

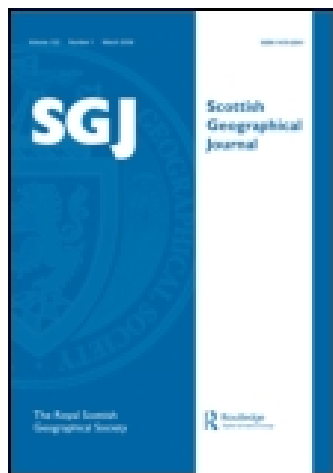
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Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954

Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Scottish Geographical Magazine

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rsgj19>

Galloway: An introductory study

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Published online: 30 Jan 2008.

To cite this article: William A. Gauld (1922) Galloway: An introductory study, Scottish Geographical Magazine, 38:1, 22-39, DOI: [10.1080/14702542208555376](https://doi.org/10.1080/14702542208555376)

To link to this article: <http://dx.doi.org/10.1080/14702542208555376>

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The mineral resources of the region are not promising, and soda is the only mineral that has been extensively worked in British East Africa at Lake Nagadi. Of coal very little has been found, and wood must always be the chief fuel. The soil is the main basis of its wealth and prospects, and some of the soil is very rich, derived from the disintegration of volcanic rock containing potash and phosphates well suited for the growth of coffee and flax.

Professor Gregory writes mainly as a geologist, but his valuable treatise is full of geographical lore of much interest, and his account of Mt. Kenya, discovered in 1849, describes a volcanic peak that he climbed in 1893 to within 600 feet of the summit. Mt. Kenya, although it stands actually on the Equator, has on its shoulders about fifteen glaciers which at one time were very much larger and descended to some 5000 feet below their existing limit. The height of Kenya has been variously calculated as between 17,040 and 23,000 feet, but the former figure is that which is now accepted. Some fine photographs—two of which by the courtesy of the publishers we are permitted to reproduce here—of this splendid peak show the glaciers and the rugged character of the volcanic rock mass. Numerous maps and geological sections and a good index add to the value of this admirable treatise.

H. M. C.

GALLOWAY : AN INTRODUCTORY STUDY.

By WILLIAM A. GAULD.

(*With Sketch-Map and Illustrations.*)

It is almost five years since a change in the parliamentary arrangements restored the old historic entity of Galloway in the south-west part of Scotland, in the form of a political constituency embracing the two county divisions of Kirkcudbright and Wigtown. (1)¹ This revival was, in a very real sense, a recognition of the importance of the geographical conditions which have determined the individuality of the Province of the south-west, and its whole regional character. A region may be a unity in its physical nature, but without diversity within itself it can hardly have individuality, and in order to understand its whole activity we must inquire into the various factors which make up its composite life.

The "region" is itself nature-determined, and we may suppose that the various elements which it contains as a geographical unity are themselves "natural units."

An important clue to such units is often provided by the "regional names" (*noms de pays*) which, born of some distinct character of environ-

¹ The figures refer to the bibliography at the end of the paper.

ment or economy, have persisted in local usage from generation to generation. (2) The name "Galloway" itself goes back a considerable way in history, and was derived from the name Gallgaidhel, applied to the population of the Province in Norse or even pre-Norse days. As the "stranger Gaels" the Gallovidians of early times were alienated from the main body of the Scottish people, and the natural isolation due to the physical build of the region kept the Province apart from the real life of Scotland even down to the eleventh century.

Galloway is sometimes said to have extended far over the Ayrshire plain, but there is little evidence that it included more than upper Carrick beyond the limits of the present two counties. Carrick, however, was part of Wigtownshire until 1186 when it became separated, later, in 1221, to be joined to Kyle and Cunningham as the sheriffdom of Ayr. The hill area between the plains of Wigtown and Ayr must have remained in some degree an unoccupied neutral zone and thus emphasised the remoteness of the Province. Such historical facts as the long survival of the Pictish régime, the existence of native chiefdoms, the claimed right of "dux Galwelensium," and the alliances of Galloway with foreign powers in the formative political period are all consequent upon the natural isolation and independence of the peninsular kingdom. And long after Galloway had thrown in its lot with the Scottish realm, the local provincial tradition asserted itself, so that even in the fifteenth century it maintained its own civil and criminal code, and the Gaelic language persisted until the latter half of the sixteenth century. (3) The geographical unity of the Province has thus had a definite influence on some phases of its history, and the name "Galloway" itself denotes the historic persistency of its regional life. Within the Province local names indicate the primary political units, *e.g.* the "Shire" of Wigtown, the "Stewartry" of Kirkcudbright. The Stewartry, it is believed, originated out of the arrangements following the War of Independence. In 1369 Galloway east of the Cree (in thirteenth century, *crioch*, Gaelic, later *creth*=a boundary) was granted to Archibald the Grim, an early Marcher earl who appointed a "steward" to collect his revenues and to administer justice there, and the name "Stewartry" survives to this day as the popular title of the eastern county. Galloway west of the Cree, however, had been to a large extent outside the sphere of the western march, but had naturally come under the control of a native nobility among whom the family of the Kennedy's was the most prominent. Notwithstanding, it remained under the jurisdiction of the king's sheriff from the Ayrshire side, whence the name "the Shire" which still obtains in the west. These two local names are historical rather than geographical, but they reflect the extra-provincial relationships, the one division sharing in the vicissitudes of marchland life and turned naturally to the Nith corridor as its economic outlet, the other linked to the Ayrshire plain by a uniformity of natural conditions.

Unity of locality within the larger units in the region is indicated by the usage of other local names; especially is this true of the western

county. Here are "the Rhinns" (Norse, *headlands*), the western promontory facing Ireland, "the Machers" (Norse, *plains*) between Luce Bay and Wigtown Bay, and "the Moors," the hill area north of a line from Newton Stewart to Glenluce. The last division is not recognised for administrative purposes, but the term is used in the text accompanying Pont's maps in Blaeu's Atlas (1655), and is still used by the Wigtown farmers. In the neighbouring county there are no such clearly defined localities, as hill and plain are less distinctive. In the northern portion, however, the area of the four parishes of Kells, Dalry, Balmaclellan, and Carsphairn, centred on the upper part of the Ken valley, is known as "the Glenkens." The local names have been referred to at some length, because their historic significance suggests that here, as in other areas, they serve to indicate the natural units within the larger region. Before an attempt is made to delimit these units, some consideration of the physical relations of the Province is necessary; regions no less than individuals are to be regarded not so much as independent and self-sufficient units, but rather as complex expressions of a larger and not necessarily definable whole.

The Physiography of the Region.—Galloway lies at the western end of the Southern Uplands; it is divided on the east by the Nith corridor from the Moffat-Lammermuir hills, whose evenly-rounded outlines and flat-topped summits contrast with the Galloway highlands, indurated by the intruded plutonic granites, and showing as a rule more rugged features. This is well seen in the metamorphosed aureole of Merrick-Kells, which surrounds the Loch Dee granite boss. (4) The general level of the peaks, and the platform character of much of the country, suggest that marine denudation has played a considerable part in its physical evolution. The fundamental rock groups of the Province were laid down in the Ordovician and Silurian periods, when the area of "proto-Galloway" formed the marginal sea of the advancing continental shore to the north-west. The tectonic movement which initiated the great Rift Valley of Central Scotland also folded the older Palaeozoic rocks of the south-west in a series of NE.-SW. folds parallel to the line of "Caledonian" faulting. A later phase of movement in mid-Devonian times caused a further subsidence in Central Scotland, and necessitated a readjustment in the rocks on either side of the rift. The intruded granitic bosses of Galloway represent the final movement associated with the lowering of the Midland valley floor. The subsequent marine transgressions are not always determinable, but the enflanking nature of the Carboniferous seas is shown by the marginal depositions of Nithsdale, the Kirkbean shore, and the Loch Ryan area. A general terrestrial recovery set in during the Mesozoic epoch, but there were periods of marine invasion especially in Jurassic and Cretaceous times. There is evidence to show that in the time of the late Chalk, the Southern Uplands were at least reduced to an island archipelago, and perhaps even underwent a complete submergence. The terraced land-forms recorded by Dr. Mort in Arran are also found in the Galloway uplands, and both

are in all probability post-Cretaceous in date. Professor Cole has argued that many immature features on the surface of the Irish Carboniferous floor are due to a capping of chalk which protected the underlying strata down to the close of the Ice age. A similar Cretaceous floor may very well have preserved the original Silurian topography of Galloway in its peneplain form, and the character of many of the streams, *e.g.* the affluents of the Nith, points to their having developed on a landscape superimposed on the older Palaeozoic country. This transgression of the Chalk sea heralded the collapse of the North Atlantic area which occurred simultaneously with the emergence of Europe in early Miocene times.



FIG. 1.—Loch Enoch, looking north, with *roches moutonnées* in the foreground.

The Tertiary period saw another great outburst of sub-crustal activity in the north-west Volcanic Province, when the Antrim basalts, the bosses of the Mourne Mountains and Arran, and the great mid-Scotland dykes came into being. The plateau lands of Galloway seem to bear little evidence of all this storm and stress, but the foundering of the Solway basin and the trough of the Irish Channel were incidents in the general collapse of the north-western margins.

Such in outline are some of the major phases in the physical evolution of Galloway. The removal of the more recent deposits by the processes of sub-aerial and marine denudation has laid bare the older grain of the original floor. The complexity of the rock succession, which baffled geologists until Lapworth brought forward the fossiliferous evidence of the graptolitic shales, is due to the fan-folding which must

have occurred just previous to the great rift subsidence on the north side of the south-west tableland.

The existing land-forms, however, bear little relation to this structure, but rather appear as relics of the residual plateau worn down from the original anticlinal fan-folds.

The characteristic rock is a coarse-grained greywacke which is associated with fissile flagstones, and exposed in long lenticular areas in the line of strike (NE.-SW.) are the carbonaceous shales with the graptolitic fauna.

The three granite bosses of Loch Dee, Cairnsmore of Fleet, and Criffel are themselves indicative of the extent of denudation, for it has been demonstrated (5) that the sediments overlying the intrusive granites must have been removed and the igneous rocks disclosed before upper Old Red times. The numerous smaller bosses, the dykes and veins and the metamorphism notable in the Ordovician rocks all suggest the share which the Galloway tableland had in the continuous instability of North-Western Britain.

The alteration of the rocks by intrusions has had an important influence on the river development of later times, *e.g.* in the Galloway "cauldron," between the Merrick and the Kells ranges, the ring of altered Ordovician grits and shales around the Dee granite has prevented a radial drainage attacking the lake-filled basins and has in fact preserved the glacial topography.

In addition to the folding movements with SW.-NE. trend great fracture lines appeared across the strike of the rocks in a general north to south direction; the great pre-Carboniferous fault of the Nith valley and the contemporaneous Loch Ryan fault are of this character, and the parallelism of the Luce, Duisk-Bladnoch, and Doon-Ken drainage basins is a feature which suggests a very early use of tectonic lines of weakness by a consequent drainage system. In his admirable paper (4) Dr. Mort has shown how this original consequent system had developed on the Palaeozoic floor tilted to the south-east; the streams originated in Kintyre and Argyll, he believes, and flowing across the site of the present Midland valley found an outlet in the North Sea area. The mid-Devonian faulting broke up this system and the old valley lines trenched in the south-western plateau were covered by later sediments. The present-day streams are however of much more recent origin, and only occupy in part the old valley courses. The studies of Professor Gregory on Arran and the Tweed valley (6, 7) show that we must look for the origin of this later system in the volcanic period of uplift affecting the north-west of Britain in Pliocene times. Again, the cutting power of the streams working in the newer and softer deposits enflanking the Galloway plateau were such as to prevent any revival of the old transverse rivers, and, as Mort says, the Galloway streams were "beheaded at both ends."

The Ice age brought further modifications, notably the deepening of portions of the valley floors. Thus the middle Cree valley was

deepened to the extent of at least 50 feet, as is proved by the tributary Cardorecan stream on the left bank of the "Loch of Cree" which descends in a 50-foot cascade into the Cree.

A very striking contrast in river-valley formation is seen in the upper part of the Glenkens valley. Above the village of Carsphairn the two main tributaries, the Upper Deugh and the Carsphairn Lane, unite to form the Water of Deugh. The Upper Deugh is a torrential stream broken by waterfalls, cutting through thick walls of boulder clay and gravelly sands, while the flow is checked by its boulder-strewn channel and the level stretches of deep and still water. The Lane on the other hand is a slow meandering stream, muddy and reed-infested. Its valley is a



FIG. 2.—The "Loch of Cree"; the middle portion of the Cree valley, deepened in the glacial period.

uniformly wide one and the stream is obviously a "misfit," being in fact post-glacial in date and occupying part of a far older and matured valley line which extended north-west along the line of the northern portion of Loch Doon, and probably across the courses of the present Ayrshire streams. There are abundant illustrations of river capture, especially in the north-west borders where the Midland valley strike-streams have been able by working in soft rocks to tap the headstreams of the Galloway rivers; *e.g.* the Feoch burn, a tributary of the Duisk, has tapped the Cumnock burn since glacial times.

Again, the river terraces which are a common feature are probably associated in their origin with the raised beaches of the Solway shore line. Many of the Galloway streams have been rejuvenated near their mouths, especially where they debouch into the raised beach estuaries, and hence the lower portions of the streams are often younger than the

upper.¹ The river systems of Galloway make an interesting physiographic study, for they exhibit the cumulative influence of the topographical conditions of successive geological phases. Although we cannot enter here into the problem, it is perhaps permissible to refer to the general uniformity of width and level in the central portions of such rivers as the Cree and Ken-Dee, which may be due to glacial erosion at the upper end of such stretches of river, or possibly to the fact that in these sections the rivers are flowing in the old consequent valleys of the Palaeozoic floor partly filled with boulder clay. The name "lane" is very frequently applied to the slow-moving streams of Galloway in hill and plain areas alike. The considerable width and the low gradient of the north-south valleys has facilitated trans-plateau communication, and these river valleys have formed the main lines of human migration in historic and prehistoric times.

Structurally, Galloway has much in common with the Southern Uplands east of Nithsdale, but its granitic bosses, its major drainage lines, and its glacial features have given it a unique and peculiar topography.

The Climate of Galloway.—In considering the climatic régime of any individual region such as Galloway, two groups of factors must be examined: (*a*) the position of the region in the general climatic control of its latitude, (*b*) the modifications resultant on influences within the region or its vicinity interpreted as local weather. The latter group is secondary and even consequent on the first or major group.

Galloway exhibits all the features of the west-coast type, sharing in the general pressure conditions of the European land mass and the North Atlantic. A small fluctuation in the relative position or intensity of the pressure systems causes a change in British weather as a whole. The Province is open on the south and west coasts to sea influences, and the effect of the Atlantic warmth is seen in the milder conditions of the coastal margins, while the climatic variations inland are determined by the orographical nature of the country. Pressure conditions are in the main outside the control of local influences. The periodicity of cyclones and anticyclones is the principal cause of variation in the general mean pressure. Charts of the paths frequented by cyclonic depressions in North-West Europe show a wide storm belt running from south-west to north-east off the north-west shores of the British Isles. This belt predominates throughout the year but is weakened in the months April, May, and June, *i.e.* in the period of the break up of the Icelandic low pressure in the spring, connected no doubt with the maximum influence of the East Icelandic water, and the spread northwards of the Azores "high" pressure system. From this main belt, which provides the prevalent south-westerlies, branches extend eastwards which frequently cross the Scottish mainland. In the months October to December such a branch runs from west to east across the Province. In the spring

¹ I owe this idea to Dr. Peach.

months Galloway lies outside the storm path, as the Southern Uplands divide a belt in the Irish Sea from one extending across Central Scotland. The pressure data are very incomplete and the seasonal control is not absolutely clear, but the fluctuations in the spring and summer weather are probably due to the interaction and relative power of the storms in these complementary belts, when the main storm belt is at its minimum farther to the west. In the autumn the south-west to north-east storm path is restored and winter conditions and cyclonic disturbances return.

The prevailing winds are westerlies and south-westerlies, but when the cyclones occupy the Solway storm track, the winds in the Galloway uplands back from east through north-east to north-west and give cold and often dry weather. The spring east winds which condition so much the agricultural growth in that season are due to the anticyclonic conditions existing to the north of Scotland. These arise from continental high pressures which force the cyclonic belts westwards. Clear nocturnal conditions in spring are often accompanied by frosts.

In the Whithorn peninsula of the southern Machers, the farmers use their wind-pumps as weather guides, and they affirm that if the wind during the day follows the sun, the weather will be fine, and it is in fact true that the wind veers from south-east to south-west in the course of fine weather. It is also maintained locally that if the seaward view is clear enough to display both the Kirkcudbright coast and the Isle of Man, a wet spell will follow.

In summer the land and sea breeze type of weather prevails, and the diurnal north-west winds, especially in Wigtown, dying down in the evening, have given rise to an old Galloway proverb, "An honest man and the north-west wind go to sleep together."

As regards temperature, the main direction of the isotherms over the Province is from north to south, owing to the uniformity in all the west coasts of Atlantic warmth. In general, the mean temperature in Wigtown is higher than that of the eastern county. The average temperatures (Fahrenheit) are as follows :—

Kirkcudbright, . . .	Jan., 38°	July, 59°
Wigtown,	Jan., 40°	July, 58°

In the summer months a wedge of maximum heat is projected westward between the more equable sea area to the south and the cooler Midland valley on the north of the Uplands. In general the coast stations like Cally and the Mull show less extremes than such interior places as Kirkcowan; the tendency to a spring minimum is a most notable feature in the Solway stations. The mists which are common in the hill-district valleys seem to depend on temperature conditions. The moisture-bearing westerlies, having lost much of their rain content on first contact with the western slopes, are pulled down in the form of mist by cooler strata in the hill valleys farther east; in the summer this is a characteristic feature in the evening after a warm cloudless day. Thunderstorms often follow the line of the main river valleys. In the Glenkens, for example,

thunderclouds are often seen travelling up the Dee from seawards to the vicinity of Loch Ken and then west into the hill country, later returning across the Ken valley and down the Water of Urr to the Castle-Douglas plain.

The normal Scottish type of rainfall is characterised by an even distribution throughout the year, with a tendency towards a spring minimum and an autumn maximum. This type is seen in general in Galloway, although west of the Cree the period of maximum rainfall tends to be in winter rather than the autumn. The bulk of the Province has 40 inches of rain in the year, and variations within the 40 inches isohyet are dependent on orographical features. (8) The area with under 40 inches is confined to the Rhinns and Machers and the southern margins of the Kirkcudbright tableland, the minimum being registered at the Mull of Galloway (26·81 inches). The 40-50 inches zone develops to a wider extent and includes all the area above the 40-inches isohyet to the 250-foot contour line, and is mainly confined to the eastern county, although in wet years it extends into the upper portion of the Luce Water farther west. The 50-60 inches zone occupies the ground up to 800 feet inside the 40-50 inches zone. The intimate connection between topography and rainfall is especially well defined in Kirkcudbright where the increase is from south to north, while in Wigtown it is west to east against the foothills. The following figures illustrate the seasonal distribution :—(9)

STATION.	Winter. (D.J.F.)	Spring. (M.A.M.)	Summer. (J.J.A.)	Autumn. (S.O.N.)
Cally, . . .	14·67 ins.	8·93 ins.	10·80 ins.	15·40 ins.
Corsewall, . .	10·0	6·62	7·61	10·43
Drumlanrig, . .	15·31	8·22	10·12	14·03
Kirkcowan, . .	16·49	8·67	10·21	13·82
Mull of Galloway,	7·53	4·68	6·23	8·37
New Galloway, .	15·74	8·90	9·94	18·89

It is interesting to note in the monthly maps how the conditions in the Nith valley serve to indicate the fluctuations in rainfall. In the wetter months of winter and late autumn the zone of 50-60 inches annual rain extends across the Upper Nith valley to join a similar zone in the Lead-hills area. In late spring and early summer, when a general drying-up occurs, this wet belt is broken up and the dry Nith valley becomes a "through" corridor. The rainfall station of Drumlanrig is in this transitional foothill type of rain zone, between the true hill type of heavy rains and the drier coast type prolonged up the Nith valley. In the hill country, stations with a westerly aspect record heavier rainfall than those facing eastwards, but there are a few exceptions to the rule; *e.g.* the Shiel of Castlemaddy in the Glenkens records a larger rainfall (77·54 inches) than the Glenhead of Trool (71·62 inches), although the latter has a westerly aspect. This leeward maximum is a well-known feature in the English Lake District, and its occurrence in Galloway is therefore an interesting parallel. Both of the stations named occupy narrow

valleys, especially Glenhead, which lies at the eastern end of the Trool Glen at an elevation, however, of only 320 feet, while the Shiel farm stands at 850 feet. Apart from the difference in elevation, the fact that the Trool station lies in a valley parallel to the direction of the rain wind, while the Shiel is in a valley which is transverse to the prevailing wind, may account for the maximum on the leeward slope.

The mildness of the climate is very largely due to the prevailing warm sea winds and the latent heat set free by frequent precipitation.

The Influence of Climate on Agriculture.—To the farmer the seasonal conditions of climate are all important, as they may be said to determine the forms of husbandry. The highly developed dairy-farming of the Rhinns and Machers, and the coastal belt of Kirkcudbright, and the inland sheep grass farms of both counties may be said to reflect the orographical nature of the rainfall and temperature distribution. Again, so far as temperature is concerned, Galloway is able to grow wheat, but the heavy autumnal rains and the absence of bright sunshine exclude that cereal on any considerable scale. The December-January maximum of rainfall in Wigtown enables wheat to be grown to a small extent there, and in such coastal parishes of Kirkcudbright as have sufficient sunshine, *e.g.* Rerrick.

In early summer the moisture of most of the Province is favourable to turnip sowing as the turnip fly is only active in a dry season, when it often necessitates re-sowing. The liability of mangolds to frosts restricts them to the coastal and low-lying areas near the sea. Root crops do well with cool rather than wet summers and thrive best away from the hill rain belt, in the Machers and the coastal regions. The prevalence of moist conditions thus makes Galloway pre-eminently a pastoral county, and the mild climate, especially in the west, permits of cattle being pastured in the fields for the greater part of the year. Along the coast the control of local weather by sea conditions is suggested in such proverbs as that of Kirkcudbright itself, "If rain with the ebb, go to bed ; if with the flow, go to the plough."

Spring frosts delay the growth of the oats crop, and are often accentuated in the low-lying farmlands by the proximity of cold peat bogs interspersed in the hollows between cultivated eskers and sand, gravel soils or drums. The September frosts, if not too severe, are regarded as beneficial, as they complete the preparation of the corn crop for harvest, but a late spell of autumnal frost is hard on the potato crop. The spring drought is a well-known feature and the farmers in Galloway as elsewhere set great value on "March dust." The preponderance of overcast skies in the ripening period is the great drawback to agriculture. The cool moist summers with spasmodic sunshine make it necessary to specialise in moisture-loving plants, and it is just these which suffer from spring droughts ; turnips on sandy soils often fail for this reason.

The lammas floods of the end of July and beginning of August before the harvest period do great damage to the meadow hay crops and are usually accompanied by high west winds.

Plant Geography.—The natural vegetation of a region is conditioned by the physical geography and in particular by the character of its climate and structure; similar vegetation types recur with the same physical environment, and a community of different species adapted in a variety of ways to one environment gives rise to a “plant association.” Much good geographical work has been done in Scotland in arranging plant associations in particular zones related to the prevalent human conditions. The fine pioneer work of Robert Smith is well known, and his zones have been largely accepted as standards to work on in other



FIG. 3.—Coast at Ravenshall, Wigtown Bay.

areas. Although no detailed survey has as yet been done in the south-west of Scotland, the following zones seem fairly well defined:—

1. The littoral zone, including the submerged, salt marsh and sand-dune vegetation.
2. The agrarian zone, 0-500 feet, divided between deciduous woodland and cultivated land.
3. The hill-pasture zone, 500-1000 feet.
4. The moorland and sub-alpine zone, 1000-2000 feet.
5. The alpine zone, above 2000 feet.

The littoral zone is distinguished from all others by the part which salt plays in the plant environment; it is divided into a lower and an upper belt, the former within the tidal area with *Zostera* as the typical plant, the latter the “saltings” area of sandy shore and salt marsh overrun by spring tides only. The “saltings” belt is very well developed on

the Galloway coast with its extensive raised beaches and wide estuarine levels. Where drainage and reclamation have been effected, the saltings provide good grazing land for dairy and stock cattle, but are not well suited for sheep. The Galloway coast was formerly the seat of a large salt industry, the existence of which was based on the natural "pans" or wide depressions and creeks in the salt marsh. The coast is being rapidly eroded in the Rhinns peninsula and the littoral plants tend to spread inland. The "blown sand" areas are largely due to tidal drift; the largest distribution is seen at Torrs Warren between Glenluce and Sandhead.

The agrarian zone includes both cultivated and grazing lands, park lands, and estates. The limits of cultivation are fixed to some extent by the relative exposure and altitude, and are very largely determined by the thinning out of the glacial deposits. Gorse (*Ulex europæus*) tends to occupy the driftless outcrops of rock in the farming zone; e.g. in the Whithorn peninsula ridges of gorse and briar bush divide the grass-park hollows. Crop rotation is largely limited by elevation, and the cultivation of mangolds, wheat, and the finer barleys ceases away from the lowlands and coast margins, the upland farms being limited to oats, turnips, and bere (coarse barley). The meadow-grass land of the alluvial "holms" margins the lower and middle courses of the main streams, and is characterised by a rush and marsh plant association.

Cultivation has cleared the major portion of the natural deciduous forest, but in early historic times the agrarian zone was covered with oak, birch, and scrub. About 3 per cent. of the Province is now occupied by woodland; oak and beech are characteristic, with Scots pine on the upper exposed margins. Beech, larch, and spruce have been the principal plantation trees, while the uncultivated alluvial deposits have willow, alder, and ash. The long woodland stretches, extending far up the river valleys, are survivals of an earlier and more widespread forest, but it seems unlikely that the timber was ever of good quality. The oak-pine association formerly so widespread in lowland and upland regions alike has now become more differentiated, and the oak tends more and more coastwise, while the Scots pine is limited to the hill and moorland country.

The hill-pasture zone is intermediate between the agrarian and moorland belts and shares in the life conditions of both. The heath or grass moor is distinct in character from the higher heather and sphagnum moors, and is in general typical of thinner soils and a small primary development of peat. Thus in the Wigtown moors the hill pasture has been restricted by the continuous growth of peat separating the vegetation from the influence of the subjacent rock, and its westerly aspect has thus deteriorated what would have been naturally good pasture ground. Bracken (*Pteris aquilina*), which is in general absent from the true moors, is common in this zone, and often covers the leeward or eastern slopes when heather occupies the western slopes.

In the moorland zone peat becomes at once the dominant factor, for

the plant groups are largely determined by the depth and nature of the peat covering. Cotton-grass moor (*Eriophorum*), heather moor (*Calluna*), and rush moor (*Scirpus*) are the three principal types in the moorland zone. Heather occupies the peat of the lower plateaus, which is shallow and seldom ascends above 1500 feet. Cotton grass prevails on the higher plateaus up to 2000 feet, the water content of these being far larger than that of the heather moors. Between 1500 and 1750 feet both heather and cotton grass exist; the 40 inches isohyet is in the nature of a boundary between the *Calluna* and *Eriophorum* moors. The *Scirpus* association is seen best in the lower portions of the moorland zone, notably in areas which are badly drained, and where the tuft grass clings to the saturated peat soil. In his researches on the Southern Uplands peat, Dr. Lewis (10) has shown how the post-glacial oscillations in climate have been recorded in the hill and plain peat alike. He says that it is only in the Wigtownshire mosses that the peat is forming to-day, while elsewhere denudation of the peat is ensuing on the general drier conditions. These mosses rest in hollows in the till and between rock outcrops, and "flow" mosses are in fine preservation in a country not greatly trenched by turbaries, as the population is sparse. This preservation, Dr. Lewis suggests, was facilitated by the general level of the country restricting the drainage. The flow mosses also gave valuable evidence as to the direction of ice movement. In speaking of the lowland mosses of Wigtown, Dr. Lewis says: "All the whale-backed hills showed the same feature, a deep excavation on the NNE. filled with a growth of peat, and at the SSW. end a great accumulation of till covered by very shallow peat." (10)

There is a great difference in the sequence of the peat beds in the upland and lowland peat; the remains in the coastal mosses of both counties show that the peat was formed in shallow lakes and swamps as distinct from the hill peat, which contains few "reed" plants. This difference results in part from the variation in the glacial drift, and in part from the climatic contrast of hill and lowland. In the more exposed portions of the moorland belt, bilberry appears as the typical sub-alpine species, and is best seen on the hill tops of the Kells Ra., Cairnsmore of Carsphairn, and the Merrick group. The Alpine zone is characterised by mosses, lichens, dwarf willows, and bilberry, and in Galloway is limited to the hills around "the cauldron," *i.e.* Merrick and the three Cairnsmores.

Soil Conditions.—The influence of the soil is hardly less important in connection with natural vegetation than that of climate, and may be referred to at this point. The soil derived from the original Palaeozoic floor is a hazel loam of a light kind suited for arable or pastoral farming. The distinction between the Ordovician and Silurian soils is not great, but the subsoil of the latter is as a rule more easily ploughed and more susceptible to cultivation, the older rocks being more gritty and metamorphosed. The general dry nature of these primary soils and their small depth are both favourable to a turnip and barley husbandry,

and where not cultivated or occupied by peat moorland, the Silurian soils give fine grassland.

The granite soils are essentially of the clay type, due to the break up of the mineral felspar, and the decomposition product is an impure yellow clay, seldom cultivated. The Carboniferous rocks of the Kirk-bean coast and Loch Ryan yield rich loams, largely mixed with till, however, and the Permo-Triassic sandstones of the Dumfries border yield a good grass belt, the basis of a large dairy-farming industry.

The recent soils of glacial origin have profoundly modified the economic life of the Province. Their importance has long been recognised. Chalmers in his *Caledonia*, 1824, notes that "on some of the heights the soil is more fruitful than it is in the vales below," and to this day



FIG. 4. —The Tarf Water, Wigtown Bay. Note cultivated esker in background.

this is the most striking feature in the arable zone of Galloway (Fig. 4). In the Newton-Stewart area, the Machers and the Glenkens, as well as many other areas, the turnip and oats cultivation is proceeding on the rounded gravel eskers or clay drumlins, while the low-lying flats between the mounds may be occupied by wet undrained peat bog. The boulder clay deposits undoubtedly stimulated peat growth, and the chilling effect they have in arable lands has proved a great hindrance to agriculture. The importance of the glacial features is also borne out by the place names; *e.g.* a large number of farms have names beginning with "drum": Drummore, Drummoral; and the Celtic "claugh" or "clach," that is "stone" or "boulder," is seen frequently: Auchincloich, Garclaugh. (11) The widespread distribution of the glacial drift may account for the universal use of round stone dykes in the Province, as being the most economical method of getting rid of the stones when new farmland was being opened up.

Some of the richest lands are found on the alluvium of the riverine areas, such as the "holm" lands of the Ken valley, the carse beaches of the Solway, and the Stranraer plain.

The abundance of boulder clay and the absence of a lime constituent in the Galloway soils necessitated the addition of artificial soils when agriculture developed. The first manure soil was derived from the "sea-sleech" of the shore. At a later stage shell marl was used, particularly in the coastal areas, and carted to the inland farms, and with the opening of a regular sea communication with Cumberland and Ireland lime was introduced and often lavishly applied.

The main distribution of the provincial soils is somewhat as follows:—

1. In the north and west of Kirkcudbright is the great moorland peat soil tract, including the granitic heather moors of Kells and the Fleet basin, and the grass Silurian moors of the lower hill areas down to 500 feet. In his *Agricultural Survey*, 1813, Samuel Smith distinguishes in his soil map what he terms "green mountains," including the upper Glenkens, the Carlins Cairn range, and Cairnsmore of Carsphairn. These hills are green with short grass, which contrasts remarkably with the heather and cotton-grass moors of the west, as seen for example on Cairnsmore of Dee. The difference is perhaps a climatic one rather than one of soil, and the primary distribution of peat has undoubtedly determined the character of the hill vegetation.

2. The Glenkens valley, and in particular the "holm" land between New Galloway and Dalry, has a rich loam soil with much gravel formed from the glacial drift. The drumlin country is seen at its best in the neighbourhood of Balmaclellan. The flat meadowlands are best developed on the east side of the valley, and open south by Crossmichael on to the Castle-Douglas plain. Below the junction of the Blackwater of Dee the flood plain opens on the west side, and the boulder-clay soils are worked to the foot of the Loch Whinyeon hill mass.

3. The third belt is the main agricultural zone of the county, and stretches from Borgue by Kirkcudbright to Castle-Douglas, Dalbeattie, and the New Abbey coast, where it passes through the parishes of Troqueer and Terregles into the new red soil of the Dumfries basin. The belt is mainly drum and esker country, with outcrops of Silurian shales and grits forming pasture grounds.

4. The siliceous soils of the north-east give a natural grass belt.

5. The granite heather and grass moors of Bengairn-Screel and Criffel form the littoral pastoral zone.

6. The narrow fringe of Carboniferous soils of the south-east, dry and sandy in nature and liable to drought.

In Wigtown there are three main soil divisions corresponding in a large degree with the triple division suggested by the local names.

1. The unreclaimed moorland is extensive, and the general lower level of the ground and the milder climate have caused the agrarian and hill-pasture zones to penetrate farther inland than in the Stewartry, so

as almost to meet the Ayrshire belts projecting southwards in the main valleys such as the Duisk-Cree. Mature systems such as the Cree and Bladnoch have strips of alluvial meadowland, and the arable drum country is intermingled with the "holm" lands.

2. The Machers peninsula has soils very similar to those of the central belt in the eastern county ; in it we may distinguish the following : (a) the estuarine belt on Wigtown Bay, with carse soils, mainly blue clay, cultivable when adequately drained ; (b) the drum and esker soils of the centre ; (c) the Wenlock shales of Burrow Head with little boulder-clay covering save in a few isolated hollows ; (d) the hill-pasture zone of the west, mainly in the parish of Mochrum, on the glaciated Silurian soils.

Early maps of the Machers show a wide distribution of "lochans" or lake-filled hollows in the boulder clay, and the numerous grass tracts in the peninsula often occupy the drained sites of these glacial lakes, the simultaneous growth of rushes and tuft grasses indicating the clay floor of the hollows. Flow-peat still occupies the undrained hollows, and the siting of farm buildings on rock outcrops above the clay is a very striking feature in the southern Machers.

3. In the Rhinns peninsula all the land save the moorland north of Portpatrick is now under cultivation. The hazelly loam soil is usual ; the Carboniferous and Permian areas are largely drift-covered. The Permian forms a rich grass belt, but the capping of boulder clay and drift sands obscures such contrast as might be expected with the Silurian soils of the adjoining areas.

The Natural Units of Galloway.—From what has been said as to the physical elements and the connection of the vegetation and soils distributions with these, it becomes evident that the Region is made up of a group of units or locality types which are based on "natural" geographical conditions.

The "natural unit" must have a distinct and peculiar character, and although a subdivision of a larger expression, it is by no means a simple one. It is not based on one single geographical element, but is itself a combination of associated factors which give it an individuality of its own. The divisions represented on the map (p. 38) are an attempt at delimiting these collective units.

Viewed structurally, the Province must be treated as a whole without reference to administrative divisions, but in determining natural units it is justifiable to utilise the two counties as entities in themselves. The units in Wigtown are the three suggested by the local names.

"The Moors" belt, the pastoral unit, forms the western portion of upper Galloway, and is continuous with the higher uplands of Minnigaff and Kells in the adjoining county.

"The Machers," by its peninsular aspect, forms a region apart, but in the west the "Moors" type of country appears in Mochrum. In general, however, the road and railway linking the towns of Newton-Stewart and Glenluce may be said to divide the hill and plain units.

Sketch-Map to show the Natural Units of Galloway.

"The Rhinns" division should, strictly speaking, be confined to the peninsula west of Stranraer, but as the economic life of the Stranraer plain is similar to that of the Rhinns proper, this may be included in the unit.

In Kirkcudbright the natural units are in no wise so evident. The Stewartry is divided for parliamentary purposes into north, east, south, and west portions, based on the lines of the parish boundaries. A combination into two groups of north-west and south-east gives expression to the geographical contrast of moorland and plain, although the divisions are never so elemental as in the Shire. The north-west group has three sections: (a) the High Moors of Merrick-Kells; (b) the Glenkens valley; (c) the Low Moors on the southern margin extending across the county from south-west to north-east.

The south-east group forms the East Galloway Lowlands and includes (a) the Southern Moors and coastal belt; (b) the central belt—an agricultural zone with three urban centres, Dalbeattie, Castle-Douglas, and Kirkcudbright.

In both counties the economic gravitation may be said to be towards the meeting-place of the two main topographical zones of hill and plain, and the population tends to be concentrated there. The natural units are the expressions of local character, and are dependent on and controlled by this fundamental distinction of physical type. Beyond this the study of regional life must assume another form. The entrance of man on the scene introduces an altogether new set of conditions. With his power to re-create environment, man becomes, in part at least, the master of geographical event, and into the connected processes of nature, consummate in the "natural unit," he introduces elements which require a different standpoint, and open up quite another aspect of the inquiry.

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