffordii* Hutch. & E. A. Bruce\* and *C. somalensis* Vatke & Pax among the lesser shrubs on eluvial ground, and *Acacia Senegal*\* on alluvial ground. The eluvial community is very similar to the xeroseral community of the *Acacia Bussei*\* open woodland association, but there are no signs that it gives way to tree *Acacia* open wood. *Commiphora crassispina* Sprague and *C. Opobalsamum* var. *induta* occur, and *Grewia tenax*\*, *Premna resinosa* and *Cadaba glandulosa*\* are common shrubs; not found lower down are *Euphorbia somalensis* Pax\* and *E. Robecchii* Pax, *Courbonia virgata* A. Brogn, *Grewia canescens* A. Rich., *Maerua crassifolia* Forssk., *Jatropha Phillipseae* Rendle and *Ochradenus baccatus* Del.; *Euphorbia scoparia* N.E.Br.\* is often abundant in river gorges. A common climber is *Psilotrichum gnaphalobryum* (Hochst.) Schinz; characteristic herbs are the grasses *Danthoniopsis barbata* C. E. Hubbard, *Enneapogon cenchroides* C. E. Hubbard, and *Sporobolus* sp. (4537), and the *Acanthaceae*, *Barleria Hochstetteri*, *B. acanthoides* forma (4436) and *Ecolium Anisacanthus* (Schweinf.) C.B.Cl. Of the hydrosere, *Balanites aegyptiaca*\*, *Acacia spirocarpa*\* and *Lawsonia inermis*\* are typical. Over-grazing of *Commiphora erythraea*\*—*Acacia Asak*\* open scrub eliminates first the *Commiphora* and then the *Acacia*, forming a community with *Croton* as its only woody plant.

The *Commiphora erythraea*\*—*Acacia Asak*\*—*Croton* communities do not occur in river valleys, where the lowest part of the tree *Acacia* formation is the *A. Bussei*\* association. They are confined to mountain slopes, where they border on the *Acacia glaucophylla*\*—*A. etbaica*\*—*Terminalia Brownei* Fres.\* association of the tree *Acacia* formation.

The transition from *Commiphora* and other species of open scrub to the sub-desert. As has been said, the *Commiphora* open scrub is represented at its lowest limits on Mt. Elmis by a scrub in which *Rhigozum somalense*\* dominates. At the lower margins of this scrub the bushes are confined to broken ground and the beds of water courses, open patches of sub-desert appearing on level ground. In the scrub are patches where both *Rhigozum somalense*\* and *Caesalpinia* sp.\* (4489) are standing dead, apparently owing to drought, showing that the transition to the sub-desert is here a matter of climate and not of grazing. At Marmar, on the other hand, where *Rhigozum* scrub does not occur, the outlying *Commiphora cuspidata*\* and *Acacia Asak*\* bushes were found in water courses and stony ground, and at Elmis there is every evidence that grazing is intense and the presence of scattered *Iphiaea rotundifolia*\* and *Cissus rotundifolia*\* within the borders of the sub-desert indicate that at least a portion of this is not climax but a grazing sub-climax to *Commiphora* open scrub.

*Economics.*—The *Commiphora*—bush *Acacia* formation yields various gums and resins of which Myrrh, from *Commiphora cuspidata*\*, and Gum Arabic, from *Acacia somalensis*\*, are the chief. It also provides temporary grazing for sheep, goats and camels.

### 3. TREE ACACIA OPEN WOODLAND.

The dominants are *Acacia* trees, sometimes adjacent to one another but usually well spaced. They are usually somewhat over 3 m. in height and have clear boles for 1' m. or more above the ground and rather flat umbrella-like crowns. They have a very extensive superficial root system so that although the trees are openly spaced there is a close network of roots a few centimetres below the ground. Beneath and between the trees is a carpet of grasses and dicotyledonous herbs, largely members of the *Acanthaceae*. These form a continuous layer except where, as often happens, they are overgrazed. Small shrubs are often present and perhaps succulents. Aloes are often abundant.

This formation seems to be the same as that described for the Buran district in eastern Somaliland by Collenette (31) and as the thorn scrub of the Sudan by Chipp (30), the thorn scrub belt stretching across West Africa south of the Sahara and the bush veldt of parts of the Transvaal and the Kalahari in South Africa.

It differs from the tree *Acacia* open woodlands of East Africa in that these are successional to deciduous scrub (Phillips (31)), while this is climax.

The tree *Acacia* open woodland is the most extensive formation in the area visited; it covers the western part of the Haud above 900 m., the Marar prairie, the Ogo plateau and the coastal mountains above 840 m., except their most well-watered portions.

*Environment.*—Weather records have been kept for some years at 5 places in this formation. The average rainfall over 10 years before 1932 at Sheikh and Hargeisa was 531 mm. and 478 mm. respectively; at Buramo and Erigavo for 6 years before 1932, 620 mm. and 336 mm., and at Burao for 9 years till 1932, 247 mm. The greatest annual rainfall during this period was in 1926 when these stations had 796 mm., 810 mm., 706 mm., 465 mm. and 312 mm. respectively. The least annual rainfall were 297 mm. 315 mm., 406 mm., 267 mm. and 165 mm. There is a short dry period about July between the two rains and a longer winter dry period of 4-5 months when almost no rain falls at all.

This rainfall is insufficient to maintain permanently flowing streams, the watercourses (tugs) only carry water after storms.

The absolute annual temperature maxima range from about 31° C. at Erigavo (1,700 m.) to 35° C. at Burao (1,030 m.), the absolute annual minima from -2° C. at Erigavo to 17° C. at Burao. Frosts occasionally occur in all the stations except Burao. The highest mean monthly maximum ranges from 26° C. at Erigavo to 20° C. at Burao and the lowest mean monthly minimum from 9° C. at Erigavo to 17° C. at Burao.

Soils in this formation are buff, reddish-buff, grey or yellow loams, usually sandy. They are always alkaline or strongly alkaline (15 samples) with Ph. values of 7.5 to 8.5, even when derived from rocks poor in lime. However, in this formation, at least in its moister parts, the vegetation on limestone differs considerably from that on non-calcareous rocks.

Soil can develop here on moderate slopes as there is sufficient vegetation to retain it; any steep slopes are, however, rocky. Salts seem to concentrate near the surface of the soil, the surface soil is found to have a higher Ph. value than that lower down, and in a great many places a hard calcareous crust which may be several centimetres thick (travertine) is formed a little below the surface of the soil.

*Communities within the tree Acacia open woodland.*—This formation is divided into three associations.

(1) The *Acacia Bussei*\* association on the lower parts of the Ogo plateau and in the Haud.

(2) The *Acacia etbaica* Schweinf.\*—*Euphorbia grandis* Lem.\* association on the more elevated parts of the Ogo plateau and the Marar prairie.

(3) The *Acacia glaucophylla* Steud.\*—*A. etbaica*\*—*Terminalia Brownei* Fres.\*—*Dracaena schizantha* Bak.\* association on the coastal mountains.

(1) *The Acacia Bussei\* Association.*—This widespread association seems to flourish under conditions of lower rainfall, higher temperatures and a more severe dry season than the other two *Acacia* open woodland associations. Burao is in this association and has a rainfall of 246 mm. per annum as against 531 mm., 521 mm. and 477 mm. for three stations in the *Acacia etbaica*\* association. An indication of the drier climate here is the absence of lichens which are common on the north side of trees in the *Acacia etbaica*\* association and in the *A. glaucophylla*\*—*Terminalia Brownei*\*—*Dracaena schizantha*\* association.

The climax community under the normal heavy grazing consists of *Acacia Bussei*\* trees from 3 to 8 m. in height, usually in small groups with intervals of as much as 40 m. between them. The superficial root system of the *Acacia* is very extensive; for instance one small individual 3.5 m. high was found to possess a root reaching, about 15 cm. below the surface, to a distance of 18 m. from the trunk. Thus rain falling in the spaces between the trees is utilised by them. The reason for the occurrence of the trees in groups is probably the difficulty of the seedlings becoming established except where some protection is provided from grazing. The branches of a fallen tree provide such protection in which a group of seedlings may often be seen springing up. These develop into one of the characteristic clumps of mature trees. A somewhat peculiar feature which becomes apparent in an air photo is that these clumps of trees, in the level plain of the Haud, all tend to be elongated, with their long axis pointing always in the same direction.

An area of 12,500 sq. metres of *Acacia Bussei*\* open woodland was found to be 20 per cent. shaded by trees and to contain 44 trees and big bushes, namely 32 *Acacia Bussei*\*, 1 *Acacia* nr. *subalata*\*, 10 *Boscia minimifolia* Chiov.\*, 1 *Maerua sessiliflora* Gilg\*, and about 30 small bushes, 10 young *A. Bussei*\*, 13 small *Boscia* and 4 young *Maerua sessiliflora*\*, and a few *Cadaba farinosa*\*.

Thus the density of wooded plants is about 1/40th of that in *Commiphora*—bush *Acacia* open scrub. The proportion of the area shaded was not significantly different, being in this case about 20 per cent.

The herbaceous vegetation consists of a fairly close cover of grasses with other plants subordinate, and 1 sq. metre of ground contained 78 grass plants and 9 other plants. Thus the density of herbs is here about 6 times that in the *Commiphora*—bush *Acacia* open scrub. The grasses and other herbs occurring in the shade of the trees differ from those in the open glades between the trees. In the former situation Acanthaceae and other herbs such as

*Justicia* sp. (4078), and another *Justicia* sp. (4079), *Lycium europaeum*, *Vernonia cinerascens*, and a few small semi-woody plants such as *Solanum obbiadense* Chiov. and chamaephytic grasses as *Chrysopogon Aucheri* var. *quinqueplumis*\* and *Tetrapogon villosus* Desf. prevail, while in the open glades are hemicryptophyte grasses such as *Cenchrus ciliaris* L. and *Sporobolus variegatus*\* often forming pure societies, with sometimes certain geophytes such as *Glossonema hispidum* Hutch. et E. A. Bruce. Frequently in a now open glade the former position of an *Acacia* is shown by a ring of *Chrysopogon Aucheri* var. *quinqueplumis*\*.

Besides the species already mentioned the following are also important in this association:—Trees, *Acacia spirocarpa*\*, *A. mellifera*\*, *Albizia* sp.\* (4095), *Balanites glabra* Mildbr. and Schlecht.\*, undershrubs, *Grewia erythraea*, grasses, *Aristida adscensionis* L., *Sporobolus marginatus* Hochst., *Sporobolus* sp. (4096), *Tetrapogon tenellus* Chiov., *Cenchrus ciliaris* and other herbs, *Polygala obtusissima* Hochst., *Hibiscus somalensis* Franch., *Barleria diffusa* (Oliv.) Lindau, *Solanum carense* Dunal., *Ipomoea cicutarica* Bak., *Commicarpus plumbagineus* (Cav.) Standl., *Hibiscus Hildebrandtii* Sprague and Hutch., *Ocimum tomentosum* Oliv., *Hydnora abyssinica* A. Braun., *Triplotaxis somalensis* (O. Hoffm.) Hutch., *Portulaca oleracea* L., *Becium knyanum* (Vatke) G. Tayl., *Thesium radicans* Hochst., ex A. Rich., *Justicia* sp. (4315), *Crotalaria dumosa* and *Zygophyllum simplex* L.

*Open Grassland*.—Open grassland occurs in two situations in the *Acacia Bussei*\* association, in slight depressions in the Haud, and on the edge of the Ogo plateau just south of the escarpment. *Chrysopogon Aucheri* var. *quinqueplumis*\* is the dominant grass in both places, in the Haud it may be almost pure, in the north other grasses such as *Paspalidium desertorum* Stapf and *Coelachyrum praeflorum* Chiov. are of almost equal importance. The reasons for the existence of the Haud open grassland are probably somewhat as follows.

The depression in which the open grassland occurs being rather moist, a dense growth of grass is possible; since there is no permanent water in the vicinity grazing is not sufficiently intense always to keep the grass down, and fires sometimes occur. These kill young trees and damage old ones. The grazing here is unusually good owing to the higher water content and accordingly a large number of Somali Kurias (nomadic parties) are attracted to the area whenever temporary rainwater pools make it possible to get water anywhere near. The Somalis destroy trees for at least five different reasons. Their camels and goats graze on them (this is especially severe on the young trees which are within reach of the goats), they lop off branches to provide grazing for the goats when the grass is dry, they need a large number of these tree branches for Zarebas which, being eaten by termites, have constantly to be renewed, and they strip the bark to make rope, mats, and other

articles, thus frequently killing trees. In a wooded area this destruction of trees is comparatively unimportant, resulting merely in open patches around large Zarebas, but where an open plain has been produced these destructive influences are intensified since the Somalis supported by the entire plain concentrate on the isolated *Acacia* trees which spring up in the plain, and on the trees at the edge of the plain. Thus an unusually large water supply produces, not, as might be expected, a more luxuriant growth of trees, but their suppression. The same general explanation holds for the open grassland on the edge of the escarpment except that since grazing is always too heavy, fire here plays no great part. The extra showers which this area gets keep the grass fresh for much longer than is usual. An unusual number of Somali Kurias are attracted to the neighbourhood and the trees suffer accordingly.

*Acacia Bussei* Association: *Sand Communities*.—On Nubian sandstone where the soil consists largely of loose sand the bush *Acacia* (*A. Sieberiana*\*) is dominant as a shrub below the trees *A. Bussei*\* and *A. spirocarpa*\*. *Aloe trichosantha* Berger\* and *Croton Cliffordii*\* or *C. somalensis* Vatke and Pax are also abundant in this community. *Grewia tenax*\* and *Maerua sessiliflora*\* also occur, and *Solanum* sp. (4279). It is noteworthy that here the tree *Acacias* show no grove-glade arrangement, but are rather evenly spaced. This may be due to the protection afforded to young trees by the *Acacia Sieberiana*\* bushes, which means that no one part of the community is especially favourable for their growth.

*Acacia Bussei*\* Association: *the Xerosere*.—As might be expected the xerosere of the *Acacia Bussei*\* Association approaches in some ways the climax community of the *Commiphora*—bush *Acacia* open scrub formation. The chief trees are *Acacias*, *A. Bussei*, *A. Senegal*\*, and *A. mellifera*\*, which are found in both the Haud and the North, and *Delonix elata*\*, *Commiphora lughensis* Chiov.\*, *C. ogadensis* Chiov.\*, *Sterculia Rivae* Chiov.\* and *Cadaba heterotricha* Stocks.\*, which are only found in the north, where the xerosere is much better developed owing to the more broken nature of the country. Among bushes in both the Haud and the North occurs *Grewia tenax*\*, in the Haud occur also *Commiphora Gowellelo*, *C. candidula* Sprague, *C. linearifolia* Chiov. and *Acacia eibatica*\*, while in the north *Grewia mollis* Juss., *G. Schweinfurthii* Burret\*, *Euphorbia infausta* N.E. Br.\*, *Aloe Rivae* Baker\*, *Senecio longiflorus* (DC.) O. and H.\*, *Senecio longiflorus* var. *violascens* (A. Berg.), *Sarcostemma viminale* R. Br.\*, *Croton Cliffordii*\* or *C. somalensis*, and on limestone *Periploca ephedriiformis* (Defl.) Schweinf. are found. Characteristic herbs in the north are *Caralluma speciosa* N.E. Br.\*, *Sansevieria Ehrenbergii*, *Aloe trichosantha*\* and in the Haud the grass *Andropogon cyrtocladus*\* which is locally dominant. This grass, which is large and bushy, has most probably been almost entirely grazed out in the north, thus making room for an increase in the *Aloes*, etc., but

survives in the Haud where, owing to the absence of permanent water grazing is less severe.

It is a curious fact that in the xerosere of the *Acacia Bussei*\* association in the Haud the *Commiphorae* are all undersized, rarely reaching 2 m. in height, whereas in the xerosere of this association in the north the *Commiphorae* reach a size unknown elsewhere; thus individuals of *C. lughensis*\* reach 6 m. in height and have trunks with a circumference of 1.5 m., while *C. ogadensis*\* trees reach 5 m. in height and a circumference of .7 m. These large *Commiphorae* in the north occur on steep rocky slopes and cliffs such as do not occur in the Haud, while the stunted *Commiphorae* of Haud occur on almost level stony ground, on which *Commiphorae* do not occur in the north, probably being grazed out. Probably some of the stony mountain sides in the north may get an unusually high amount of rain through catching moisture-laden winds from the Gulf of Aden, and their vegetation, containing large tree *Commiphorae*, then represents not so much the xerosere of the *Acacia Bussei*\* association as a transition towards deciduous scrub.

*Acacia Bussei*\* Association: *Hydrosere*.—The hydrosereal communities in this association are intermediate between those in the *Acacia etbaica*\* association and those in the *Commiphora*—bush *Acacia* formation. The usual pioneer and binding grasses are followed, where there is permanent moisture, by *Typha angustifolia*, *Saccharum Ravennae*, and reed beds with *Phoenix* species. Tamarisk is not very important. The next stage is a *Ziziphus-Acacia spirocarpa*\* wood which is distinguished from that in the *Acacia etbaica*\* association by the presence of the trees *Lawsonia inermis*\*, *Ficus Sycomorus*\*, *Tamarindus indica*\* and the liane *Cissus quadrangularis*\*, while the more open community which follows contains, besides the *Euphorbia nubica*\* and *Aloe abyssinica* Lam.\* characteristic of this stage in the hydrosere of the *Acacia etbaica*\* association, evergreen thickets of *Salvadora persica*\* and *Dobera glabra*\*, abundant *Sansevieria Ehrenbergii*\* and *Aloe trichosantha*\* among the succulents and *Berchemia discolor* Hemsl.\*, *Balanites aegyptiaca*\*, *Cordia ovalis* R. Br.\* and *Turraea parvifolia* Deflers\* among the trees and shrubs.

(2) *The Acacia etbaica*\* Association.—This association is very widespread on the upper parts of the Ogo plateau, mostly above about 4,400 feet.

It contains the following communities:—

- (1) The grazing sub-climax open woodland.
- (2) Hydrosereal communities.
- (3) Xerosereal communities.
- (4) Open grass plains (fire sub-climax).

*Climax (grazing sub-climax) community*.—The dominant tree (*Acacia etbaica*\*) retains its leaves until far into the dry season so that in this respect it is contrasted with the *Acacia Bussei*\* whose leaves fall off much earlier. On account of the persistence of its

foliage the *Acacia* is much lopped to obtain fodder for stock, and as it responds to this treatment by sending up shoots from ground level the community often comes to consist of bushes rather than trees. The only other important tree is *Euphorbia grandis*\*, which may be co-dominant on non-calcareous rocks. *Acacia* nr. *subalata*\* (3948), *Balanites glabra*\* and *Maerua sessiliflora*\* also occur and among the shrubs *Cadaba farinosa*\* and *Euphorbia nubica*\*. Abundant everywhere and sometimes forming close sheets on deeper soil is the 1 m. high *Aloe abyssinica*\*. *Cissus rotundifolia*\* is frequent.

Among the grasses which are always closely grazed *Tetrapogon villosus*, *Chrysopogon Aucheri* var. *quinqueplumis*\*, *Eragrostis aulacosperma* Steud. and *Rhynchelytrum villosum* Chiov. are important. Succulents are *Caralluma speciosa* N.E. Br., *Euphorbia turbiniformis* Chiov., *Caralluma Dicapuae* (Chiov.) Chiov., and *Ceropegia* sp. (4234). A great number of dicotyledonous herbs and shrublets under  $\frac{1}{2}$  m. occur among the grass; of these the Acanthaceae, *Hypoestes Hildebrandtii*\*, *Blepharis fruticulosa* C.B. Cl., *B. edulis* and *Barleria proxima* Lindau are especially prominent; also *Ipomoea cicatricosa*, *Vaupelia heliocharis* (S. Moore) Brand., *Boerhaavia reniformis* Chiov., *Lasiosiphon somalensis* Pearson, *Orthosiphon tenuiflorus* Benth., and *Vernonia cinerascens*. Other herbs are *Barleria parviflora* R. Br. ex T. Anders., *Bouchea sessilifolia* Vatke, *Barleria quadrispina* Lindau, *Lasiosiphon somalensis* var. *glabra* Pearson, *Helichrysum somalense* Bak. f., *Cienfuegosia Welshii* (T. Anders.) Garcke, *Tephrosia simplicifolia* Franch., and *Helichrysum glumaceum* DC.

*The Acacia etbaica*\* Association: *Hydrosere*.—No permanently wet tugs or pools have been observed in this association. Beside temporary tugs, grasses such as *Panicum turgidum* Forssk., *Aristida adscensionis* L. and *Cymbopogon floccosus* Stapf bind the sand. These are followed by a close wood about 8 m. high, of *Acacia spirocarpa*\* with occasional large trees of *Zizyphus mauritiana*\*. This *Acacia spirocarpa*\* woodland consists of much finer trees than those in the climax community. An average specimen of the *Acacia* has a trunk 2.3 m. in circumference 1 m. above ground level, and reaches 8 or 9 m. in height, while the *Zizyphus* trees which occur scattered among the *Acacias* reach 20 m. in height. This in turn gives place to an *Acacia*—*Euphorbia nubica*\* open woodland of *Acacia spirocarpa*\*, *A. Bussei*\*, *Acacia* nr. *subalata*\* (3948), *A. senegal*\* and *A. etbaica*\*, and of *Balanites glabra*\*, amongst which is a dense growth of *Euphorbia nubica*\*, *Aloe abyssinica*\* and other bushes. Where the ground is liable to be water-logged a different succession is followed and a turf of short grasses, such as *Cynodon Dactylon* Pers., is produced under the normal heavy grazing. An example of this near Buramo has been protected for some dozen years from heavy grazing as a Government grazing reserve and here the short grasses are replaced

by others up to 1.8 m. high, in the shelter of which a mixture of *Ziziphus mauritiana*\* wood, and post-climax *Acokanthera Schimperi* Schweinf.\* scrub, seems to be developing.

In the *Ziziphus mauritiana*\*—*Acacia spirocarpa*\* wood, the chief creepers are *Commicarpus plumbagineus* and *Cissus rotundifolia*\*. Species of *Loranthus* are often abundant. Beneath the trees is a rank mesophytic herbaceous vegetation including *Leucas urticifolia* R. Br., *Hypoestes Hildebrandtii*\*, *Boerhaavia diffusa* Lam., *Panicum maximum* Jacq., *Urochloa panicoides* Beauv., *Chloris virgata* Sw., *Setaria verticillata* Beauv., *Chloris pycnothrix* Trin., *Commelina albescens*, *C. Forskalaei* Vahl., *Hibiscus calycinus* Willd., *Crotalaria laxa* Franch., *Wedelia abyssinica* Vatke, *Abutilon ramosum* Guill. and Perr., *Justicia flava* Vahl., *Sida rhombifolia* L., *Ocimum suave* Willd., *Leucas Jamesii* Bak., *Acalypha fruticosa* Forssk., *Dicliptera verticillata* (Forssk.) Nees, *Monechma debile* (Forssk.) Nees, *Verbena officinalis* L.

In the *Acacia*—*Euphorbia nubica*\* open woodland, which succeeds the *Ziziphus mauritiana*—*Acacia spirocarpa*\* wood, occur the following shrubs:—*Solanum incanum* L., *Grewia mollis* Juss., *Cadaba farinosa* Forssk.\*, *Grewia tenax*\*, *Ehretia obtusifolia* Hochst., *Grewia villosa* Willd., *Sarcoslemma viminale*, *Ceropegia De Vechii* Chiov., and a great variety of herbs such as *Solanum carense*, *Dactyloctenium scindicum* Boiss., *Commicarpus plumbagineus*, *Vernonia amplexicaulis* Baker, *Ocimum americanum* Baker, *Eragrostis aulacosperma*, *Sporobolus marginatus*, *Tragus racemosus* All., *Aerva tomentosa* Forssk., *Diceratella sinuata* (Franch.) Oliv., *Cyphocarpa pallida* C.B. Cl., *Hibiscus Hildebrandtii*, *Ochradenus somalensis* Bak., *Pergularia Daemia*, *Ipomoea obscura* Ker., *Nidorella pedunculata* O. and H., *Salsola Bottaie* Boiss., *Pentatropis cynanchoides*, *Sansevieria abyssinica* N.E. Br., *Ruellia discifolia* Oliv., *Justicia aridicola* Rendle, *Pupalia lappacea* Juss., *Cynanchum sarcostemmatoides* K. Sch., *Cucumis dipsaceus* Ehrenb., *Ruellia patula* Jacq., *Ecbolium Anisacanthus*, *Indigofera intricata*, *Ochradenus somalensis*, *Crotalaria albicaulis* Franch., *Melothria* sp. (3962), and *Tragia brevipes* Pax.

Typical of the trees and bushes in these two hydroseral communities are long tap roots which penetrate to underground water. Thus a small individual of *Euphorbia nubica*\* was noticed with a tap root 2.5 cm. in diameter 4 m. below ground level, while a specimen of *Ziziphus mauritiana*\* of under medium size was noticed with roots 6 cm. in diameter 7 m. below ground level. *Acacia spirocarpa*\* also differs from most of the *Acacias* whose roots were examined in having, besides the usual long spreading horizontal roots just below ground level, a strong central tap root. A small individual of this species had a tap root 6 cm. in diameter 3 m. below ground level.

*The Acacia etbaica*\* Association: Communities in the xerosere. The xerosere of the *Acacia etbaica*\* open wood may be not very different from the climax community but succulents are

often much more abundant, for instance *Caralluma speciosa* and *Senecio longiflorus*\* and *S. longiflorus* var. *violascens* A. Berg. (chiefly on non-calcareous soil). *Aloe somaliensis* C. H. Wright\*, *A. trichosantha*\*, *A. abyssinica*\*, *Acacia Senegal*\* and *A. Bussei*\* are frequent. The small bushes *Croton Cliffordii*\* or *C. somalensis* and *Grewia Schweinfurthii*\* are also often abundant.

In loose sand, which is rare in this association, *Acacia Sieberiana*\* occurs.

*The Acacia etbaica*\* Association: Open plains.—In this association is the large open grass tract known as the Marar prairie. Here the soil is deep, the rainfall good, and owing to the lack of permanent water for drinking grazing is less intense than usual. As a result the grass is allowed to grow tall and grass fires occur (observed, February, 1933, and by Burton in 1854), and woody vegetation and Aloes are destroyed. It seems probable that with the advent of more settled conditions and a consequent increase in grazing and diminution in fires *Acacia etbaica*\* is now encroaching upon this plain, at any rate in its most northern part. Patches of *A. etbaica*\* may also be seen wherever any broken ground reduces the intensity of the fires.

(3) *The Acacia glaucophylla*\*—*A. etbaica*\*—*Terminalia Brownei*\*—*Dracaena schizantha*\* Association.

This association occupies the northern slopes of the coastal mountains above the *Commiphora*—bush *Acacia* open scrub where these are not occupied by evergreen scrub or *Juniperus* forest. The association is less prominent on limestone than on non-calcareous rocks owing to the better growth of the evergreen *Buxus* and of *Commiphorae* on the limestone. Where it does occur on limestone the association is represented by a very handsome *Acacia glaucophylla* Steud.\*—*A. spirocarpa*\*—*Dracaena schizantha*\* open wood, the *Dracaenae* being fine spreading trees 10 m. high. On other rocks the dominants are *Acacia glaucophylla*\*, *A. etbaica*\*, *A. nilotica* Del.\* and *Terminalia Brownei*\*. Besides these trees other bushes are scarce, though *Commiphora tubuk* occurs, and in the xerosere *Peucedanum fraxinifolium* Hiern\* on non-calcareous rocks, *Ficus populifolia* Vahl.\*, *Combretum tricanthum* Fres.\* and (on limestone) *Periploca ephedriiformis*. In the hydrosere occur especially *Acacia spirocarpa*\*, *Balanites aegyptiaca*\* and *Grewia mollis*\*. The absence of Aloes from this association is noteworthy. Among the grasses *Chrysopogon Aucheri* var. *quinqueplumis*\*, *Tricholaena setacea* C. E. Hubbard, *T. Gillettii* C. E. Hubbard and *Hyparrhenia hirta* Stapf are prominent. Some of the other herbs found here are *Hypoestes Hildebrandtii*\*, *Selaginella rupestris* Spring on non-calcareous rocks, the *Tiliaceae*, *Triumfetta trigona* Hutch. & Sprague and *T. flavescens* Hochst. which are especially characteristic, *Indigofera oblongifolia* Forssk., *Asystasia Colcae* Rolfe, *Dorstenia foetida* (Forssk.) Schweinf. & Engl., *Lindenbergia sinaica* Benth.,

*Polygala abyssinica* Fres., *Chascanum africanus* Moldenke, *Stylosanthes flavicans* Baker, *Linaria hastata* R. Br., *Pulicaria petiolaris* Jaub. & Spach, *Polygala erioptera* DC., *Pentanisia ouranogyne* S. Moore, *Oxygonum atriplicifolium* Martelli var. *sinuatum* Baker, *Pavonia Kotschyi* Hochst., *Melhania Denhami* R. Br., and *M. rotundata* Hochst.

In this association the Acacias retain their foliage until well into the dry season, if not throughout the year. The lower part of the association, which adjoins *Commiphora erythraea*\*—*Acacia Asak* open scrub, usually has abundant small shrubs such as *Croton Cliffordii*\* or *C. somalensis* and tall woody herbs such as *Triumfetta* and various *Labiatae* and *Malvaceae*. Above, where it adjoins evergreen scrub or Juniper forest, these shrublets are wanting and there is an open sward beneath the Acacias. This latter part may in reality be a grazing sub-climax to the evergreen scrub.

*The effects of grazing upon the tree Acacia open woodland.*—The whole formation is more or less closely grazed and the results of this can be seen in the scarcity of non-thorny trees and shrubs, in the way in which those that do exist are grazed down to a close compact mass, in the frequent patches bare of grass and the abundance of inedible plants such as *Euphorbia nubica*\*, *Aloe abyssinica*\* and *Cissus rotundifolia*\*. In parts of the Haud, owing to the absence of permanent drinking water for the stock, grazing is much less intense and this fact probably accounts for the abundance of the tall *Andropogon cyrtocladus*\* in the Haud, and of small *Commiphorae* and the absence of Aloes and *Sansevieria* which are eliminated by the competition of the grasses.

The problem of what would happen if grazing were eliminated or very much reduced depends on whether or not fires were permitted. In the former case one would expect a great extension of open grass plains. In the latter, parts of the *Acacia elbaica*\* association would probably develop towards evergreen scrub, the species of the latter formation being able to establish themselves in a dense grass cover. Elsewhere in the formation there would probably be a wide development of various small shrubs between the trees.

*Transition from the tree Acacia open woodland to Commiphora—bush Acacia open scrub.*

As the boundary between the two formations is approached species of the open scrub appear in the xerosere of the tree *Acacia* formation. Where the ground is broken the open scrub appears first on south-facing slopes. On level ground isolated dead *Acacia Bussei*\* trees, or whole patches of them, appear. These have probably been killed by drought; the rainfall occurs as thunder-showers and as these cover small well-defined tracts small areas

may get very much less than the usual rainfall if they happen to have been missed by the storms. The *Commiphorae* seem unable to establish themselves under the shade of the Acacias but can do so where the Acacias have been killed. The instability of the *Acacia Bussei*\* open woodland near its lower limit is shown by an occurrence at Burao, where an area of open woodland having been cleared for military purposes it was found that the South-West Monsoon, the "Kharif", whipped up sand and dust storms in the open area which destroyed the open woodland to the North-East, thus continually extending the bare area.

*Economics of the Formation.*—The whole formation provides grazing for sheep, goats and camels. The *Acacia etbaica*\* and the *Acacia glaucophylla*\*—*Terminalia Brownei*\* association also provide grazing for cattle. On alluvial tracts in the *Acacia etbaica*\* association occur the only agricultural areas in British Somaliland, the crops being sorghum, maize and grain. The formation produces gum arabic from *Acacia Senegal*\* and *A. Bussei*\*, and were the demand sufficient, most of the Acacia association could be converted into an *Acacia Senegal*\* plantation by broadcasting the seed, giving a few years' protection from grazing to allow the establishment of the seedlings, and killing the competing *Acacia Bussei*\* and *A. mellifera*\*.

Two of the dominants in the formation, *Acacia Bussei*\* and *Terminalia Brownei*\*, produce barks used for tanning, but these may be of little economic importance. *Sansevieria Ehrenbergii*\* and *S. guineensis*, which are abundant (especially the former) in the *Acacia Bussei*\* association on alluvium, yield fibres of economic importance, and alluvial tracts in this association could be converted into plantations of these species were the demand for the product sufficiently great.

In the *Acacia Bussei*\* association, more especially on caravan routes, the conservation of trees is of economic importance, as these protect the grazing and prevent dust. The government therefore issues edicts against the cutting of trees for fodder in times of drought and for Zarebas. In many parts of the formation, especially in the *Acacia etbaica*\* association, the destruction of the herbaceous vegetation by over-grazing is now leading to serious soil erosion and consequent deterioration of the grazing. Though the destruction of land suitable for agriculture and the gravity of the damage done is realised, no measures of control, whether by reducing the number of stock or giving the grazing areas periodic rests, are being put into practice. Any such remedial measures are made difficult by the lack of education among the Somalis, their mistrust of an alien government, their unwillingness to sell stock owing to the low prices obtained and excessive charges by middlemen, and the lack of money for fencing.

In a great part of the tree *Acacia* formation the value of the grazing is much reduced by the abundance of *Aloe abyssinica*\*; such is the case for example around Buramo and Hargeisa. Since this plant is quite inedible, and nothing else can grow on the ground it occupies, it may reduce the grazing value of a piece of land considerably. It could probably be removed by the following practice, which in other ways would benefit the land. The area would be protected from grazing for some years and the grass allowed to grow tall, where this did not occur readily owing to the tall-growing grasses having been eliminated by continual intense grazing they should be sown. The tall grass would then be fired once, or more often, which would kill off the Aloes and the area would then once more be made open to grazing.

#### 4. DECIDUOUS SCRUB FORMATION.

*Description.*—Small deciduous trees about 3 or 4 m. high, belonging largely to the genera *Acacia*, *Combretum*, *Terminalia* and *Commiphora* are crowded fairly closely together with bushes filling in gaps so that the community is often difficult to walk through. On the ground a fairly dense herbaceous covering is found, in which dense aspect societies of *Acanthaceae*, *Amaranthaceae*, etc., play a large part. It most resembles the tree *Acacia* open woodland, but differs from it in its much greater density and greater richness in species. From the *Commiphora*—bush *Acacia* open scrub it differs in its density and in that the dominants are trees rather than shrubs, while the ground vegetation is continuous and not tufted.

This deciduous scrub seems to be the same formation as that described by Phillips (31) for the central province of Tanganyika territory.

*Area.*—To the south and south east of Harar at 1200–1500 m.

*Habitat.*—No meteorological data are available. It would seem likely that the rainfall is rather higher than in the tree *Acacia* open wood formation, probably about 569 mm. per annum, the average temperature slightly greater and the minimum higher, certainly never falling towards freezing point. Probably the most important factor distinguishing the climate of this formation from that of the tree *Acacia* open woodland is the shorter length of the dry season. The rainfall is insufficient to supply permanent rivers, and those streams which, rising higher up in the evergreen forest formation, run down into this formation, gradually peter out. A soil sample from near the upper limit of this formation (1440 m.) on granite, had a  $P_H$  of 7.5 and .404 per cent. organic matter.

This formation was not examined at all closely as it was merely hurriedly visited towards the end of the dry season (February) when but few of its plants were in flower. Some of the chief trees and shrubs are, *Dichrostachys glomerata* (Forsk.) Chiov., *Acacia*

*pennata* Willd., *A. Seyal* Del., *Capparis tomentosa* Lam., *C. Rothji* Oliv., *Combretum collinum* Fres., *Terminalia Brownei*\*, *Commiphora resiniflua*; others are, *Cissus quadrangularis*\*, *Sterculia Rivaie* Chiov., *Peucedanum fraxinifolium* Hiern, *Acacia spirocarpa*\*, *A. Senegal*\*, *Cadaba farinosa*, *Oncoba spinosa* Forssk., *Ximiphora americana* L., *Gardenia lutea* Fres., *Pavetta gardeniifolia* Hochst. ex A. Rich., *Maerua Hoehnelii* Schweinf. and *Balanites glabra*. Among the herbs was the scarlet-flowered composite, *Notonia coccinea* O. & H.

*Hydrosere*.—On the banks of streams are found groves or woods of tree Acacias and, in places, thickets of *Tamarix* sp.

*Economics*.—Agriculture is practised and in conjunction with it the grazing of cattle and goats. Camels are not important. The cultivated ground is not confined to alluvial tracts but is also on gentle slopes. Where there is permanent running water sugar-cane is grown.

5. EVERGREEN SCRUB FORMATION.

The climax community on mature deep soils is rarely or never found owing to the prevalence of agriculture in this formation. It seems that it would consist of a closed scrub of evergreen or almost evergreen shrubs, small trees and climbers with occasional larger trees. The shrubs are usually thornless and their leathery glossy leaves seem to be very frequently poisonous or distasteful to stock. The shade cast, while fairly deep in places, is much interrupted. Epiphytes other than crustose lichens do not occur. Continuous soils develop even on quite steep slopes. Grass grows densely where the bushes are removed but does not form a regular turf.

The *Buxus* community described by Collenette on the Al Hills in Eastern Somaliland belongs to this formation. It seems also to be the "Gebirgs busch" of Engler.

*Area*.—The formation occupies a fairly extensive zone in the Harar district, between the evergreen forest above about 6,500 feet and the tree *Acacia* open woodland or deciduous scrub below about 5,000 feet. In Somaliland only the xerosere is represented, in the most well-watered parts of the escarpment above about 3,700 feet, where it occurs in fairly small patches.

*Environment*.—There are no meteorological records for the evergreen scrub formation in Somaliland. It is certain, however, that it gets a certain number of showers in the dry season, and also heavy mists and dew. In Abyssinia there are certain data for Harar, which is in this formation. There are two rainy seasons, one with a maximum in April-May and a second with a maximum in July-August. There is no month quite without rain but less than 1 in. per month from October to February. The total annual rainfall is about 33 ins. Permanent streams occur but seem to get

most of their water from the more humid evergreen forest formation above.

The soils are brown, red or black loams. Even when derived limestone they may be sufficiently leached to be poor in lime and approaching neutrality. Organic carbon contents of 0.492 per cent. in an agricultural soil and 2.01 per cent. and 2.49 per cent. in native soils were found. On soils derived from limestone Ph. values ranged from 7 to 8, on those from non-calcareous rock 6.2 and 6.6 were found. It seems that this formation marks the zone above which leaching and below which evaporation predominate in their effects upon the soil.

*Communities within the evergreen scrub formation.*—In Somaliland four different types of xeroseral communities are found, their differences depending on the nature of the underlying rock and on altitude. The climax community does not occur in Somaliland owing to a lack of suitable situations. In the Harar district conditions are suitable for the development of the climax but it has been destroyed by agriculture and the search for firewood. The evergreen scrub around Harar is treated as a whole as sufficient time was not available to work out the various communities within it.

The communities to be described are then; in Somaliland (1) *Buxus-Acokanthera* scrub on lava rock below about 4,200 ft.; (2) *Acokanthera* scrub on non-calcareous rocks from about 4,200 ft.—5,700 ft. with *Euphorbia abyssinica*\*; (3) *Buxus-Commiphora* scrub with *Mimusops Kummel* Hochst. on limestone below 4,700 ft.; (4) *Buxus-Juniperus*, etc., scrub on limestone 4,700 ft.—5,700 ft.; (5) around Harar, the evergreen scrub as a whole.

(1) *Buxus-Acokanthera* scrub on non-calcareous rock below 4,400 ft. This was seen best at Duwi pass, 10° 5' N. by 44° 15' E. on basaltic lava. The dominants are *Buxus Hildebrandtii* Baill.\* and *Acokanthera Schimperii* Schweinf.\* *Buxus* is the only member of the scrub in its lowest parts in ravines at 2,800 ft., *Acokanthera* commences at 3,700 ft. and is dominant in the southern margin of the scrub.

Scattered trees are *Cussonia Holstii* Harms and *Ficus vasta* Forssk.\* and *F. populifolia*. Also *Dracaena schizantha*\* on rocks. Large shrubs, besides the dominants, are *Gymnosporia luteola* (Del.) Loesn., *Teclea pilosa* (Engl.) Verdoorn, *Rhus natalensis* Bernh., *Tarenna graveolens* (S. Moore) Bremek., *Pavetta gardenii-folia*, *Fluggea virosa* Baill., *Canthium bogosensis* Hutch. & E. A. Bruce\* (*Plectronia bogosensis* Mart.), the evergreen *Commiphora Playfairii*, *Maerua sphaerogyna* Gilg & Benedict, *Euclea Kellau* Hochst. and *Grewia tembensis* Fresen. Smaller shrubs are *Coleus* sp. (4493), *Cordia purpurea* Ait., *Clerodendrum myrsinoides* R. Br., *Jasminum Steuderi* Schwarzf., *Azima tetracantha* Lam., *Tremato-*

mostly occupy spaces between the large shrubs, but do not form a layer beneath them. Climbers are two species of *Asparagus* and *Vigna nilotica* Hook. f., *Tragia arabica* Baill. var. *parvifolia* Prain, *Cissus Schweinfurthii* Planch., *Vigna* sp. (4429). These are not abundant in individuals, except *Cissus Schweinfurthii*. Among the herbs of the *Buxus-Acokanthera* scrub are *Haemanthus abyssinicus*, *Cheilanthes coriacea* Decne., *Actiniopteris australis* (L. f.) Link., *Crassula galunkensis* Engl., species of moss, *Selaginella rupestris* and *Commelina benghalensis* Linn.

(2) *Acokanthera scrub* on non-calcareous rocks.—The general features are much the same as for the *Buxus-Acokanthera* scrub but the species are largely different. *Buxus* is subordinate or absent, *Acokanthera Schimperii*\* is everywhere dominant. Other trees and large bushes are *Euphorbia abyssinica* (*E. grandis*), *Olea somalensis* Baker\*, *Gymnosporia luteola*, *Ficus populifolia*\*, *Pappea Radlkoferi* Schweinf.\* Smaller shrubs are *Azima tetracantha*, *Cadia purpurea*, *Euphorbia nubica*\* and *Dodonaea viscosa* Linn.\* Climbers are *Asparagus* sp. and *Senecio subscandens* Hochst., and herbs are much the same as in the *Buxus-Acokanthera* scrub.

(3) *Buxus-Commiphora scrub* with *Mimusops Kummel*\*.—This is a much more open scrub than those previously considered and between the evergreen trees and bushes are numerous deciduous ones, and a high proportion of succulents. The community was seen on the limestone Libah Heleh range, 10° 20' N. by 43° E. where it is fairly extensive.

Dominants are *Buxus Hildebrandtii*\* and *Commiphora lughensis*\*. Other common trees and shrubs are *Dracaena schizantha*\*, *Commiphora ogadensis*\*, *Lannea malifolia* (Chiov.) Hutch. & E. A. Bruce (*Odina malifolia* Chiov.), *Pappea Radlkoferi*\*, *Olea chrysophylla* Lamk.\*, *Sterculia Rivaie*, *Grewia tembensis*, *Canthium bogosensis*\* (*Plectronia bogosensis*), *Combretum tricanthum* Fres., and at intervals of a few hundred metres occur large "Anjel" trees, *Mimusops Kummel*.

Among the small shrubs which occur between the larger ones *Euphorbia infausta*\*, *Croton Cliffordii*\* and *Grewia Schweinfurthii*\* are abundant and *Periploca ephedriformis*, *Dodonaea viscosa*\*, *Aloe Rivaie*\*, and *A. abyssinica*\* and *Adenia venecata*\* are frequent. *Sansevieria abyssinica*\*, *Aloe somalensis*\* and *Haemanthus abyssinicus* also occur here. The relationships of this community are obscure; it seems to pass in places into *Commiphora erythraea*\* open scrub, elsewhere patches, apparently relict, of *Acacia Bussei*\* open woodland are found in it, and, in yet other parts, patches of the *Acacia glaucophylla*\*—*Acacia etbaica*\* open woodland. The rocky soil on which it grows would lead to its being included in a xerere but it seems impossible to suggest what it leads up to.

X (4) *Buxus-Juniperus scrub*.—This type of scrub occurs on the Libah Heleh between 4,700 ft. and about 5,700 ft. In it a succession from *Buxus* scrub to *Juniperus* forest appears to be

taking place, which is periodically checked, probably by droughts. A large number of dead Junipers were seen which may have been killed by the drought of 1927-28. In its more developed upper parts it approaches a low forest, while below it may be quite open. In it are found a larger number of bushes and trees than in any of the other evergreen scrub communities.

The trees in approximate order of importance are Juniperus procera Hochst.\*, Olea chrysophylla\*, Sideroxylon Gillettii Hutch. & E. A. Bruce\*, Pappea Radlkoferi\*, Lannea malifolia Hutch. & E. A. Bruce\* (Odina malifolia Chiov.), Pistacia falcata Becc.\*, Ficus populifolia Vahl\*, F. vasta Forssk.\*, Dracaena schizantha\* and Euphorbia grandis\* (E. abyssinica), the last three being scarce. The Ficus spp. are chiefly found on limestone. The absence of Mimusops Kummel\* and Cussonia Holstii is noteworthy.

The bushes and small trees in approximate order of importance are Buxus Hildebrandtii\*, Gymnosporia luteola, Euclea Kellau, Greua lembensis, Acokanthera Schimperi\*, Canthium bogosensis\* (Plectronia bogosensis), Ziziphus mucronata Willd.\*, Teclea nobilis Del., Ficus glumosa Del., Jasminum Steudneri Schweinf., Pistacea Lentiscus var. emarginata L., Heeria insignis (Del.) O. Kuntze, Ficus salicifolia Vahl, Carissa edulis Vahl, C. edulis var. tomentosa Stapf, Sageretia spiciflora (A. Rich.) Chiov., Commiphora Playfairii, Maerua sphaerogyna, Tarchonanthus camphoratus L., Rhus retinorrhoea Steud. and Fagara chalybea Engl. Climbers are Asparagus sp. and Rhoicissus Revouilii Planch.

Small shrubs are in order of importance, Cadia purpurea Ait.\*, Dodonaea viscosa\*, Euphorbia infausta\*, Ephedra Alte C. A. Meyer, Periploca ephedriformis, Coleus sp., Ballota fruticosa Baker, Euryops pinifolia A. Rich., Lasiosiphon somalensis, and Osyris abyssinica Hochst.

A dry open form of evergreen scrub.—This community occurs above about 5,600 ft. on the south side of the Libah Heleh range and on the Darabileh range to the south of this, in each case on limestone. Its altitude requirements are thus similar to those of the Juniperus forest and, on the Libah Heleh, succession from it to the forest may sometimes be seen; it shares several species with the Juniperus forest and it is *a priori* to be expected that fire and heavy grazing should reduce parts of the Juniperus forest to an open woodland.

For these reasons it is here considered as a fire-grazing sub-climax to the Juniper forest. On the other hand there is a close parallel between the relations of this community with the Juniperus forest and those of the Acacia etbaica\* association with the evergreen scrub, and it is quite possible that this community should be treated either as an association in the open woodland formation or as a separate "broad-leaved tree open woodland" formation.

The five chief trees are *Olea somalensis*\*, *Acokanthera Schimperi*\*, *Combretum ferrugineum* A. Rich., *Sideroxylon Gillettii*\*, and *Acacia elbaica*\*; other trees are *Ficus ingens* Miq. and *F. glumosa*, *Pistacia falcata*\*, and *Pittosporum abyssinicum* Del. These are well spaced and between them are numerous bushes of *Dodonaea viscosa*\*, *Periploca ephedrififormis* on rocky places, *Dicoma somalensis* S. Moore, and *Cadia purpurea*\*.

The transition to *Juniperus* forest is as follows:—Shrubs of the species listed as fringing *Juniperus* forest appear in the shade of trees of the open woodland, forming clumps, Juniper appears in the clumps, the clumps grow larger, coalesce, the fringing shrubs disappear and the process is complete.

(5) *Evergreen scrub* around Harar.—Local dominants are *Acokanthera Schimperi*\*, *Cadia purpurea*\* where *Acokanthera* has been destroyed by fire, *Euphorbia* sp., *Dracaena*, at low altitudes on limestone. Among the larger trees which occur scattered through the scrub are *Ficus* spp., including *F. Thonningii* Blume, *Pappia Radlkoferi*\*, *Croton macrostachys* Hochst., *Erythrina* sp., *Terminalia Brownei*\*. Other bushes and small trees are *Carissa edulis*, *Calpurnia subdecandra* (L'Herit.) Schweickerdt, *Premna viburnoides* A. Rich., *Osyris abyssinica*, *Rumex nervosus* Vahl, *Rosa abyssinica* R. Br., *Vangueria apiculata* K. Schum., *Euclea Kellau*, *Rhus glutinosa* Hochst. ex A. Rich., *Brucea antidysenterica* Lam., *Cassia mimosoides* S. Moore, *Dovyalis abyssinica* Warb., *Tephrosia barbiger* Welw., *Rhus retinorrhoea*, *Acacia seyal*, *Grewia ferruginea* Hochst., *G. canescens*, *Heeria insignis*, *Grewia tembensis*, *Lannea Schimperi* (Hochst.) Engl., *Ochna inermis* Schweinf., *Sageretia spiciflora*, *Secamone punctulata* Decne., *Cussonia Holstii*, *Acacia elbaica*\*, *Fagara usambarensis* Engl., *Periploca ephedrififormis*, *Dodonaea viscosa*\*.

Some of the chief climbers are *Rubia discolor* Turcz., *Commicarpus plumbagineus*, *Cissus adenocaulis* Steud. and *C. Schimperi* Hochst., *Jasminum floribundum* R. Br., *Pterolobium exosum* (Gmel.) Bak. f., *Osyridicarpus Schimperianus* A. DC., *Adhatoda Schimperiana* Nees, *Helinus mystacinus* E. Mey., *Rhoicissus erythroides* Planch., *Stephania abyssinica* var. *tomentella* Oliv.

Parasites:—*Loranthus Schimperi* var. *parviflorus* Hutch. & E. A. Bruce, *L. ugogensis* Engl., *Viscum nervosum* Hochst.; Herbs, *Sida Schimperiana* Hochst., *Rumex nervosus*, *Eulophia Rueppelii* (Rchb. f.) Summerhayes, *Dyschoriste radicans* Nees, *Plumbago zeylanica* L., *Rhynchelytrum repens* (Schum.) C. E. Hubbard, *Arthropteris orientalis* (Gmel.) O. Posth., *Aloe Steudneri* Schweinf., *Hibiscus crassinervius* Hochst., *Indigofera brevicalyx* Bak. f., *Polygala Quartiniana* A. Rich., *Orthosiphon somalensis* Vatke, *Lantana salvifolia* Jacq., *Abutilon angulatum* Mast.

*Economics*.—Cultivation in this zone is comparatively intensive. Sorghum and Maize are the chief cereals and near Harar wherever

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a little water is available for partial irrigation the hill sides are terraced for the cultivation of coffee, *Catha edulis*, banana, sweet potato and other crops. Cattle are kept and mules and donkeys for transport. The population is fairly dense, and has caused much destruction of trees and bushes for firewood.

*The transition from Evergreen scrub to tree Acacia open woodland.*—Evergreen scrub borders on each of the three associations of the tree *Acacia* open woodland. Where the transition is to *Acacia Bussei*\* open woodland, the chief evergreen shrub is *Buxus Hildebrandtii*; where the transition is to *Acacia etbaica*\* open woodland, *Acokanthera Schimperi*\* predominates. Patches of evergreen scrub occur as post climaxes in such places as the banks of stream beds, shady ravines and steep north-facing slopes. An interesting example of the dependence of the evergreen scrub on a higher water supply than that necessary for the *Acacia* open woodland was seen on a Jurassic limestone hill approximately 10° 7' N. by 43° 16' E. Here, on a north-facing slope was an outcrop of a brown limestone fairly rich in clay in the middle of the usual pale limestone poor in clay. On the brown rock, and strictly confined to it were abundant bushes of *Buxus Hildebrandtii*\*, *Ficus salicifolia* and *Lannea malifolia*, while on the surrounding white rocks was *Acacia Bussei*\* open woodland, with *Croton Cliffordii*\*, *Aloe abyssinica*\* and *A. Rivae*\*.

Thus here at the transition zone the greater water retaining capacity of the more clayey soil decided whether evergreen scrub or open woodland should prevail. Elsewhere where the rainfall is higher, evergreen scrub is found on all types of rock.

There is evidence that parts of the open woodland bordering upon the evergreen scrub are in reality a sub-climax which would develop into evergreen scrub if the grazing were less intense. Thus, on the Libah Heleh mountains old *Acacia etbaica*\* trees are found with young evergreen shrubs springing up all round them and at Buramo evergreen shrubs (*Acokanthera*) appear in an alluvial area which has been protected as a government grazing reserve.

## 6. THE EVERGREEN FOREST FORMATION.

The climax community is a forest of evergreen trees with well-marked layers of shrubs and herbs beneath them. Owing to fires and cultivation the climax forest is mostly replaced by various successional communities.

This formation is the same as the sub-tropical evergreen forests of Abyssinia, East Africa and South Africa (Phillips 29).

The area occupied includes the upper parts of the Harar massif from about 6,500 ft. to 9,500 ft. and a small area on the Libah Heleh mountains in western Somaliland. In central and eastern Somaliland it occurs on the summit of the Golis range and on the Surud mountains (Collenette 31).

*Environment.*—No weather records are available. The rainfall however is probably greater than that of Harar, 33 in. per annum. In Somaliland clouds are frequent. The more mature soils are dark brown, dark grey or black. Organic carbon contents of 1.72 per cent., 2.78 per cent. and 4.82 per cent. were found in forest soils and 6.31 per cent. in a moist peaty soil in a marsh. This last soil had a  $P_H$  of 5.4. Eight other soils from various types of community in the moister *Podocarpus* section of the formation had  $P_H$  values ranging from 6.0 to 7.1. Some of these soils were overlying limestone, although none held more than a trace of lime and thus it is clear that here leaching is sufficient for slightly acid soils to be developed even from calcareous rocks. In the drier *Juniperus procera*\* association two soils had  $P_H$  values of 7.2 and 7.4. In this formation a more or less deep layer of soil is produced everywhere except on vertical cliffs.

*Communities within the evergreen forest formation.*—Two well-marked associations occur, a *Juniperus procera*\* association in the drier parts of the formation and a *Juniperus-Podocarpus* association in the moister parts. Only the former is represented in Somaliland.

*The Juniperus procera association.*—The forest is comparatively open and dry, the *Juniperus* not casting a very heavy shade. Generally it grows sufficiently openly to retain its branches down to near ground level and thus differs in appearance from individuals of the same species in the *Juniperus-Podocarpus* association, which grow closer together and develop tall clear boles. In this association *Juniperus* cannot become established in the open but only in the shelter of bushes. This again is in contrast with the other association where *Juniperus* develops out of open grassland. The shrubs of the succession towards *Juniperus* forest are usually also found in the evergreen scrub. Examples are, in the Harar district, *Carissa edulis*, *Calpurnia subdecandra*, *Osyris abyssinica*, *Rosa abyssinica*, *Dovyalis abyssinica*, *Celtis Kraussiana* Bernh., *Juniperus procera*\*, *Clerodendrum myricoides*, *Podocarpus gracilior* Pilger, *Sideroxylon oxyacantha* Baill., *Myrsine africana* L., *Euphorbia polyacantha* Boiss., *Dovyalis verrucosa* Warb. In the Libah Heleh are *Rhus natalensis*, *Pittosporum abyssinicum*, *Teclea nobilis*, *Gymnosporia luteola*, *Adhatoda Schimperiana*, *Carissa edulis* var. *tomentosa*, *Euclea Kellau*, *Sageretia spiciflora*, *Cadia purpurea*.

In the Libah Heleh about 70 per cent. of the trees were *Juniperus procera*\*, 20 per cent. *Sideroxylon Gillettii*\*, and 10 per cent. *Olea somalensis*\*. Among the undershrubs and tall herbs *Ephedra Alte*, *Gymnosporia luteola*, *Psiadia arabica* Jaub. & Spach, *Stachys Hildebrandtii* Vatke, *Coleus albidus* Vatke, *Pollichia campestris* Ait., *Galium Aparine* L., *Umbilicus botryoides* Hochst. occurred. The lesser herbs include *Pleurochaete Beccarii* Vent., *Tortulea atrovirens* (Sm.) Lindl., *Actiniopteris australis*, *Cheilanthes coriacea*, *Asplenium aethiopicum* (Burm.) Becherer, *Eragrostis* sp. The climber *Secamone*

*punctulata* is sometimes abundant. No angiospermous epiphytes occur in this forest, but lichens, including *Usnea articulata* Hoffm., are frequent. This absence of angiospermous epiphytes is another contrast with the *Juniperus-Podocarpus* association.

In very many respects this association represents a transition from the evergreen scrub to the evergreen forest formation. The coffee and *Catha edulis* cultivation, typical of the evergreen scrub, with their characteristic hedges largely composed of tree *Euphorbiae*, disappear in this association, while the cultivation of wheat and barley, typical of the forest formation, begins.

*Juniperus-Podocarpus* forest.—The communities within this formation are numerous and the relations between them obscure. Of the forest itself there are several types containing different proportions of *Juniperus*, *Podocarpus* and other trees, sometimes with neither *Juniperus* nor *Podocarpus* present at all. No attempt can be made to describe these types in any detail but it seems clear that the type with *Juniperus* as dominant is a xeroseral community generally occurring on steeper slopes with shallow soil. The *Podocarpus* only becomes important on deeper soils. On very steep and rocky places a xeroseral evergreen scrub or bush occurs which contains at lower altitudes many species of the evergreen scrub formation and at higher altitudes species typical of the *Erica* thicket formation, including *Erica arborea* Linn. itself.

A very important and extensive subclimax community is open grassland which is produced by the clearing of the forest for grazing and cultivation and is prevented from reverting to forest by fires, grazing and the search for firewood. A stage in the secondary succession from this grassland to forest is represented by a tangled mass of tall rank herbs, climbers and shrubs.

The climax forest consists of (a) large trees up to about 30 m. tall forming either an open or a closed canopy; (b) a layer of shrubs and small trees, interrupted where the big trees form a closed canopy, and continuous where they are open; (c) climbers; (d) herbs; (e) epiphytes.

Among big trees are *Podocarpus gracilior*, *Juniperus procera*\*, *Olea Hochstetteri* Bak., *Pygeum africanum* Hk. f., *Schefflera abyssinica* (Hochst.) Harvey (usually on steep slopes), *Lachnopylis congesta* (R. Br.) C. A. Sm., *Dombeya Bruceana* A. Rich., *Myrica salicifolia* Hochst. ex A. Rich. (in marshy places), *Erythrina Brucei* Schweinf. Some of the chief small trees and shrubs are *Discopodium penninervium* Hochst., *Trichilia Volkensii* Gürke, *Maesa lanceolata* Forssk., *Gymnosporia* sp. (5131), *Teclea nobilis*, *Dracaena afromontana* Mildbr., *Pavetta abyssinica* Fresen., *Cassipourea abyssinica* Alston, *Lasiosiphon glaucus* Fres., *Ekebergia Ruppeliana* A. Rich., *Olea chrysophylla*\*, *Rhamnus Staddo* A. Rich., *Acacia abyssinica*\*

*Galiniera coffeoides* Del., *Lovanthus sarertaensis* Hutch. & F. A. Bruce, *Rhus abyssinica* Hochst., *Buddleja polystachya* Fresen., *Rubus Volkensii* Engl., *Jasminum abyssinicum* R. Br., *Gymnosporia luteola*, *Halleria lucida* L., *Vernonia amygdalina* DC., *Allophylus abyssinicus* (Hochst.) Radlk., *Debregeasia salicifolia* Rendle, *Trichocladus malosanus* Baker, *Bersama abyssinica* Fresen., *Gymnosporia arbutifolia* (Hochst.) Loes.

Some of the climbers and lianes are *Rosa abyssinica*, *Urera hypselodendron* Wedd., *Jasminum abyssinicum*, *Cissus cyphopetala* Fresen., *Toddalia asiatica* Lam., *Asparagus asiaticus* Linn., *Rubus apetalus* Poir., *Periploca linearifolia* Dill. & Rich., *Clematis* sp.

Among the herbs, *Hypoestes triflora* (Forssk.) Roem. & Schultes, *Sida triloba* Cav., *Asplenium monanthes* L., *Acanthus eminens* C.B. Cl., *Ceratostigma abyssinicum* Aschers., *Crassula alsinoides* (Hk. f.) Engl., *Poa leptoclada* Hochst. ex A. Rich., *Veronica abyssinica* Fres., *Digitaria abyssinica* Stapf, *Cardamine africana* L., *Arisaema Schimperianum* Schott, *Pteris dentata* Forssk., *Caucalis incognita* Norman, *Sanicula europaea* Linn., *Euphorbia longecornuta* Pax, *Pimpinella simensis* Bth. & Hk. f., *Phyllanthus meruensis* Pax, *Coleus lanuginosus* Hochst., *Pimpinella Neumannii* Engl., *Viola abyssinica* Steud., *Primula verticillata* Forssk. var. *simensis* Hk. f. (damp rocks), *Hibiscus Ludwigii* E. & Z., *Otostegia repanda* Benth., *Eragrostis Schweinfurthii* Chiov., *Crassula abyssinica* A. Rich., *Vernonia Leopoldii* Vatke, *Athrixia rosmarinifolia* O. & H., *Pteris cretica* Linn., *Stachys aculeolata* Hk. f., *Ranunculus pubescens* Thunb., *Phalaris arundinacea* Linn., *Calamintha simensis* Benth., *Orizopsis* sp., *Sempervivum leucoblepharum* (Webb) Hutch. & E. A. Bruce (cliffs), *Argyrolobium ramosissimum* Bak., *Epilobium fissipetalum* Steud., *Asplenium abyssinicum* Fée, *Apium nodiflorum* Linn., *Adiantum Capillus-Veneris* Linn., *Funaria hygrometrica* Hedw., *Anthroceros* sp.

Among the epiphytes *Usnea longissima* Ach., *Lindbergia abbreviata* (Schimp.) Broth., *Leucodon dracaenae* Vent., *Anaptychia leucomela* Ach., *Peperomia abyssinica* Miq., *Neckera remota* Bry., *Tortula erubescens* (C.M.) Broth., *Xanthoria parietina* Th. Fr., a Lichen (indet.), *Polypodium lanceolatum* Linn., *Peperomia reflexa* A. Dietr., *Orchidaceae* spp. and *Polystachya Rivae* Schweinf., *Leptogium cyanescens* Kbr., *Physcia stellaris* Fr., *Parmelia* sp. (5432), *Ramalina yemensis* Lyl., *Loxogramma lanceolata* (Sw.) Pr.

*Subclimax communities*.—Open grassland. This consists of a close growth of tufted grasses which do not however form a turf such as could be lifted except in places which are unusually damp and well grazed. The area was visited at the end of the dry season, very few of the plants of this community were in flower and it was impossible to determine the dominant grasses. Some members of the community were *Pennisetum clandestinum* Hochst., *Aristida*

*adoensis* Hochst., *Hyparrhenia hirta*, *Silene chirensis* A. Rich., *Cynodon Dactylon*, *Microchloa abyssinica* Hochst. This almost complete cessation of flowering in the dry season is in marked contrast with the state of affairs in the evergreen forest itself where almost all the trees and shrubs were more or less in flower.

In moist places, around springs, etc., there occurred *Lythrum rotundifolium* Hochst. ex A. Rich., *Epilobium hirsutum* L., *Potentilla reptans* Linn., *Nasturtium officinale*, *Alchemilla cryptantha* Steud., *Anagallis serpens* Hochst., *Carex acutiformis* Ehrh., *Siegesbeckia abyssinica* O. & H., *Hydrocotyle monticola* Hk. f., *Scirpus costatus* Boeck., *Pycreus aethiops* C.B. Cl., *Juncus Bachiti* Hochst., *Alchemilla pedata* Hochst., *Fuirena pubescens* (Lam.) Kunth, *Cotula abyssinica* Sch. Bip., *Lobelia stellaroides* Bth. & Hk. f., *Scirpus setaceus* Linn., *Hydrocotyle asiatica* Linn., *H. natans* Cyr.

*Tangle in the secondary succession to forest.*—This community contains a great variety of tall herbs and in addition many of the shrubs listed as members of the forest appear in it. There is usually no single dominant but locally *Echinops Ellenbeckii* O. Hoffm., with its large globular heads of crimson flowers, may be very conspicuous. Other important plants are *Tephrosia atrovioleacea* Bak. f. ex De Willd., *Hypericum Quartinianum* A. Rich., *Momordica Schimperiana* Naud., *Barleria* sp., *Hypoestes antennifera* S. Moore, *Lactuca capensis* Thunb., *Kalanchoe Quartiniana* A. Rich., *Cluytia abyssinica* Jaub. & Spach., *Echinops macrochaetus* Fres., *Hypericum lanceolatum* Lam., *Myrsine africana*, *Senecio myrioccephalus* Sch. Bip., *Phagnalon hypoleucum* Sch. Bip., *Inula confertiflora* A. Rich., *Leonotis velutina* var. *rugosa* Bak., *Lavatera abyssinica* Hutch. & Bruce, *Stephania abyssinica* Walp., *Microglossa Elliotii* S. Moore, *Coreopsis macrantha* Sch. Bip., *Brachypodium flexum* Nees var., *Lithospermum officinale* L., *Pentas Schimperiana* Vatke, *Nepeta Petitiiana* Baker, *Helichrysum globosum* Sch. Bip., *H. Hochstetteri* Hk. f., *H. Schimperii* Sch. Bip., *Pitosporum abyssinicum* Del.

*Economics.*—The forest produces timber of *Podocarpus* and *Juniperus* which might be valuable (that of the *Juniperus* is resistant to insect attacks) but is at present largely wasted, being burnt down to clear the ground for temporary cultivation. Large areas now covered by valueless tangle and scrub or almost valueless grassland could grow *Juniperus* in fairly large quantities. Cattle are kept and the chief crops are wheat (*Triticum durum* and *dicoccum*), barley, various pulses and maize. Coffee and *Catha* are not grown and irrigation is not practised in this community.

*Transition from evergreen forest to evergreen scrub.*—The forest becomes more and more restricted to alluvial areas. Elsewhere *Juniperus* occurs simply as scattered bushes among the other members of the scrub. In the Libah Heleh interesting areas occur in which the *Juniperus* trees have been killed by drought, their

dead stems standing above the *Buxus* bushes which are left in sole possession. Everywhere the transition between the evergreen scrub which is the climax in its own formation and that which is a stage in the xerosere of the *Juniperus* forest is very gradual and it is often impossible to say which community one is in.

(7) *Erica thickets formation*.—The climax community is an evergreen thicket casting a rather light shade of small trees about 4 m. high with *Erica arborea* Linn. as dominant, beneath this is a rich herbaceous vegetation. As a fire-grazing subclimax a grassland is found in which the herbaceous plants form a turf that might be lifted in a sheet. The area occupied is very small, being restricted to a small patch on the summit of Mt. Kondudo above 9,300 ft. (where only the grassland subclimax is represented) and a somewhat larger patch on the summit of Gara mulata above 9,500 ft.

For the climate no data are available. It seems probable, however, that the main difference between the climate of this formation and that of the evergreen forest is one of temperature and not of rainfall. The soils are dark brown or black, leached almost free of lime, organic carbon percentages of 6.29 and 4.55 were found and  $P_H$  of 5.63, 6.63, 6.9 and 7.25.

The climax community occurs chiefly on the more shaded northern slopes of the mountains as here it does not dry out so completely in the dry season and hence is less liable to destruction by fire. The small trees and shrubs are *Erica arborea* dominant, frequent *Hypericum lanceolatum*, *Hagenia abyssinica* Willd., occasional *Pitiosporum lanatum* Hutch. & E. A. Bruce, and *Crotalaria Erlangeri* Harms, *Myrsine africana*, an abundant undershrub, *Lobelia Rhyncoptalum* Hemsl., *Rubus Volkensii*, and among the herbs *Leonotis velutina* var. *rugosa*, *Dryopteris Schimperiana* (Hochst.) C. Chr., and other ferns, *Thalictrum minus* L., *Arabis albidia* Stev., *Scabiosa Columbaria* L., *Helichrysum Traversii* Chiov. (No. 5321), *Ranunculus oreophytus* Del., *Alchemilla kivuensis* Engl., *Conium maculatum* Linn., *Malabaila abyssinica* Boiss., *Cynoglossum coeruleum* Hochst., *Geranium simense* Hochst. ex A. Rich., *Cerastium caespitosum* Gilib., *Bartsia longiflora* Hochst., *Veronica abyssinica* Fres., *Swertia Schimperii* Griseb. and *S. Quartiniana* A. Rich., *Pellaea quadripinnata* (Forssk.) Prantl, *Anthemis abyssinica* J. Gay, *Vicia sativa* var. *angustifolia* Ser., *Lysimachia africana* Engl., *Calamintha simensis* Benth., *Bromus adoensis* Hochst., *Cystopteris fragilis* (L.) Bernh., *Oxyrrhynchium kenyae* Dix. ined., *Mnium rostratum* Schrad., *Funaria hygrometrica*.

On Gara mulata mountain several areas where this *Erica* thicket had recently been burnt down were noticed. The *Erica* was regenerating from its roots but it is clear that too frequent burning would destroy it. Thus is created the open grass fire subclimax which is more extensive than the *Erica* thickets. The

chief grasses were not seen in flower. A marked feature is the abundance of *Helichrysum abyssinicum* Sch. Bip., *Landtia Rüppellii* Benth. & Hk. f., *Hypoxis* sp. (5221), *Thymus serpyllum* Linn., and *Micromeria biflora* Benth. *Albuca abyssinica* Jacq., *Gerbera piloselloides* Cass., *Alchemilla kiwuensis*, *Merendera abyssinica* A. Rich., *Bartsia Petitiiana* Hemsl., *Caucalis melanantha* Steud., *Salvia nudicaulis* Vahl var. *nubica* Bak., *Moraea diversifolia* Baker, and *Argyrolobium virgatum* Baker also occur.

The grassland provides grazing for cattle and on Gara mulata one Galla village is found in this formation.

*Evidence, chiefly Botanical, for a Pluvial Period in Western British Somaliland and Adjacent Regions.*

1. The western subdesert is very poor in plants not found in other formations and the North-Western *Commiphora*-bush *Acacia* open scrub formation is poor in species if compared with the same formation in the eastern coastal districts, and in the eastern Haud. For instance at one spot in the Haud, on a uniform level plain, twelve species of *Commiphora* were collected in three days, while this number of species was not found in as many weeks in this formation in the northern coastal districts, on several types of soil and at different altitudes. Many species of plants do not occur much west of Berbera in spite of apparently favourable conditions being found. Examples are *Conocarpus lancifolius* Engl., *Kelleronia splendens* Schinz and *K. Gillettii* Bak. f., *Acacia misera*\*, *Zygo-phyllum Hildebrandtii*. These facts can be accounted for on the hypothesis that a pluvial period has occurred in geologically recent times in Western British Somaliland during which the subdesert and *Commiphora*-bush *Acacia* open scrub were replaced by more mesophytic formations. When arid conditions prevailed after the pluvial period these formations were formed through migration from the east and south-east and therefore have naturally only a certain number of the species of the latter regions, and a few endemic species of their own. Such a hypothesis will also account for the wide distribution of species belonging to the evergreen scrub formation which are now restricted to small isolated patches. In the pluvial period the evergreen scrub must have occupied a much larger area and the migration of its species was relatively easy. Without some such hypothesis it is very difficult to account, for instance, for the occurrence of *Erica arborea*, a plant with no special means of dispersal, on the Golis range separated by 150 miles of country too dry for it from its nearest station in the Harar district.

Evidence bearing on this question is also available from the *Erica* thicket formation of the mountains near Harar, since here there occur a number of plants such as *Thalictrum minus*, *Ranunculus oreophytus* and *Lobelia Rhyncho-petalum*, which do not occur

below about 9,000 ft. and are separated by many miles of lower country from their nearest station in the main highlands of Abyssinia.

To explain the distribution of these plants it is necessary to assume that the pluvial period was also one of rather lower temperature as it seems to be, in their case, temperature rather than moisture which restricts them to above a certain altitude.

Geological evidence for a pluvial period, according to Mr. Farquharson, the government geologist, is not wanting in Western Somaliland; it takes the form of alluvial gravels more extensive than any present stream could deposit and erosion of eocene deposits greater than could be accomplished with the present climate.

This hypothesis of a recent pluvial period is in harmony with the conclusions of archaeologists and geologists working in Egypt, Kenya and Palestine. See particularly G. Caton Thompson and E. W. Gardner. The hypothesis has certain economic implications as it means that various trees such as *Cordeauxia edulis* Hemsl.\*, valuable for its nuts, and *Conocarpus lancifolius*, valuable for its shade, could probably be successfully introduced into the northern *Commiphora*-bush *Acacia* formation from the eastern and south-eastern regions, the reason for their absence in the north-west being simply a failure to migrate there.

#### *Material in amplification of Collette's Paper.*

*Somali plant names.*—Mr. Collette remarks that Somali plant names fall into two classes, those of Ishaak tribes and those of Darod tribes. To this it should be added that among the Darod tribes there seems to be a division between the Harti group, including the Mijertain, Warsangeli and Dolbahanta, and the remainder of the Darod including the Ogaden, Abasgul, Ali Gheri and Bartiri in the South and South-West. Mr. Collette's Darod plant names are of the Harti group. In the west the Esa have another set of names for plants, which is used in part by the Gudabirsi who, however, also use some of the Ishaak names. The names in this paper are those used among the Ishaak.

*Notes on certain species.*—The two species of *Dorstenia* collected, *D. crispa* and *D. foetida*, were not confined to the southern sides of rocks as Mr. Collette reports for *D. crispa* in the Al Hills.

*Cynanchum sarcostemmatoides* K. Sch., *Caralluma Dicapuae*, *Portulaca somalica* N.E. Br., and *Sarcostemma viminale* are among the numerous succulent plants chewed by the Somalis to allay thirst. These plants taste bitter and it is said that they are always much more bitter in the morning than in the afternoon. This would seem strongly to suggest that they possess that type of metabolism in which organic acids are produced as a product of respiration and later consumed in photosynthesis.

*Smoke used as a disinfectant.*—When their wicker and gum milk vessels or "Hans" have become foul the Somalis cleanse them in

an interesting way. They make in the ground a small pit, having a narrow opening. In the pit, which is a foot or two deep, they make a fire of the wood of certain species of tree, principally *Balanites aegyptiaca*\*, *B. orbicularis*\*, *Acacia spirocarpa*\*, *Commiphora tubuk*, and *Boscia minimifolia*\*. The Han is then inverted over the mouth of the pit and is said to be cleansed by the smoke so that it no longer sours the milk put into it.

*Notes on ornithophily in Somaliland and the Harar district of Abyssinia.*

In Somaliland, according to the Somalis, several kinds of birds visit a large number of different kinds of flowers in order to obtain the honey. The following observations were made on this habit. The red or orange flowered *Aloe abyssinica*\*, which grows in sheets in parts of the tree *Acacia* open woodland, was seen to be visited by the Somali Mariqua Sunbird, *Cinnyris mariquensis hawkeri*, by the Superb Starling, *Spreo superbus*, and also by another species of Glossy Starling. The starlings, although assiduous in visiting this species of *Aloe* when it was in bloom, were not seen visiting any other flowers. They are common in Somaliland in the tree *Acacia* open woodland and may at any time be seen feeding on the ground, on insects. The sunbird on the other hand, which though very generally present is by no means so abundant as the starling, was several times seen visiting a number of other flowers. For instance *Aloe somaliensis*\* and *A. Rivae*\*, *Blepharis fruticulosa*, a white flowered Labiate, *Loranthus curviflorus* Benth., *Justicia* sp. (4881) and *Coleus cicatricosus* Hutch. & E. A. Bruce. These plants have yellow, white, blue or crimson flowers, and thus the sunbird is in no way limited in its choice of colours. In the dry season the sunbirds are very much restricted to the *Loranthus* which is one of the few common plants in flower at that time. It seems also that its flowers are not visited by insects, at any rate no insect visitors were seen. In the case of the Aloes, on the other hand, both bees and butterflies were seen visiting the flowers. The sunbird is far more suited to visiting flowers than the glossy starlings on account of its lesser weight, its longer, slenderer beak, and the fact that unlike the starling it can cling upside down in order to get at the flowers.

In Abyssinia several unidentified species of sunbird were seen visiting a number of plants, and sunbirds were seen in greater numbers than in Somaliland. The plants visited were *Carissa edulis*, *Vangueria apiculata*, which was seen visited on more than one occasion by several species of sunbird, *Adhatoda Schimperiana*, *Erythrina* sp. (5094) very much visited, *Echinops Ellenbeckii*, *Leonotis velutina* var. *rugosa*, *Woodfordia uniflora* (A. Rich.) Koehne, *Crotalaria Erlangeri*, and *Erythrina Brucei*. Several of these plants have red flowers (in *Echinops* this is an unusual colour), red being generally considered very common among ornithophilous flowers. *Vangueria apiculata*, however, which is very assiduously

visited, has green flowers. These plants occur in the evergreen scrub, the evergreen forest and also the *Erica* thicket formations, and it seems very probable that in the last named the Tree *Lobelia*, *L. Rhynchopetalum*, is also visited by sunbirds.

It is thus clear that ornithophily is a common occurrence in this part of Africa, except in the more arid zone, where it was not observed. Most of the observations made here can be paralleled from Southern Tropical Africa where Aloes and *Erythrina* and *Leonotis leonurus* are visited by sunbirds. M. S. Evans in a paper on "The fertilisation of flowers, with some illustrations from the Natal flora" remarks that *Loranthus Kraussianus* Meisn. is pollinated only by sunbirds and that if these are kept from it no seed is set. He also remarks that other species of birds besides sunbirds may sometimes visit flowers. It has long been known, that ornithophily is very prevalent in the South-Western Cape, but it has wrongly been considered that this was somewhat of a special feature of this region separating it from the rest of Africa.

That sunbirds are ready to visit flowers unfamiliar to them is proved by an instance when I saw one visiting a species of *Opuntia* near Harar.

*List of Scientific Names of the more important plants in the foregoing pages with their equivalent vernacular names.*

**Acacia** Asak Willd.—Adad medu. *A. Bussei* Harms.—Galol. *A. etbaica* Schweinf.—Sugsug, Khansa, Yube. *A. glaucophylla* Steud.—Rede. *A. mellifera* Benth.—Bilel. *A. misera* Vatke—Khansa, Sarman. *A. nilotica* Del.—Marah. *A. Senegal* Willd.—Jalefon, Adad. *A. Sieberiana* DC.—Jerin. *A. somalensis* Vatke—Hini. *A. sp. nr. Bussei* Harms—Sarman. *A. spirocarpa* Hochst.—Gurha. *A. sp. nr. subalata* Vatke—Marah. **Acokanthera** Schimperi Schweinf.—Waba. **Adenia** venenata Forssk.—Adahi medu. **Aerva** tomentosa Forssk.—Sorna. **Albizzia** sp.—Rhedib. **Aloe** abyssinica Lam.—Daar Gabar. *A. Rivae* Baker—Daar Burug. *A. somaliensis* C. H. Wright—Daar biyu. *A. trichosantha* Berger—Daar merodi. **Andropogon** cyrtocladus Stapf—Dur. **Balanites** aegyptiaca Del.—Ghot. *B. glabra* Mildbr. & Schlecht.—Kidi. *B. orbicularis* Sprague—Kulan. **Berchemia** discolor Hemsl.—Den. **Boscia** minimifolia Chiov.—Megag. **Buxus** Hildebrandtii Baill.—Dusogh. **Cadaba** farinosa Forssk.—Ditab. *C. glandulosa* Forssk.—Dukhul. *C. heterotricha* Stocks—Highi. **Cadia** purpurea Ait.—Salabma. **Caesalpinia** sp.—Jirma. **Calotropis** procera Ait.—Bon ad. **Canthium** bogosensis Hutch. & E. A. Bruce—Gorurgi. **Caralluma** speciosa N.E. Br.—Udab tis. **Chrysopogon** Aucheri Stapf var. quinquiplumis Stapf—Daremo. **Cissus** quadrangularis (L.) Planch.—Gaad. *C. rotundifolia* Vahl—Arno. **Combretum** tricanthum Fres.—Obol. **Commiphora** cuspidata Chiov.—Didin, Myrrh. *C. erythraea* Engl.—Hagar. *C. lughensis* Chiov.—Hagar ad. *C. ogadensis* Chiov.—Hagar medu. **Cordeauxia** edulis Hemsl.—Yeeb. **Cordia** Gharaf Ehrenb.—Mared. *C. ovalis* R. Br.—Mared.

**Croton** *Cliffordii* Hutch. & E. A. Bruce—Bahie. **Cymbopogon**  
**Schoenanthus** *Spreng.*—Aus Damer. **Delonix** *elata* (L.) Gamble—  
 Lebi. **Dobera** *glabra* Juss.—Garas. **Dodonaea** *viscosa* L.—  
 Hairimat. **Dracaena** *schizantha* Bak.—Morli. **Eragrostis**  
*hararensis* Chiov.—Gubungub. **Euphorbia** *abyssinica* Lem.—  
 Hasadin. *E. grandis* Lem.—Hasadin. *E. infausta* N.E. Br.—  
 Dibu. *E. nubica* N.E. Br.—Ergin. *E. scoparia* N.E. Br.—Mirhig.  
*E. somalensis* Pax—Fala fala. **Ficus** *populifolia* Vahl—Nidir.  
**F. Sycomorus** L.—Dare. *F. vasta* Forssk.—Berde. **Grewia**  
*mollis* Juss.—Debi ad. *G. Schweinfurthii* Burret.—Debi medu.  
*G. tenax* (Forssk.) Fiori—Duferu. **Hypoestes** *Hildebrandtii*  
*Lindau*—Ged waraba. **Indigofera** *Ruspoli* Bak. f.—Jelub.  
**Iphiaea** *rotundifolia* O. & H.—Gegabot. **Juniperus** *procera*  
*Hochst.*—Deyib. **Lannea** *malifolia* Hutch. & E. A. Bruce—Bero.  
**Lawsonia** *inermis* L.—Elan. **Leptadenia** *Spartum* Wight—  
 Morogh. **Maerua** *sessiliflora* Gilg—Ji-eh. *M. somalensis* Pax—  
 Kalan. **Mimusops** *Kummel* Hochst.—Anjel. **Olea** *chrysophylla*  
*Lamk.*—Wigir. *O. somalensis* Bak.—Wigir. **Panicum** *turgidum*  
*Forssk.*—Dungara. **Pappea** *Radlkoferi* Schweinf.—Adadak.  
**Peucedanum** *fraxinifolium* Hiern—Ged bidawi. **Pistacia** *falcata*  
*Becc.*—Hraa mali. **Rhigozum** *somalense* Hall. f.—Binin. **Salsola**  
*foetida* Del.—Gulan. **Salvadora** *persica* L.—Adi. **Sansevieria**  
*Ehrenbergii* Schweinf. ex Bak.—Hig. **Sarcostemma** *viminale*  
*R. Br.*—Hangeyu. **Senecio** *longiflorus* (DC.) O. & H.—Godor.  
**Sideroxylon** *Gillettii* Hutch. & E. A. Bruce.—She. **Sporobolus**  
*variegatus* Stapf—Dihe. **Sterculia** *Rivae* Chiov.—Garaho.  
**Suaeda** *fruticosa* Forssk.—Horun. **Tamarindus** *indica* L.—  
 Hamar. **Tamarix** *nilotica* Ehrenb.—Dot. **Terminalia** *Brownei*  
*Fres.*—Wob. **Turraea** *parvifolia* Defters—Dornai. **Ziziphus**  
*Hamur* Engl.—Hamud. *Z. mauritiana* Lam.—Gob. *Z. mucronata*  
*Willd.*—Gob yer. **Zygophyllum** *Hildebrandtii* Engl.—Bal ad.

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