

This article was downloaded by: [UQ Library]
On: 14 November 2014, At: 05:36
Publisher: Taylor & Francis
Informa Ltd Registered in England and Wales Registered Number:
1072954 Registered office: Mortimer House, 37-41 Mortimer Street,
London W1T 3JH, UK



Transactions of the Botanical Society of Edinburgh

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tped18>

Acacias In Various Places: A Study In Associations

G. F. Scott Elliot M.A. B.Sc. F.L.S.

Published online: 29 Nov 2010.

To cite this article: G. F. Scott Elliot M.A. B.Sc. F.L.S. (1908) Acacias In Various Places: A Study In Associations, Transactions of the Botanical Society of Edinburgh, 23:1-4, 119-133, DOI: [10.1080/03746600809469138](https://doi.org/10.1080/03746600809469138)

To link to this article: <http://dx.doi.org/10.1080/03746600809469138>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

TRANSACTIONS AND PROCEEDINGS
OF THE
BOTANICAL SOCIETY OF EDINBURGH.

SESSION LXX.

MEETING OF THE SOCIETY,

November 9, 1905.

Professor I. BAYLEY BALFOUR, President, in the Chair.

The following Office-Bearers of the Society were elected
for the Session 1905-6:—

PRESIDENT.

Professor ISAAC BAYLEY BALFOUR, M.A., M.D., D.Sc., F.R.S., F.L.S.

VICE-PRESIDENTS.

ALEXANDER COWAN, Esq.	J. RUTHERFORD HILL, Esq.
SYMINGTON GRIEVE, Esq.	JAMES WHYTOCK, Esq.

COUNCILLORS.

A. W. BORTHWICK, D.Sc.	J. A. TERRAS, B.Sc.
ARTHUR E. DAVIES, Ph.D., F.L.S.	Professor J. W. H. TRAIL, M.A.,
JAMES GRIEVE, Esq.	M.D., F.R.S., F.L.S.
WILLIAM YOUNG, Esq.	PERCIVAL C. WAITE, Esq.
R. STEWART MACDOUGALL, M.A.,	WILLIAM WILLIAMSON, Esq.
D.Sc., F.R.S.E.	HARRY F. TAGG, F.L.S.

Honorary Secretary—WILLIAM CRAIG, M.D., F.R.S.E., F.R.C.S.E.
Curator of Herbarium—W. CALDWELL CRAWFORD, M.A., F.R.S.E.

Foreign Secretary—REV. D. PAUL, M.A., LL.D.

Treasurer—RICHARD BROWN, C.A.

Honorary Assistant-Secretary—W. W. SMITH, M.A.

Artist—FRANCIS M. CAIRD, M.B., C.M., F.R.C.S.E.

Auditor—ROBERT C. MILLAR, C.A.

LOCAL SECRETARIES.

Aberdeen—Professor J. W. H. TRAIL, M.A., M.D., F.L.S., F.R.S.

Bathgate—ROBERT KIRK, M.D., F.R.C.S.E.

Berwick-on-Tweed—FRANCIS M. NORMAN, R.N.

Birmingham—W. H. WILKINSON, F.L.S., F.R.M.S., Manor Hill, Sutton Coldfield.

Bournemouth—JOHN ARCHIBALD, M.D., F.R.S.E.

Calcutta—DAVID PRAIN, M.B., F.R.S.E., F.L.S., Royal Botanic Garden.

„ Professor S. C. MAHALANOBIS, B.Sc., F.R.S.E., F.R.M.S.,
Presidency College.

Cambridge—ARTHUR EVANS, M.A.

Croydon—A. BENNETT, F.L.S.

Dumfries—Professor G. F. SCOTT-ELLIOT, M.A., B.Sc., F.L.S.

Dundee—Professor P. GEDDES, F.R.S.E.

East Liss, Hants—JAMES SYKES GAMBLE, M.A., C.I.E., F.R.S.

Glasgow—Professor F. O. BOWER, Sc.D., F.R.S., F.L.S.

„ Professor J. CLELAND, M.D., LL.D., D.Sc., F.R.S.

„ ALEX. SOMERVILLE, B.Sc., F.L.S.

Lincoln—GEORGE MAY LOWE, M.D., C.M.

London—WILLIAM CARRUTHERS, F.R.S., F.L.S.

„ J. F. DUTHIE, B.A., F.L.S.

„ E. M. HOLMES, F.L.S., F.R.H.S.

„ Sir GEORGE KING, M.D., F.R.S.

Melrose—W. B. BOYD of Faldonside.

Otago, New Zealand—Professor JAMES GOW BLACK, D.Sc., University.

Perth—Sir ROBERT PULLAR, F.R.S.E.

Philadelphia, U.S.A.—Professor JOHN M. MACFARLANE, D.Sc., F.R.S.E.

St Andrews—Professor M'INTOSH, M.D., LL.D., F.R.S.E.

„ ROBERT A. ROBERTSON, M.A., B.Sc.

„ Dr. J. H. WILSON.

Toronto, Ontario—W. R. RIDDELL, B.Sc., B.A.

„ Professor RAMSAY WRIGHT, M.A., B.Sc.

Wellington, New Zealand—Sir JAMES HECTOR, M.D., K.C.M.G.,
F.R.S.S. L. & E.

Wolverhampton—JOHN FRASER, M.A., M.D.

The TREASURER submitted the following Statement of Accounts for the Session 1904-5:—

INCOME.

Annual Subscriptions for 1904-1905	£48 15 0
Do. Arrears	9 15 0
Do. in Advance	1 10 0
Contributions of Life Members	17 17 0
Transactions sold	13 1 3
Subscriptions to Illustration Fund	1 10 0
Interest on Deposits in Bank	1 11 9
	<hr/>
	£94 0 0

EXPENDITURE.

Printing (including Transactions for 1903-1904, £23, 7s. 9d. ; and for 1904-1905, £36, 10s. 10d.) . .	£76 9 1
Rooms for Meetings, Tea, etc.	8 7 0
Stationery, Postages, Carriages, etc.	3 7 5
Fire Insurance on Books, etc.	0 5 0
Excess of Income over Expenditure	5 11 6
	<hr/>
	£94 0 0

STATE OF FUNDS.

Amount of Funds at close of Session 1903-1904 . .	£107 14 8
Add—Increase during Session 1904-1905, as above . .	5 11 6
	<hr/>
	£113 6 2
Being:—Sum in Current Account with Union Bank of Scotland, Ltd. . . £10 8 7	
Sum in Deposit Receipt with do. . . 100 0 0	
Due by Treasurer 2 17 7	
	<hr/>
As above	£113 6 2

Note.—Subscription in arrear, 1904-1905, 15s.

The PRESIDENT remarked that the Society would receive the report of the year's finance with satisfaction, and on his motion a cordial vote of thanks was given to the TREASURER and to the AUDITOR.

The following gentlemen, recommended by the Council, were elected Honorary Foreign Fellows:—

- Dr. GOTTLIEB HABERLANDT, Professor of Botany in the University and Director of the Botanic Garden, Graz.
 Dr. EDUARD JANCZEWSKI, Professor of Plant Anatomy and Physiology in the University, Cracow.
 Dr. ERNST STAHL, Professor of Botany in the University and Director of the Botanic Garden, Jena.

The following candidates were proposed as Resident Fellows of the Society:—

- ROBERT CAMPBELL, M.A., B.Sc., Geological Department, University of Edinburgh. Proposed by Professor BAYLEY BALFOUR, F.R.S., seconded by W. W. SMITH, M.A.
 W. EDGAR EVANS, B.Sc., 38 Morningside Park. Proposed by Professor BAYLEY BALFOUR, F.R.S., seconded by W. W. SMITH, M.A.
 JAMES WATERSTON, B.D., 9 Woodburn Terrace. Proposed by Professor BAYLEY BALFOUR, F.R.S., seconded by W. W. SMITH, M.A.

Mr. WILLIAM EVANS exhibited living examples of five species of *Riccia* found this autumn at the reservoirs in the Edinburgh district, and explained that the unusually low state of the water in the ponds had favoured the appearance of these plants. One species, *R. crystallina*, was an addition to the Scottish list; while another, *R. fluitans*, had not been recorded from Scotland since 1864.

Professor I. BAYLEY BALFOUR gave his Presidential Address.¹

The following communication was read:—

¹ During reconstruction of buildings at the Royal Botanic Garden, the manuscript of the President's address, containing the obituary notices and other matter read to the Society at its opening meeting, has been mislaid by him, and is not yet available for publication.

ACACIAS IN VARIOUS PLACES: A STUDY IN ASSOCIATIONS.

By G. F. SCOTT ELLIOT, M.A., B.Sc., F.L.S.

In the study of Plant Associations, one is met at the outset by serious difficulties arising from the various classifications adopted by different authors.

Those employed in England and in France are, so far as the general idea is concerned, very much the same: but in Germany, in the United States, in Russia, and in Scandinavia respectively, the system of classification does not agree, even in essentials, either with that used in France or with each other, whilst as regards details almost every observer seems to make up his own descriptive terms.

Thus this, the youngest department in botany, runs a risk of being choked, whilst still growing up, in a thorny wilderness of terminology, which nevertheless shows how rich and fertile is the field of inquiry.

The reason of this confusion seems to be that botanists have at once rushed to the task of mapping out associations and giving them names. But no one would make a geological map without having both a definite idea of the succession of geological strata and of the numerous variations in the structure of ordinary sedimentary strata by the occurrence of volcanic dykes. I think there is just as definite and regular a succession of associations on any one spot as there is of geologic strata, whilst wherever rock, water, or desert conditions interrupt the ordinary climatic factors, whole series of transitional or fringing associations occur which connect the normal type of the district with rock, water, or desert associations. It is a mistake in policy, in my opinion, and produces confusion, if these transitional fringes are classed as associations in themselves. To attack the general question is much too dangerous an attempt for a short paper, and I shall only try to show how, if we recognise that many associations bordering desert countries are only transitional, the study of the subject is very much simplified.

The characteristic plant of all those associations which surround deserts in sub-tropical and tropical countries is the genus *acacia*. It is a very variable genus, and contains some

420 species. Why it should appear so regularly near but not quite over true deserts seems to depend on the following adaptations:—

1. The roots are usually very long, twenty to thirty feet in some cases, so as to reach deep-seated water. 2. The leaves are generally protected against strong sunlight by special devices, phyllodes, special powers of movement, etc. 3. Grazing animals are kept off usually by stipule spines, or, especially in the Australian species, by the development of tannin in the bark. Some species are extremely hardy: *A. Greggii* (the one used for the lac-insect) is able to do with only three inches of rainfall in the year; *A. longifolia* is a sand-dune plant.

Now in a general way, when one passes from an ordinary tropical “monsoon” wood into a desert, the vegetation changes as follows:—

First, the ordinary, close-ranked array of the tropical wood becomes altered into a light, more open wood. Second, the trees separate, forming clumps or patches, as one finds in an English park. Third, the trees become thorn-trees. Fourth, the thorn-clumps scatter and become scrub or thickets of thorny bushes. Finally, the thickets open out into isolated pioneer thorn-shrubs or small trees dotted over the ground like the plants in an orchard.

These isolated pioneers or scouts are almost invariably acacias, whilst the proportion of acacias and certain other Leguminosæ diminishes gradually in the vanguard of scrub and advanced guard of thorn woods until in the true “monsoon” wood there are exceedingly few or none at all.

This sort of succession can be seen in a great many places. Even in the Mediterranean region *A. Farnesiana* thrives and is even cultivated for its flowers (100,000 lbs. of essence has been made at Grasse).

In Egypt their importance is at once manifest. As one slowly steams up the Nile between sloping mudbanks a few feet high and covered with lupines and Lubia beans, the only vegetation above the bank consists of acacias or an occasional line of tall, graceful date-palms.

On landing, one finds a perfectly distinct line which shows the limit of the last inundation of the Nile. Beyond this line, acacias are almost the only shrubs or trees. They also

often form rough hedges near the villages. They are very prominent in the rocky islets of the second cataract at Wady Halfa. The species of which I took special note were *Acacia Seyal*, L. "Seyal," the Shittah of the Bible; a shrub usually seven feet high, with a stem ten inches in diameter. It occurs in crevices of granitic rocks and also in sand or alluvium, sometimes at altitudes fully five feet above the level of high Nile. This is of great importance both as fuel and for use in the "sakkiehs" or waterwheels (Nos. 3364, 3333).¹ *A. albida*, Del., "Arras" or "Tolla'ih," a plant twenty feet high, was found in a wind-sheltered position some two miles south of Korosko. It also extends above the limits of high Nile and occurs in the Wady Halfa islets (3369, 3403). *A. tortilis*, Del., "Sallah" or "Seyal," also above the inundation limit and in the sandy granitic soil of the islets (3370). *A. arabica*, Willd., "Garra" of Berbers, "Sunt" of Egyptians, Babool; fairly common at or a little above the level of high Nile (3381). *A. laeta*, R. Br., fairly common in granitic rocks at the first cataract; a shrub or small tree just about the inundation limit (3436). These acacias are all liable to injury from the numerous camels, donkeys, and goats. In some places they seem to be disappearing altogether.

With the exception of *A. laeta*, they all extend over a very wide range of country from Abyssinia and the Upper Nile to Senegambia: probably they are found all along the southern border of the Sahara. *A. arabica* extends eastward through Persia to Afghanistan. Some of them form woods of enormous extent, as, *e.g.*, the *Seyal*, from about 29° N. lat. to Konka. This species goes as far south as 9° N. lat. on the Nile. *A. tortilis* is the gum-acacia of the Tripoli desert. According to Ascherson in Rohlf's "Kufra," it is this species that makes the acacia woods in South Tunis between Gafsa and the coast on the southern flanks of the mountain Ben Hedma at 34½° Grad. It is also generally distributed on the stony desert on the road to Sokna from Beni Ulid and south of Misda. When upon the Anglo-French Sierra Leone Boundary Commission, I was able in the hinterland of that colony to reach an altitude of 3000 to 3500 feet at the Farana branch of the Niger. Here the ordinary monsoon forest had already been modified. The country was grass-

¹ The numbers refer to my herbarium book.

covered, with everywhere scattered trees: one could see perhaps a quarter of a mile in every direction. I selected seven plants as characteristic of this grassy, tree-covered plateau. All of them were Leguminosæ (*Albizzia fastigiata* and others). At this point the first step in the change from monsoon wood to acacia scrub had been taken, but to get the acacia pioneers, we should have been obliged to go much further to the north.

The district bordering the Sahara on the south is precisely that of which we know very little, but it is at least likely that similar acacia woods are or were common all along the border of the Sahara.

Somaliland is in some places a desert almost as devoid of vegetation as the Sahara itself. A transitional acacia and thorn-scrub region, with a long dry season, occupies a large area in British and German East Africa to the south of Somaliland.

From Mombassa to Kibwezi and Machakos I marched through this transitional zone. Acacias are exceedingly common and characteristic: they are, with succulent Euphorbias and Dioscoreas, perhaps also the most impressive features of the flora. There is a great deal of variation in the character of this scrub. Sometimes the acacias and other trees are scattered and distant, whilst the ground between is almost bare of vegetation. In other places the trees are in close order: flowering plants, creepers, and grasses cluster round their stems, and a considerable undergrowth springs up. Gnarled and twisted acacias of all sorts and sizes, with bright white bark and a very thin and naked appearance, are the most usual shrubs and trees. Grasses and sedges growing in small tufts are dotted over the ground between these trees, but only as an open flora, for the soil can be distinctly seen. These grasses form no sward or turf: except immediately after the rains, they are dead, dry, and withered up. Occasionally a tiny gazelle or "paa" with large ears springs out of the thorns and vanishes down the path. A closer search reveals (or at least used to do so) quantities of game such as ostriches, zebras, giraffes, Clarke's gazelle, etc. This district is in part the same as that described in Engler's "*Pflanzenwelt Ost-Afrikas*," which is connected especially with German East Africa. There is, in

this book, the usual wealth of detail which is characteristic of German botanical work. Dr. Engler makes about ninety-five associations grouped under nine heads or formations, and in at least twenty of these associations acacias are found. The table which follows gives the titles of these acacia associations and the species which are recorded for each.

Now if one glances over this table, it must be confessed that it is exceedingly difficult to form any clear idea of the distinctions between and characters of these twenty associations. The first four belong to the coast, the next three are associations found below an altitude of 125 metres. Those marked v. *a*, *b*, and *c.a* are frankly acknowledged as *transitional* by Engler himself. My view, however, is that all these twenty associations are transitional: the majority of them are variations of an acacia-scrub region dependent on local differences in soil, in shelter, and in the amount of moisture. On the coast where the air is laden with moisture from the sea, one finds the usual thick evergreen wood with an occasional acacia on its outer edge (ii. C). This wood becomes more open in drier places where *A. pennata* is best able to take a prominent position (ii. D): further inland, where the influence of the sea moisture is less pronounced, the wood becomes a thick bush (iii. *c*); and in still drier places what Engler calls a thorn-bush thicket (ii. E and iii. *o*).

If a river cuts through this bush or thorn-scrub, its banks are covered by a strip of wood dependent on the river moisture, with a few acacias which are probably on the outside edge of the wood next the bush or thorns (ii. F). Much of the land is too dry even for thorn-bush thickets, and here comes in a pioneer acacia association, the so-called "orchard steppe," from a somewhat fanciful resemblance of the scattered acacias to an orchard (iv. *c*). In rocky places and little broken hills where the moisture is in crevices of the rock, the acacias are often partly replaced by Euphorbias and other succulents (iv. *f*).

At a height of about three thousand feet, this acacia region begins to shade off towards the monsoon wood, or, as Engler calls it, an "upper dry tropical wood," which is characteristic of African plateaux at about this altitude. The transitional stages are a close steppe bush thicket (iv. *a*) and a steppe wood (iv. *k*)

Downloaded by [UQ Library] at 05:36 14 November 2014

Where rivers cut their way through a monsoon wood their banks are covered with closely set riverside woods. In these riverside woods acacias may be present (iv. *r*).

But between Uganda and the coast and round Kilimanjaro and Kenia there is elevated land which has plenty of water and enjoys a distinctly temperate climate. The flora is also of a temperate character, and consists of grasslands on the plains and forests on the hill-flanks and sheltered valleys.

Where this rainfall makes itself felt, the grass, *e.g.* on flat or open ground, obtains some advantage and grows more luxuriantly. The scattered bushes or trees of acacia and other plants are then surrounded by distinct grass, and constitute the "bush-grass steppes" and "tree-grass steppes" (iv. *h*, iv. *i*, iii. *n*) of Engler.

On the other hand, at the meeting-place of temperate mountain forest and acacia scrub, one finds mountain steppe woods in which the acacias are abundant so long as the soil is reddish laterite (v. *a*), but become much less prominent when humus has accumulated and forms a rich black soil (v. *b*).

The bush-woods on the southern bank of the Victoria Nyanza seem, if I can judge from the notes of Dr. Stuhlmann, to be not one special association but a mixture of several. The so-called savannahs (iv. *p*) appear to be quite similar to what I have seen along the Kagera river, viz. alluvial plains, very dry and bare in the dry season, but overflowed in the rains. In other words, they are exactly the same as the Nile acacia region in Egypt.

Thus these twenty "associations" seem to me to fit fairly well into their places as transitional stages between wood and the orchard steppe, or between mountain forest and the latter.

Turning to South Africa, the desert of the Kalahari, Damaraland, Namaqualand, and the Karoo are not without the usual border of acacias. These occur in the high veldt of the Orange River Colony and Transvaal, where *A. robusta*, etc., grow either in a scattered, pioneer fashion over the grasslands, or sometimes in close order, forming light, open woods.

In Cape Colony, one of the views that I remember best is that from the top of the Boschberg in Somerset East. Looking over the plains, which are interrupted here and there

by great flat-topped hills of recent sandstone, one sees how the dense thorn-woods and thickets which cluster round the base of the Boschberg open out into patches of wood which again scatter into isolated acacias and extend far out into the plain. Green river-woods accompany the windings of the Fish river, which also extends across the plains.

On the banks of dry riverbeds in the Karoo itself, *A. horrida* (Doornboom), *A. detinens* (Wait-a-bit), and *A. Giraffæ* are almost the only shrubs which can exist (Drude, "Handbuch der Pflanzengeographie"). Also in the deserts of Damaraland there are thick woods along some of the watercourses which are composed chiefly of acacias (*A. detinens*, var. *bijuga*, *A. hebeclada*) (Schimper, "Pflanzengeographie," p. 660).

I have no exact data as to the occurrence of acacias in India, but *A. planifrons* seems to be a pioneer in certain deserts (*cf.* Schimper, *l.c.*, p. 290), and thorn-woods are common. Kurz (see Schimper, *l.c.*, p. 407) describes in Pegu certain dry forests, Sha-woods, chiefly of *Acacia catechu*, which, from description, resemble very closely the East African thorn-bush.

In Australia there is the Mulga Scrub (*A. aneura*). Also, according to Tenison Woods (Drude, *l.c.*, p. 497) the Brigalow Scrub, on the western side of the coast mountains of Queensland, would seem from his description to be a similar association and similarly situated. The dominant plant is *Acacia harpophylla* (with *A. saligna* and *A. excelsa*); the bluish-gray colour of its sickle-shaped leaves gives to the whole scrub a peculiar silver-gray sheen. This scrub is a fairly close thicket, and covers a large amount of ground. It seems able to hold its own even on fairly good soil, for cattle do not eat the young shoots and devour the grasses (Proc. R.S. N.S. Wales, vol. vii. p. 565). The Kangaroo thorn, *A. armata*, is protected by thorns, but many of the Australian acacias rely upon the astringency of the bark, which has sometimes from 26 per cent. to 48 per cent. of tannin.¹ One species, *A. glaucescens*, is poisonous, and a narcotic is obtained from it which is used by the natives to stupefy fish. So far as one can gather from descriptions, these Australian acacias fringe the inland desert in quite a typical way.

¹ *A. binervata*, *A. decurrens*, *A. dealbata*, and other wattles.

In South America I found that an acacia, *A. cavenia* (332, Chile), is or used to be the dominant plant over a considerable part of the Central Chilian valley, *i.e.* from Itata to Chillan.

This is the transitional zone between the temperate flora of South Chile and the horrible desert of Atacama and Tarapaca, where the only plant found by Darwin was a lichen growing on mule-bones.

In the locality where this acacia once existed in great numbers there is a very long dry season, and probably there is underground water. The Guanaco used to be common all over this part of Chile, so that the stout spines are not unexpected.

On the other side of the Andes, near Mendoza (Argentina) there is an association of thorny shrubs, the Chanar (*Gourliea decorticans*), which, though not an acacia, seems to have a similar habitat.

In Brazil the "Carrascos," composed of *Acacia dumetorum*, are thickets of thorn-shrubs sufficiently open to allow a horseman to pass in any direction (Schimper, *l.c.*, p. 282).

In Nicaragua *A. sphærocephala* and *A. cornigera* are well known on account of the ant-police which they support, but I have not been able to satisfy myself as to their country.

In Northern Mexico, Arizona, and Texas, the extensive chaparal (*Prosopis glandulosa* and *P. pubescens*) is an acacioid thorn-scrub association, and acacias occur also in the sub-tropical steppes of Mexico, but here again I have not definite data (Schimper, *l.c.*, p. 509).

I must not omit the Island of Socotra, where the acacias *socotrana*, Balfour fil. (on plains near the sea on north side of island) and *A. pennivenia*, Schweinfurth (Tamha), as well as *Dichrostachys dehiscens*, Balf. fil. (Kadhab and Hadibu plains) occur, as well as an acacia undescribed¹ (plains near Galonsir). These plains have been described by our President as part of the Arabo-Saharan desert.

I think that this very imperfect sketch of the distribution of acacia shows that it is the commonest and most characteristic constituent of desert-bordering associations both in tropical and sub-tropical countries. They are often the dominant plant in thorn-scrubs, thorn-woods, and light woods

¹ Balfour, "Flora of Socotra."

near deserts, and, so far as my own experience goes, they are almost always the scouts or pioneers which extend farthest into the desert.

Any attempt to make separate associations of every transitional stage between desert and wood must result in confusion, because all sorts of changes take place. Climates do not, as is usually supposed, remain invariable. In such a transitional zone, if a climate becomes, ever so little, drier, then the pioneer acacias will be killed out, woods will break up into thickets, and pioneers are formed from the thickets. If, on the contrary, the climate becomes a degree more humid, then the acacias break new ground in the desert and the whole army of plants behind them colonises a little more of it.

Moreover, changes in the vegetation may occur without any change in climate. The acacia fringe is, or used to be, the favourite pasture of hordes of grazing animals, antelope, zebra, guanaco, kangaroo, etc. Now these animals are not necessarily mere vegetable demons. If one watches a flock of merino kids devastating an acacia without paying the slightest attention to its horrible-looking spines, one is apt to think that this mild, innocent-looking little animal is a mere Apollyon of plants. The camel and the goat also are supposed, and probably with some reason, to have utterly devastated the flora of Egypt. But in all such cases the battle is unfair: grazing animals in big battalions are supplied with water and protected by man, so that enormous numbers act on one particular spot. Under natural conditions I think that grazing animals, although they may do harm, do an enormous amount of good.

Desert soil consists of sand, gravel, or rock; it is unworked soil, "urboden" in the German sense; it has no leaf-mould, no black earth full of valuable salts and decaying animal matter; there are no worms and probably no nitrogenous bacteria except those of the acacia and other leguminous roots. In such places the manure of grazing animals is scattered by birds and insects over a square foot or so of the neighbouring soil and improves it enormously. On this square foot young herbaceous seedlings will develop vigorously; they will form a close green carpet during the rainy season and will protect each other, remaining green

long after their unprotected neighbours have withered away. So that the manure of grazing animals favours the change from pioneers to thicket or from thicket to woods.

I shall mention two cases in which such differences have been brought about.

The guanaco in South America has the curious habit of depositing its droppings in one locality for long periods. These spots are conspicuous on account of their rich green vegetation amidst the surrounding desolate and burnt-looking steppe.

Then also, in some parts of India, conspicuous green patches may be noticed on the burnt-up, brownish-yellow hillsides. These are where the natives have folded their flocks, and the more vigorous growth due to manure has prevented drought from having its usual effect.

I could mention similar cases in this country.

These considerations are sufficient, I think, to show that an association is not a stationary organism susceptible of exact definition, but that it is always trying to extend its borders. It is probably also, like a species or like an animal during its life, perpetually changing with varying conditions, or, if it refuses to adapt itself, being suppressed by something better able to stand the new conditions.

Since writing the above paper, a remarkable confirmation of my views has appeared ("Geographical Journal," Dec. 1905, p. 670).

"This year the whole distance between Algeria and the Niger has been traversed by one traveller, M. E. F. Gautier, whose excellent studies on the physical geography of the North Saharan borderlands have been frequently alluded to in the Journal. The explorers set out from Tuat on 12th May 1905. Gao, on the Niger, was reached on 3rd August. A short account of the journey, based on a communication to "Le Temps," appeared in the October number of "La Géographie." For the last 375 miles before reaching the Niger, the traveller crossed an unbroken steppe, covered with a widely spaced forest of mimosas, between which a fine grass grows. This M. Gautier considers as characteristic of the southern border of the desert from the Atlantic to Egypt."