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JAMES BRITTEN, K.S.G., F.L.S.

LATE SENIOR ASSISTANT, DEPARTMENT OF BOTANY, BRITISH MUSEUM.

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WITH PLATES AND TEXT ILLUSTRATIONS

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1914.

ferrugineo-furfuraceo; *staminibus* omnino inclusis; *ovario* dense appresse griseo-pubescente biloculari.

Mexico: shaded places on rocks at crossing of the river near Tocotepeque, July, *Hartweg!* Hb. Kew.

Remarkable for the creeping habit, thin leaves with densely packed and conspicuous cystoliths, rounded corolla-lobes, and included anthers.

**L. acuminatissima** Wernham, sp. nov. Frutex, *foliis* pergamaeis lanceolatis utrinque angustatis acutis ad ca.  $3 \times 1.2$  cm. supra subnitentibus necnon glabrescentibus subtus pubescentibus, brevissime petiolatis, *stipulis* brevibus acutissimis rigide subulato-triangularibus. *Floribus* in axillis solitariis; *calycis* lobis subulato-linearibus ca. 4–7 mm. longis; *corollæ* tubo ad 7–8 cm. longo extus dense appresse sericeo, lobis  $2.6 \times 1$  cm. ellipticis caudato-acuminatis acutissimis.

*Barclay!* in Hb. Kew.

The label bears the names "Gardenia mitis. Tobago Jasmine"; the exact locality is thus, unfortunately, doubtful. The new species is allied to *L. rivalis*, but it is readily distinguishable therefrom by the lengthy acumination of the corolla-lobes and the much shorter calyx-lobes.

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EXPLANATION OF PLATE 533.—*Neosabicea Lehmannii* Wernham.—1. Portion of flowering-shoot, natural size. 2. Single flower,  $\times 4$ . 3. Flower in longitudinal section,  $\times 4$ .

## ALPINE VEGETATION ON BEN-Y-GLOE, PERTSHIRE.

BY ALBERT WILSON, F.L.S., AND J. A. WHELDON, F.L.S.

IN the copious literature devoted in recent times to the subject of plant geography, the constituents of the chief plant associations of Great Britain have been well discussed, and the subject has reached a further stage in its evolution, *viz.* the investigation of the inter-relation of the various units included in each group, and the causes which determine the presence or absence of certain of them. This necessitates a careful biological study of each species, and an inquiry into its means of adaptation to the ecological conditions of the habitat.

Although this advanced stage has been rapidly reached in the case of the higher plants, owing to wide floristic knowledge gleaned by generations of enthusiastic "field botanists," our information on the grouping of associations dominated by cryptogams is still incomplete, and the literature somewhat scanty. In the various associations dominated by spermatophytes, their cryptogamic associates have not been fully worked out, and only the more conspicuous ones are mentioned in lists of characteristic species, frequently, indeed, the generic name alone being deemed sufficient, e. g. *Bryum*, *Sphagnum*, *Polytrichum*, *Cladonia*, &c. Yet these genera contain species insisting on very varied climatic and edaphic conditions, and as a rule it will be

found that cryptogamic plants are very sensitive to such influences, and often form a reliable index to the climatic and geological conditions of the environment.

But before the effect of these conditions can be adequately gauged, there is much preliminary work of a systematic and floristic nature to be done. These few notes, meagre as they are, may therefore have their value as a small contribution to our knowledge of one of the more inaccessible and less easily worked "formations," viz. the Upper-Arctic Alpine Formation.

Before going further it may be well to explain what is meant by the term Upper-Arctic Alpine Formation. It consists briefly of the flora of the higher mountain summits in Great Britain. Where the continuous undulating and rising ground begins to be differentiated into individual summits, a change from the prevailing moorland and subalpine vegetation becomes noticeable. In addition to the characteristic plants of such habitats, we begin to find examples of Arctic types; and, to meet conditions of greater exposure, the morphological features of the species become modified in various ways, with which botanists are now familiar. At 2700 ft. and upwards, the Upper-Arctic Alpine Flora predominates. It is divided by Moss (1) into three groups. The first, the *Chomophyte Association of Crags and Corries*, does not concern us here, as we did not meet with this class of habitat on the route by which we ascended Ben-y-Gloe. The two remaining divisions are sections of what R. Smith (2) termed the "Alpine plateau" and Warming "Fell-field." One of them, the *Moss-Lichen Association*, is an open association occurring on fairly level plateaux and scree-slopes, the vegetation being sparsely scattered over ground strewn with gravel, stones and boulders. The other is a closed association, occurring on slopes of usually less broken ground at similar altitudes, known as *Racomitrium Heath*, which at its lower limits, and under certain conditions, passes into various moorland groups. Two other associations are possibly to be separated within the formation—that dominated by *Anthelia* (3) on wet rocky slopes; and the *Marsupella Association of Macvicar* (4), which is partial to slopes facing east and north, and is dominated by hepatics and such plants as *Dicranum falcatum*. The two associations described in this paper are the *Moss-Lichen Association* and the *Racomitrium Heath*, which are well-marked and distinct on Ben-y-Gloe, although they frequently show transition stages, and become more or less intermingled. Such modifications we have observed on a slope of Braeriach towards Glen Eunach in West Invernesshire, and elsewhere.

The flowering plants of these associations have been fairly well worked out and recorded, and we do not propose to devote attention to them now. Many of our most interesting Highland plants are included amongst them, such as alpine species of *Potentilla*, *Alchemilla*, *Vaccinium*, *Arctostaphylos*, *Saxifraga*, *Azalea*, *Salix*, *Juncus*, *Luzula* and *Carex*. The species are,

however, less numerous than in the *Chomophyte Association*, or in the groups of the lower slopes of the hills.

The Cryptogamic Flora, on the contrary, requires much further exploration. In Mr. Tansley's *Types of British Vegetation*, the flora of the *Rhacomitrium Heath* is represented by a list compiled from field notes by R. Smith and C. E. Moss, and from indications in local floras. The only cryptogams mentioned in this list are *Rhacomitrium lanuginosum*, *R. ericoides*, *Cetraria islandica*, *Cladonia rangiferina* and *Peltigera canina*. It may be remarked in passing that, of the subsidiary species named, *Cladonia rangiferina* was the only one we saw on Ben-y-Gloe. In the list representing the *Moss-Lichen Association* in the same work (1), no mosses or lichens are included, which is rather suggestive of a certain Shakespearian play produced with the part of Hamlet excised. But the florulæ of these associations vary greatly on different mountains, and even on different portions of the same *massif*, according to the altitude, aspect, degree of moisture, steepness of slope, and rock-constituents. In a more recent work by C. B. Crampton (5), the plateaux *débris* of quartzite hills in Caithness is stated to contain the following mosses and lichens:—*Rhacomitrium lanuginosum*, *Hypnum Schreberi*, and *Cladonia*, spp. Dr. Moss says (*loc. cit.*): "The lists of species available at present do not warrant any attempt to draw up complete lists; as to the lower plants there is little information."

It was principally for this latter reason that, happening to meet with fine examples of these associations on Ben-y-Gloe, we deemed it advisable to make a few notes on their constituents. This mountain, "the mountain of the mist," attains a greater height and has a finer outline than any other in Perthshire, east of Tay and Garry. It is situated about seven miles north-east of Blair Atholl and rises direct from Glen Tilt. There are two peaks, a western one having an altitude of 3505 ft., and an eastern—known as Carn nan Gabhar or "Cairn Gowar"—rising to 3671 ft.

We spent but a few hours on the mountain, and owing to thick mist only reached the lower of the two peaks. The ascent was made from Glen Tilt in rain and mist, on May 6th, 1912, the course being up the north-west side of the mountain. The aspect presents very little crag or rock exposure, and loses the interest provided where the chomophytic formation is present. Where this latter exists contiguous to the associations we are dealing with, the species are often reinforced from the crags and show greater variety.

The lower slopes of Ben-y-Gloe are covered with the usual grass association so common in the Highlands, above which there is a considerable area of heather moor, with, in places, patches of ground dominated by *Scirpus cespitosus*. In the heather moor the chief *Sphagna* noted were compact tufts of *Sphagnum rubellum*, *S. fuscum*, and a little *S. subnitens*, thus differing from our Lancashire moors, on which *S. papillosum* predominates, and *S. fuscum* is practically absent. The ling thins out as the ground rises, and above 2500 ft. becomes much

mixed with crowberry (*Empetrum nigrum*) and some bilberry (*Vaccinium Myrtillus*). At about 2800 ft., near the shoulder of the flat-topped ridge or plateau which leads up to the summit on the south-west, the ground is somewhat broken and stony, the association becomes gradually more open, and eventually resolves itself into a fair area of the *Moss-Lichen Association*. We were able to make a careful examination of only a small portion of this ground, and the list of species submitted below is of necessity incomplete. The season was very early for this altitude, and the time allowed by train arrangements was all too short for searching out the more minute cryptogams. Moreover, the different classes of these plants require searching for on separate occasions. We have found from experience how easily mosses and hepatics may be overlooked when lichens are being collected, and how incompatible the quest of flowering plants is with that of the smaller cryptogams. Subject to allowance for these limitations the following is a complete list of all the species noted on this detached portion of the *Moss-Lichen Association*, occurring on boulders, stones, and thin soil overlying the quartzite rock:—

## FLOWERING PLANTS.

*Alchemilla alpina* L.  
*Empetrum nigrum* L.  
*Gnaphalium supinum* L.  
*Vaccinium Myrtillus* L.  
*Salix herbacea* L.  
*Aira* and other grasses not in flower.

## VASCULAR CRYPTOGRAMS.

*Lycopodium Selago* L.  
*L. alpinum* L.

## MOSSSES.

*Andreaea petrophila* Ehrh.  
*Polytrichum alpinum* L.  
*P. piliferum* Schreb.  
*Dicranum fuscescens* Turn.  
*D. scoparium* v. *turfosum* Milde.  
*Rhacomitrium heterostichum* Brid.  
*R. lanuginosum* Brid.  
*Webera nutans* Hedw.

## HEPATICES.

*Diplophyllum albicans* Dum.

## FUNGI.

*Ticothecium erraticum* Massal.

## LICHENS.

*Cladonia cervicornis* Schaer.  
*Thamnomia vermicularis* Schaer.

LICHENS (*continued*).

*Stereocaulon coralloides* Fr.  
*S. evolutum* Graewe.  
*Sphaerophorus fragilis* Ach.  
*Cetraria aculeata* Fr.  
*Platysma triste* Cromb.  
*Gyrophora polyphylla* T. & B.  
*Parmelia alpicola* Fr. fil.  
*P. lanata* Wallr.  
*P. lanata* var. *reticulata* Cromb.  
*Lecanora polytropa* Schaer.  
*L. badia* Ach.  
*Hæmatomma ventosum* Mass.  
*Lecidea aglæa* Sommerf.  
*L. fuscoatra* Ach.  
*L. Kochiana* Hepp.  
*L. lithophila* Ach.  
*L. lapicida* Fr.  
*L. auriculata* Th. Fr.  
*L. contigua* Fr.  
*L. confluens* Ach.  
*L. fusco-cinerea* Nyl.  
*L. limosa* Ach.  
*L. demissa* Th. Fr.  
*L. griseoatra* Schaer.  
*Buellia badioatra* Koerb. var. *atrobadia* A. L. Sm.  
*Rhizocarpon geographicum* DC.  
*R. geographicum* DC. var. *atrovirens* Koerb.  
*R. confervoides* DC.

Ascending another 700 ft., the summit plateau is reached, consisting of the same kind of broken gravelly ground, with scattered stones, and patches of very thin soil, formed chiefly of the *débris* of cryptogamic plants. The flora at this elevation is slightly different. The dominant plants are *Carex rigida* and *Alchemilla alpina*.

The quartzite blocks, of which the cairn is built, yield additional *Gyrophora*, viz. *G. erosa*, *G. torrefacta*, and *G. cylindrica*, the first and last-named being very scarce. On loose stones we saw a small quantity of a sterile *Pyrenopsis*, but *Parmelia alpicola* was fairly well developed on quartz crystals. On half-decayed patches of *Cladonia*, *Rhacomitrium* and *Dicranum fuscescens* there is an abundance of *Lecanora tartarea* var. *frigida*, with *Lecidea arctica* Somm. and *L. limosa* Ach., on peaty soil filling the crevices of the stones. These two lichens appear to thrive in the most bleak and exposed situations offered by our mountains. They are accompanied by a few starved-looking examples of *Thamnolia vermicularis*, a curious *Cladonia*-like plant, resembling in shape a small white earthworm. So far as we observed, this lichen is much less fine and abundant here than in the moss-lichen association of the granitic summits of the Cairngorm range. We saw here the hepatic *Gymnomitrium obtusum*, and no doubt other minute species might have been noted had conditions permitted a more careful search; but the Bryophyta were not obtrusively evident. Two lichens, *Lecidea tabidula* Nyl., and *L. deparcula* Nyl., are recorded by Crombie (6) as occurring on small stones on this summit, but we failed to find them, although they doubtless enter into this association, as also does *Lecidea nigroglomerata* A. L. Sm. on Cairn Gowar.

Turning now to ecological considerations, this particular ground, from the broken nature of the surface, which is weathered into stones and gravelly detritus, is subject to rapid drainage, and there is practically no available subsoil water for the plants near the surface. The hard crystalline rock is markedly dysgeogenous, and not retentive of moisture. Any soil formed is either washed down into the interstices, or completely removed by the fierce gales to which these plateaux are exposed. But for the frequent showers and cloud-fog, and occasional pockets in which a little humus is detained by the matted stems of cryptogams, the higher plants would scarcely be able to exist. In such situations the amount of rainfall is of minor importance as compared with its frequency, and probably the plants depend more on the prevalent cloud-mist than on rain for their supplies. There are intervals of bright sunshine and strong wind, producing rapid evaporation of moisture. Added to this frequent desiccation there is considerable fluctuation of temperature, producing together a set of conditions which reduce the possibilities of plant life almost to zero.

The special contrivances by which certain flowering plants are enabled to face these untoward circumstances are well known and need not be repeated. As regards the Bryophyta, they are mostly

small and densely tufted, and the tufts are frequently sunk in crevices of the rock or ground which they completely fill, allowing little purchase to the wind. The leaves are frequently very hygroscopic, as in chomophytic species, in wet weather open, in drought closely appressed and imbricate. The stunted growth, often attained by a shortening of the internodes, brings the leaves closer together, so that when appressed their apices alone are exposed. The cells are usually small, thick-walled, and often the thickness is increased externally by papillæ. This seems to be especially the case with mosses having comparatively blunt leaves. These papillæ probably act, like the apices of the leaves, as foci on which moisture condenses during cloud-fog. The Lichens, also, are usually diminutive in size, or, if of larger growth, more or less compact and cushion-like. The only *Cladonia* noted was a small form of *C. cervicornis*, in which the thallus was reduced to a dense squamulose cushion, and the podetia very diminutive. *Stereocaulon* and *Sphaerophorus* occur in very compact forms, the outer stems prostrate, the next inclined, the central ones erect, so that the points only are exposed, and no lateral stress is received in wind-storms. The only foliose *Parmelia* seen was the closely appressed *P. alpicola*, which is so reduced as to resemble a crustose *Lecanora*. The lacinia of the thallus are very convex, imbricate and complicate, and often torulose, so that when wetted the water is partly retained in the very numerous depressions thus formed in the thallus, and such as finds its way under the subtubular divisions is retained. The tough leathery *Gyrophora* are centrally affixed, and often depressed at the margins, forming shields beneath which moisture is retained longer than on the open rock. In the case of *G. torrefacta* the under side is often fibrillose and covered with several trabeculate membranes, the whole producing a sponge-like texture. Occasional perforations admit moisture under the thallus. *Lecanora tartarea* assumes a very different appearance from that which it presents on trees or rocks at lower altitudes. It creeps over mosses and plant-roots, giving off at intervals slender spinulose processes, which no doubt act as dew-collecting points. The erect fruticose lichens, so plentiful in the next group, are almost absent. They are represented by *Parmelia lanata*, a decumbent or prostrate appressed plant with the appearance of *Alectoria nigricans*, but a totally different habitat and mode of growth; and *Thamnolia vermicularis*, a prostrate plant which hardly leaves the ground except where it turns up its pointed ends as an attraction to the dew. Many of the *Lecideæ* have large fruits, and very little thallus. The hyphæ ramify in minute interstices of the stone, and the gonidia cluster under the lee of their own apothecia, so that they often at first sight appear to be quite athalline. This is especially the case on loose stones of small size, where the conditions are intensely dry.

Like the scouts of an army, these outposts of vegetable life lead a precarious existence, and they take "cover" behind any prominent object, especially on the leeward side. Their growth

in a horizontal direction is often determined by the height of some neighbouring tuft or stone, in the shelter of which they lie.

The attitude of many of the species may be described as one of "crouching" to obtain shelter from the wind. When shelter and moisture are both denied them, they have still a defence in reserve. Before a prolonged drought they simply adopt a condition of suspended animation. How long they can so live would be difficult to ascertain, but they must certainly be able to lie dormant for several weeks without injury.

From the lower to the higher of the two plateaux or terraces described above, the ground rises in a moderate slope, and affords an excellent example of the closed *Rhacomitrium* Heath Sub-association. The requisite conditions appear to be rapid drainage, shallow soil, and a low mean temperature. Another condition which has been suggested as favourable for the production of *Rhacomitrium* heath is the absence of direct sunshine from northern slopes for several months during the winter, owing to the low angle of elevation of the sun. The ground is also usually too steep and wind-swept for great accumulations of snow. On Ben-y-Gloe the drifts or *Schneeflechten* which we encountered lay below the *Rhacomitrium* heath.

Except where the thick dense carpet of *Rhacomitrium* has been accidentally torn away, or where jutting rocks protrude through its compact layers, this association in its most perfect development contains few or none of the higher plants. The stems of the moss become procumbent, overlapping each other to a considerable depth, and the subsidiary vegetation consists mainly of lichens attached to its decaying branches. Macvicar (4) in alluding to the *Rhacomitrium* heath says "the hepatics are almost absent from it," and so we found it here. We are able also to agree fully with the following statement by Moss (1): "While the closed *Rhacomitrium* association would appear to increase the shelter for other species, it is noteworthy that the proportion of Highland species is generally less in it than on the more open stony waste." It is probable these remarks were intended to apply to flowering plants, but they are also applicable to the mosses, hepatics, and lichens.

The *Rhacomitrium* heath forms a delightfully soft and springy carpet to the feet of the traveller, and the change from the arduous toil of the heathery lower slopes is always welcomed by the climber. We found the flora here, as on similar tracts of other mountains, poor and scanty. It is doubtful if a prolonged search even at a more favourable time of the year would have added very materially to the list of species noted in the centre of the moss-carpet, *i. e.* where the association is closed and perfect. Probably, however, a considerable number of small cryptogams and encroaching spermophytes might be detected at various points where it merges into other formations. The paucity of species in the closed *Rhacomitrium* heath overlying quartzite rocks will be seen from the following list, in which the species are arranged in order of frequency.

## DOMINANT.

*Racomitrium lanuginosum*  
Brid.

## ABUNDANT.

*Cladina rangiferina* Nyl.  
*Cetraria crispa* Nyl.  
*Alectoria nigricans* Nyl.

## FREQUENT.

*Cladina sylvatica* Nyl.  
*C. uncialis* Nyl.  
*C. uncialis* Nyl. v. *obtusata* Nyl.  
*C. uncialis* Nyl. v. *turgescens*  
Cromb.  
*Cladonia deformis* Hoffm.  
*Empetrum nigrum* L.

## OCCASIONAL.

*Hypnum Schreberi* Willd.  
*Cladonia furcata* Hoffm.  
*Dicranum fuscescens* Turn.  
*Carex rigida* Good.

*Lycopodium alpinum* L.  
*Polytrichum alpinum* L.  
*Cetraria aculeata* Fr.  
*Cladonia cervicornis* Schaer.  
*C. gracilis* Hoffm.  
*C. macilenta* Hoffm. v. *coronata*  
Nyl.

## RARE.

*Cladonia destriata* Nyl.  
*Lecanora tartarea* Ach.  
*Cladonia bellidiflora* Floerke.  
*C. squamosa* Hoffm. forma.  
*C. degenerans* Floerke.  
*C. degenerans* Floerke v. *pleolepidea* Nyl.  
*Alectoria ochroleuca* Nyl.  
*Baeomyces aruginosus* DC.  
*Bilimbia melæna* Arnold.  
*Hypnum cupressiforme* L.  
*Hylocomium loreum* B. & S.  
*Ptilidium ciliare* Hampe.  
*Galera hypnorum* Fr.

The majority of the species in this list ascend considerably above the 3000 ft. contour. The vegetation of the plateau gravel has been described as cushion-like or crustaceous; that of the present association may be said to be mat- or carpet-like. The dominant moss has long, much divided, trailing stems, which are interlaced together by numerous short hooked branches and long leaves. This clinging of the stems does not always prevent strong gales from tearing up large sheets of the carpet. Bare patches formed in this manner revert to the moss-lichen stage until the *Racomitrium* reassumes dominance. The apices of the leaves of this moss are devoid of chlorophyll, papillose and eroso-ciliate, thus presenting innumerable small prominences for the reception of dew. It will be observed that this echlorophyllose area is as papillose as the rest of the leaf, and therefore we cannot in this instance regard the papillæ as simply designed to shield the chlorophyll from the sun, or to prevent evaporation, which is usually accepted as their *raison d'être*. The condensed moisture, or, during showers, rain-water, runs down to the thick underlying mass of old stems and leaves, which hold it like a sponge. Still lower a layer of humus is rapidly formed. Most of the flowering plants and other dependent species cower beneath the shelter of the moss, only in favourable seasons protruding their growing tips, and, as is apparent from the paucity of individuals as well as species, often suffering severely for their temerity in so doing. The smaller mosses and lichens, especially those of effuse horizontal growth, have no chance, and are rapidly smothered, the erect fruticulose lichens greatly preponderating. *Cladinæ* and *Cladoniæ* with elongate podetia are frequent, presenting often

spinulose points above the moss. *Cetraria crispa* straggles up through the mats, singly or in dense tufts. Its margins are beset with cilia, giving it a distant resemblance, on a larger scale, to the eroded leaf-margin of the dominant moss. In dry weather the thallus rolls up and becomes subtubular. Some of the large-branched *Cladonia* have perforate axils, the orifices being at times spinulose, the spines acting as water conductors to the interior of the hollow podetia. A lichen almost confined to this association is *Alectoria nigricans*, and the allied *A. ochroleuca* is also partial to it. They resemble miniature trees. The trunks obtain support by standing buried in the *Rhacomitrium*, the branches rising above the surface, where they ultimately become dark and discoloured by exposure to sun, wind, and frost. In dry weather they are readily overlooked, but under moister conditions their entangled ramuli and slender branchlets become everywhere studied with tiny drops of dew, and are then very noticeable. When dry they are rigid and brittle; then the feet of the alpine hare or ptarmigan readily crush them into small particles, to be disseminated by the wind. In this manner this rare lichen is probably propagated; its fruit is unknown with us, but has been found, according to Crombie (7), in Labrador and Arctic North America.

It must be observed that this list of species applies only to the Upper Arctic-Alpine formation of Ben-y-Gloe, and that had we been dealing with the similar formation of the micaceous *débris* of Ben Lawers, or granitic detritus of the Cairngorms, we should have a very different list of species, and in the case of the former a very much richer one. Such beautiful plants as *Solorina crocea* on Lawers, and *Platysma nivale* on Braeriach, with many others as rare if not so handsome, would reward the explorer of the Arctic-Alpine area of those mountains. A comparative list of plants from the various summits above 3000 ft. would provide exceedingly interesting matter for speculation.

#### References.

- (1) A. G. Tansley and C. E. Moss: Types of British Vegetation. 1911.
  - (2) R. Smith: Botanical Survey of Scotland. Scott. Geog. Mag., 1904.
  - (3) W. G. Smith: Anthelia, an Arctic-Alpine Association. Scott. Bot. Review, No. 2, April, 1912.
  - (4) S. M. Macvicar: The Distribution of Hepatics in Scotland. Trans. Bot. Soc. Edin. xxv., 1910.
  - (5) C. B. Crampton: The Vegetation of Caithness considered in Relation to the Geology. 1911.
  - (6) J. Crombie: Grevillea, i. p. 62, and viii. p. 112.
  - (7) J. Crombie: Monograph of British Lichens, part i., 1894.
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