

Flowers and Insects in Great Britain.

PART I.

BY

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THE observations detailed in this first part of our paper refer, with a few exceptions, to lowland plants growing not more than 1,000 feet (305 metres) above sea level. They were made during 1892-93-94 in several places, viz. Cambridge, Scarborough, Mid-Wales (Plynlimmon district of Cardiganshire), and Auchencairn (South Scotland). The observations at each place are given separately; one of us is entirely responsible for those made at Scarborough, the other for those at Auchencairn. A few high-level visitors in Wales are given here. We have also made observations in the Grampian mountains, which (together with the general results) we hope to give in a second portion of this paper at some future period.

We desire to express our gratitude to the following entomologists, who have most generously named for us a very considerable number of insects which we could not ourselves

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identify, thus rendering this paper far more accurate and complete than it could otherwise have been made.

DR. D. SHARP, F.R.S. (Coleoptera and many others).

G. H. VERRALL, ESQ., F.E.S. (Diptera).

R. C. L. PERKINS, ESQ., M.A. (Hymenoptera Aculeata).

In addition to naming our Coleoptera, &c., Dr. Sharp has given us several valuable suggestions and criticisms, for which we desire to express our thanks.

I. INTRODUCTORY.

The first person to emphasize the need of studying the insects that visit flowers, as well as the flowers themselves, was H. Müller. In his classical books he gives descriptions of the mechanisms of many flowers, and also full lists of their insect-visitors. From these it is easily seen that there are degrees of specialization in the flowers—more effectual shelter of pollen and honey, more conspicuousness, scent, &c.—and corresponding degrees of specialization in their insect-visitors—greater adaptation of mouth-parts to procuring pollen and honey, greater cleverness in finding concealed honey, preference for certain colours or scents, &c. Müller himself was the first to put these facts into shape, as the ‘Theory of Flowers’ which is enunciated in his ‘Alpenblumen’ (1881; it was partly, however, set forth in earlier papers). Entomophilous flowers are there divided into several classes; beginning with the lowest, these are:—

1. Pollen-flowers (Po) of simple type, offering pollen only to their visitors; examples are *Helianthemum vulgare*, *Spiraea Ulmaria*.

2. Flowers with freely exposed honey (A); Umbelliferae, *Parnassia*.

3. Flowers with partially concealed honey (AB); Cruciferae, *Potentilla*.

4. Flowers with fully concealed honey (B); *Mentha*, *Calluna*.

5. Capitula with fully concealed honey (B’); Compositae, *Phyteuma*.

[6. Flowers specially adapted to Diptera (D); *Veratrum album*, *Saxifraga umbrosa*¹.]

7. Flowers specially adapted to Bees (H); most Labiatae, *Echium*, *Gentiana*.

8. Flowers specially adapted to Lepidoptera (F); *Silene acaulis*, *Gymnadenia*.

Similarly the insects visiting the flowers are divided into classes according to their degrees of specialization for flower-visiting. The chief groups are:—

1. Neuroptera, Orthoptera, Hemiptera, Thysanoptera.
2. Coleoptera.
3. Long-tongued Diptera (Syrphidae, Conopidae, Bombylidae, Empis).
4. Short-tongued Diptera (all others).
5. Long-tongued Bees (*Apis*, *Bombus*, &c.).
6. Short-tongued Bees (*Prosopis*, *Andrena*, &c.).
7. Other Hymenoptera.
8. Lepidoptera.

Arranging these in order of specialization to floral diet, we should have first groups 8 and 5, then 6 and 3, and lastly 7, 4, 2, and 1.

Tables are given showing the numbers of species of insects of each kind that visit the different floral groups, and it is at once seen that the bulk of the visitors to the higher types of flowers are insects of high degree of specialization, e. g. in the Alps, to 100 flowers of class H, the visitors were:—Lepidoptera, 39.1 per cent.; long-tongued bees, 48.8 per cent.; and all other insects together, 12.1 per cent. On the other hand, of the visitors to flowers of class A, the Lepidoptera and bees form only 14.2 per cent.

Loew (292 *b*) observed the visitors to exotic plants in the Berlin Botanic Garden, and the results thus obtained were in accord with Müller's theory, and gave it great support. Since that time many observations have been made in various parts

¹ Class 6 is not usually considered a separate class.

of the world, all tending to support the same general view. An excellent review of the whole has recently been published by MacLeod (18 in literature list, below).

At the same time, great variation occurs in the case of any single flower between the results obtained in various places. The composition of the list of visitors varies much, though their type remains comparatively the same; so also there are variations in the floral mechanism itself and in the amount of vegetative reproduction, &c. This being so, it becomes of interest to study various flowers in many different parts of their distribution areas, as we may thus obtain some information of value with regard to geographical distribution, variation, effect of environment, &c. Loew's recent work (4) contains an abstract and literature list of all the work done in this direction upon the European flora since 1883, but from the regions studied, our own country is conspicuously absent. The present paper (with the second portion to follow) is an attempt to fill some small portion of this gap. The literature relating to our British flora is small, and chiefly contained in out-of-the-way journals (see list). The only paper of any importance is that of Scott-Elliott, but the observations are fragmentary, and no conclusions are drawn from them. One of us (6) has drawn attention to the great preponderance of flies over other visitors in certain cases, but no general conclusion has been drawn, extending over the whole flora.

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2. OBSERVATIONS AT AUCHENCAIRN, 1894,

BY J. C. WILLIS.

Auchencairn is a small village about two miles from the sea, on the southern coast of Scotland. It lies in lat. $54^{\circ}50'N$. (corresponding to Schleswig-Holstein), and has an approximate mean annual temperature of 9° . To the west is the Ben Gairn range of hills (highest point 1,250 feet), and to the east a small bay, dry except at high water. The conditions for vegetable growth are all very favourable, and there is a rich flora. The writer stayed in Auchencairn from August 15 to September 15, 1894, and the weather being favourable throughout, succeeded in determining, with some completeness, the visitors of almost all the plants which formed, at that period of the year, important features in the flora. Great care was taken to watch each plant at all the different

hours of the day, and to record only *genuine* visitors; notes were made of what each insect was doing upon the flowers. The whole of the observations (one moth excepted) were made within three miles of Auchencairn, and a brief description of the 'hunting-grounds' will now be given.

A. *Forest Hill* (F.H), an open moor, on the east side of Ben Gairn, covered with *Calluna* and *Erica* (*cinerea* and *Tetralix*), *Calluna* being far more abundant. Amongst the heather occur *Potentilla Tormentilla*, and *Polygala*.

B. *Forest Hill Road* (F.H. Rd.), the road to A from Auchencairn. By the side of it are masses of *Hypericum perforatum*, *Spiraea*, *Lychnis*, *Rubus*, *Leontodon*, *Centaurea*, *Digitalis*, and *Scabiosa*.

C. *The beach of Auchencairn Bay* (A. B.), a grassy expanse covered with *Aster* and (less common by far) *Statice*, up to the extreme high water mark; above this occur *Senecio Jacobaea*, *Centaurea*, *Ononis*, *Rubus*.

D. *Rascarrel beach* (Ras.). Rascarrel Bay is on the open sea and faces SE. The western end has lofty cliffs, but the eastern end has a large extent of flat beach above the high water mark, and this rises inland by a slope of about 30° to a height of 100 feet. The slope is covered at the top with *Erica*, *Calluna*, and *Helianthemum*; further down chiefly with *Teucrium*; while its lowest parts and the flat beach are covered with a tangled mass of vegetation, in which the chief flowers are *Rubus*, *Lonicera*, *Senecio Jacobaea*, *Angelica*, *Pimpinella Saxifraga*, *Mentha aquatica*, *Geranium Robertianum*, *Scutellaria galericulata*, *Lycopus europaeus*, *Centaurea nigra*, *Achillea Millefolium*, *Scabiosa succisa*, *Campanula rotundifolia*, *Prunella vulgaris*, *Matricaria inodora*. Facing south, and well sheltered, this part of the bay forms an excellent place for insect observations and a great deal of time was spent here.

E. *Road from Auchencairn to Rascarrel* (Rasc. Rd.). Along the road are masses of *Senecio Jacobaea*, *Calluna*, *Leontodon*, *Stachys palustris*, *Galeopsis Tetrahit*, &c.

F. Road from Auchencairn to Collin (Cl.). About a mile from the village this road has broad green sides, covered with masses of *Angelica*, *Pimpinella*, *Spiraea*, *Leontodon*, &c.

The flowers will now be treated of in systematic order, giving lists of visitors and references to previous papers. In the lists of Diptera, the Syrphidae are placed first as being long-tongued.

Abbreviations:—s. h. = sucking honey; c. p. = collecting pollen; f. p. = feeding on pollen; ab. = abundant; freq. = frequent; do. = ditto. F. H., Cl., &c. are explained above. The date of observation is given.

COMPOSITAE: 1. *Leontodon autumnalis* L. [Class B'. See Literature, 1, 2, 3, 4, 11, 14, 15, 17, 18, 25, 48 b.] This flower abounds in the district, and is very abundantly visited by short-tongued flies; one at least, and often as many as six or eight, may usually be seen on every head. They feed upon pollen, manipulating the anther-tube with their forelegs and proboscis. Though so numerous they are comparatively of little importance in the work of fertilization.

Visitors. **Lepidoptera**. Rhopalocera: (1) *Lycaena icarus* Rott., s. h. F. H. Rd. 6. 9. 94. Heterocera: *Tortricidae*: (2) *Simaëthis fabriciana* L., do. *Crambidae*: (3) *Crambus* sp.?, 5. 9. 94. **Hymenoptera**. Aculeata: *Acutilingues*: (4) *Bombus terrestris* L., s. h. Rasc. Rd. 7. 9. 94. (5) *B. muscorum* L., do., 5. 9. 94. (6) *Halictus rubicundus* Chr., s. h. freq. Terebrantia: *Chalcididae*: (7) one sp. **Diptera**. *Syrphidae*: (8) *Platychirus manicatus* Mg., f. p. freq. Cl. 3. 9. 94. (9) *Syrphus ribesii* L., s. h. and f. p. freq. 3-10. 9. 94. (10) *Sphaerophoria scripta* L., f. p. freq. Cl. 3. 9. 94. (11) *S.* sp.?, do. (12) *Brachyopa bicolor* Fln., s. h. F. H. Rd. 6. 9. 94. (13) *Sericomyia borealis* Fln., f. p., do., 11. 9. 94. (14) *Eristalis aeneus* Scop., f. p. Cl. 3. 9. 94. (15) *E. tenax* L., f. p. F. H. Rd. 11. 9. 94. (16) *E. pertinax* Scop., do. *Mycetophilidae*: (17) *Sciara* sp.? f. p.? *Anthomyiidae*: (18) *Trichophthicus cunctans* Mg., f. p. Cl. 3. 9. 94. (19) *Anthomyia radicum* L., do. (20) *A.* sp.?, do. *Ephydridae*: (21) *Hydrellia griseola* Fln., do. **Coleoptera**: (22) *Sitones puncticollis* Steph., do. **Hemiptera**: (23) *Calocoris fulvo-maculatus* De G., Cl. 3. 9. 94. (24) *C.*

bipunctatus F. (?), do. (25) *Miris laevigatus* L., do. (26) *Acocephalus* sp.?, do.

2. *Centaurea nigra* L. [Class B', Lit. 8, 10, 17.] This plant is everywhere abundant, and was in full flower throughout the time.

Visitors. Lepidoptera. Rhopalocera: (1) *Argynnis aglaia* L., s. h. near F. H. 30. 8. 94. (2) *A. sp.* (? *paphia* L.), s. h. F. H. Rd. 12. 9. 94. (3) *Epinephele janira* L., s. h. Rasc. 29. 8., F. H. 30. 8., Cl. 3. 9. 94. (4) *Pieris napi* L., s. h. freq. at all stations 24. 8. to 8. 9. 94. (5) *P. rapae* L., s. h. Rasc. 29. 8., Cl. 3. 9. 94. (6) *Polyommatus phloas* L., s. h. freq. Rasc. &c. 3-12. 9. 94. (7) *Vanessa urticae* L., s. h. F. H. 30. 8., Cl. 10. 9. 94. Heterocera: *Crambidae*: (8) *Crambus* sp.? s. h. freq. Cl. 29. 8., Rasc. 3-12. 9. 94. *Hymenoptera.* Aculeata: *Acutilingues*: (9) *Apis mellifica* L., s. h. Cl. 8. 9. 94. (10) *Bombus hortorum* L., s. h. freq. at all stations 24. 8. to 10. 9. 94. (11) *B. lapidarius* L., s. h. freq. Cl. and A. B. 27. 8. to 10. 9. 94. (12) *B. muscorum* L., s. h. ab. at all stations except Rasc. 24. 8. to 12. 9. 94. (13) *B. terrestris* L., s. h. ab. everywhere, do. (14) *B. scrimshirani* Kirb., s. h. freq. Cl. 27. 8. 94. (15) *B. pratorum* L., s. h. A. B. 2. 9. 94. (16) *Anthidium manicatum* L., s. h. Rasc. 29. 8. and freq. F. H. Rd. 6. 9. 94. *Diptera. Syrphidae*: (17) *Platychirus manicatus* Mg., f. p. Cl. 31. 8. and 3. 9. 94. (18) *P. albimanus* F., f. p. freq. Cl. 31. 8. 94. (19) *Syrphus balteatus* Deg., do. (20) *Sphaerophoria scripta* L., s. h. Cl. 27. 8. 94. (21) *Rhingia rostrata* L., s. h. and f. p. freq. Cl. &c. 24. 8. to 1. 9. 94. (22) *Eristalis aeneus* Scop., s. h. freq. Rasc. 5. 9. 94. (23) *E. tenax* L., s. h. A. B. 2. 9. 94. (24) *E. pertinax* Scop., f. p. Rasc. Rd. 24. 8. 94. *Anthomyiidae*: (25) *Trichophthicus cunctans* Mg., s. h.? Rasc. 23. 8. 94. (26) *Hylemyia strigosa* F., do. 27. 8. 94. (27) *Anthomyia radicum* L., f. p. Rasc. 23 and 31. 8. 94. (28) *A. sp.*?, freq. Rasc. 23-31. 8. 94. *Coleoptera*: (29) *Crepidodera ferruginea* Scop., in copulâ, F. H. Rd. 6. 9. 94. (30) *Meligethes viridescens* F., f. p. very ab. 23. 8. to 12. 9. 94. *Hemiptera*: (31) *Calocoris bipunctatus* F., Cl. 31. 8. 94. (32) *C. fulvo-maculatus* De G., Rasc. Rd. 30. 8. 94. (33) *Anthocoris* sp.?, ab. F. H. Rd. 27-28. 8. 94.

3. *Senecio Jacobaea* L. [Class B', Lit. 1, 3, 4, 11, 14, 17, 18.] This is by far the most conspicuous plant in the district

in late summer, excepting *Calluna* and *Erica* upon the moors. Enormous masses of it, visible half a mile away, occur on Rascarrel beach, and it is common everywhere. It was in full bloom during the period of these observations, and was visited on fine days by countless insects.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Epinephele janira* L., s. h. Rasc. 29. 8. 94. (2) *Pieris rapae* L., do. (3) *Polyommatus phloea* L., s. h. ab. Rasc. &c. 24. 8. to 12. 9. 94. Heterocera: *Noctuidae*: (4) *Charaëas graminis* L., s. h. F. H. 30. 8. and 12. 9. Rasc. 4. 9. 94. *Tortricidae*: (5) *Simaëthis fabriciana* L., s. h.? freq. on the flowers 1-9. 9. 94. (6) *Choreutis myllerana* F., s. h. Rasc. 29. 8. 94. *Tineidae*: (7) *Plutella cruciferarum* Zel., s. h. Rasc. 29. 8. Cl. 1. 9. 94. *Crambidae*: (8) *Crambus* sp.? s. h. freq. 21. 8. to 10. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (9) *Apis mellifica* L., s. h. ab. Rasc. 23 to 29. 8. 94. (10) *Bombus lapidarius* L., s. h. Rasc. 28. 8. to 10. 9. 94. (11) *B. cognatus* Steph., s. h. freq. Rasc. 29. 8. 94. (12) *B. pratorum* L., s. h. ab. Rasc. 23-29. 8. 94. (13) *B. hortorum* L., s. h. ab. Rasc. Rd. 31. 8. 94. (14) *B. muscorum* L., s. h. ab. Rasc. 28. 8. to 10. 9. 94. (15) *Psithyrus quadricolor* Lep., s. h. ab. Rasc. Rd. 23-30. 8. 94. (16) *Andrena nigriceps* Kirb., s. h. ab. Rasc. 29. 8. 94. (17) *Halictus rubicundus* Chr., s. h. ab. A. B. 21. 8., Rasc. 29. 8. 94. (18) *H. albipes* Kirb., s. h. ab. Rasc. 29-31. 8. 94. *Eumenidae*: (19) *Odynerus pictus* Curt., s. h. Rasc. 4. 9. 94. *Myrmicidae*: (20) *Myrmica rubra* L., freq. trying to suck honey. Terebrantia: *Ichneumonidae*: (21) one sp. *Chalcididae*: (22) one sp., both Rasc. 29-31. 8. 94. **Diptera.** *Syrphidae*: (23) *Chilosia* sp.?, s. h. Rasc. 29. 8. 94. (24) *Syrphus balteatus* Deg., f. p. F. H. Rd. do. (25) *S. ribesii* L., f. p. Rasc. Rd. 31. 8. 94. (26) *S. topiarius* Mg., s. h. do. (27) *Sphaerophoria scripta* L., s. h. and f. p. Rasc. 29-31. 8. 94. (28) *Arctophila mussitans* F., s. h. Cl. 3. 9. 94. (29) *Eristalis aeneus* Scop., s. h. and f. p. ab. Rasc. &c. 21. 8. to 4. 9. 94. (30) *E. pertinax* Mg., do. (31) *E. horticola* Deg., do. (32) *Helophilus pendulus* L., s. h. ab. Rasc. 29. 8. 94. *Bibionidae*: (33) *Dilophus* sp.?, s. h. Rasc. Rd. 29. 8. 94. (34) *Bibio pomonae* F., s. h. freq. do. *Tachinidae*: (35) *Olivieria lateralis* F., s. h. ab. Rasc. 29. 8. 94. *Sarcophagidae*: (36) *Sarcophaga carnaria* L., s. h. Rasc. 8. 9. 94. *Muscidae*: (37) *Lucilia caesar* L., s. h. ab. Rasc. Rd. 23. 8. 94. (38) *L. sericata* Mg., do. (39) *Calliphora erythrocephala* Mg., s. h. Rasc. Rd. 23. 8. 94.

(40) *Morellia* sp.?, s. h. Rasc. 5. 9. 94. *Anthomyiidae*: (41) *Hyetodesia incana* W., s. h. Cl. 10. 9. 94. (42) *Mydaea* sp.?, s. h. and f. p. freq. Rasc. &c. 22-31. 8. 94. (43) *Trichophthicus cunctans* Mg., s. h. Rasc. Rd. 18-28. 8. 94. (44) *Anthomyia radicum* L., s. h. and f. p. freq. Rasc. and A. B. 18-24. 8. 94. (45) *A.* sp.?, do. *Cordyluridae*: (46) *Scatophaga stercoraria* L., s. h. freq. A. B. 21. 8. 94. *Phytomyzidae*: (47) *Phytomyza geniculata* Macq., f. p. F. H. Rd. 27. 8. 94. **Coleoptera**: (48) *Antherophagus nigricornis* F., f. p. Rasc. Rd. 28. 8. 94. (49) *Meligethes* sp.?, f. p. ab. 18. 8. to 12. 9. 94. **Hemiptera**: (50) *Calocoris bipunctatus* F., freq. Rasc. 29. 8. 94. (51) *Anthocoris* sp.?, freq. Rasc. 23. 8. to 1. 9. 94. (52) *Acocephalus* sp.?, Rasc. Rd. 28. 8. 94.

4. *Matricaria inodora* L. (? var. *maritima* Linn.). [Class B', Lit. 1, 3, 4, 11, 14, 18, &c.] Abundant on Rascarrel beach, and visited by great numbers of short-tongued flies. All observations were made there.

Visitors. **Lepidoptera.** *Rhopalocera*: (1) *Polyommatus phloea* L., s. h. freq. 7-14. 9. 94. *Heterocera*: *Tortricidae*: (2) *Choreutis myllerana* F., s. h. 7. 9. 94. (3) *Simaethis fabriciana* L., do. **Hymenoptera.** *Aculeata*: *Acutilingues*: (4) *Bombus lapidarius* L., 12. 9. 94; one insect visited two heads, s. h., and then went away. (5) *Halictus cylindricus* F., s. h. 5. 9. 94. (6) *H. rubicundus* Chr., s. h. ab. 7. 9. 94. (7) *Sphecodes affinis* v. Hag., s. h. freq. 5. 9. 94. *Obtusilingues*: (8) *Prosopis brevicornis* Nyl., s. h. 7-12. 9. 94. *Eumenidae*: (9) *Odynerus pictus* Curt., s. h. freq. 5. 9. 94. **Diptera.** *Syrphidae*: (10) *Ascia podagrica* F., s. h. freq. 5-7. 9. 94. (11) *Eristalis tenax* L., s. h. 7. 9. 94. (12) *E. pertinax* Scop., do. (13) *Sphaerophoria scripta* L., do. *Mycetophilidae*: (14) *Sciara* sp.?, s. h. ab. 7. 9. 94. *Bibionidae*: (15) *Scatopse brevicornis* Mg., do. *Muscidae*: (16) *Lucilia sericata* Mg., do. *Anthomyiidae*: (17) *Spilogaster communis* Dsv., s. h. 7. 9. 94. (18) *Anthomyia radicum* L., s. h. and f. p. very ab. 5-12. 9. 94. (19) *A.* sp.?, f. p. 7. 9. 94. *Sepsidae*: (20) *Themira minor* Hal., s. h. freq. 7. 9. 94. *Ephydridae*: (21) *Hydrellia griseola* Fln., s. h. and f. p. ab. 5-7. 9. 94. *Drosophilidae*: (22) *Scaptomyza graminum* Fln., s. h. freq. 7. 9. 94. *Chloropidae*: (23) *Oscinis frit* L., f. p. freq. 7. 9. 94. **Coleoptera**: (24) *Anthonomus rubi* Herbst, freq. 7. 9. 94. **Hemiptera**: (25) *Calocoris bipunctatus* F., do. (26) *C. fulvo-maculatus* De G., do.

5. *Achillea Millefolium* L. [Class B', Lit. 1, 2, 3, 4, 8, 11, 12, 14, 17, 18, 24, 287 b, 610 b, &c.] Abundant in the district. It is visited chiefly by flies, but great numbers of *Microlepidoptera* are often to be seen on the heads. Some of these, e.g. *Simaëthis*, are very like in colour to the withered flowers and are not easily noticed at a little distance. As many as seven specimens of this moth have been seen at once on a single tuft of flowers. The idea suggested itself that they might be there for protection, as often they stayed motionless for a long time.

Visitors. Lepidoptera. Rhopalocera: (1) *Pieris rapae* L., s. h. Cl. 3. 9. 94. (2) *P. napi* L., s. h. Rasc. 4. 9. 94. (3) *Polyommatus phloea* L., s. h. F. H. 30. 8., Rasc. 14. 9. 94. Heterocera: *Noctuidae*: (4) *Hydraecia nictitans* L., s. h. Dundrennan Abbey (5 miles from Auchencairn) 13. 9. 94. *Tortricidae*: (5) *Simaëthis fabriciana* L., s. h. or sitting on the heads, very ab. Cl., F. H. Rd., Rasc. 30. 8-14. 9. 94. (6) *Choreutis myllerana* F., s. h. Rasc. 8. 9. 94. *Diptera.* *Syrphidae*: (7) *Syrphus balteatus* Deg., s. h. Rasc. 4. 9. 94. (8) *Sphaerophoria scripta* L., s. h. freq. 24. 8-10. 9. Rasc. &c. (9) *Eristalis tenax* L., s. h. Cl. 3 and 10. 9. 94. (10) *E. pertinax* Scop., f. p. Rasc. Rd. 24. 8. 94. (11) *Syritta pipiens* L., s. h. Rasc. Rd. 30. 8. *Chironomidae*: (12) *Cricotopus* sp.?, f. p. Cl. 1. 9. 94. *Tachinidae*: (13) *Olivieria lateralis* F., s. h. Rasc. Rd. 30. 8. *Muscidae*: (14) *Lucilia sericata* Mg., s. h. and f. p. Rasc. 24-29. 8. *Anthomyiidae*: (15) *Hyetodesia incana* W., s. h. Cl. 3. 9. (16) *Spilogaster communis* Dsv., s. h. Rasc. Rd. 30. 8. 94. (17) *Anthomyia radicum* L., s. h. and f. p. freq. Rasc. &c. 24. 8-10. 9. 94. (18) *A.* sp.?, do. (19) *Phorbia floccosa* Mcq., f. p. Rasc. Rd. 24. 8. *Cordyluridae*: (20) *Scatophaga stercoraria* L., f. p.? Cl. 27. 8. *Ephydriidae*: (21) *Hydrellia griseola* Flh., f. p. Cl. 1. 9. 94. *Coleoptera*: (22) *Quedius boops* Grav., do. (23) *Cercus rufilabris* Latr., f. p. very ab. Rasc. Rd. 23. 8. 94. *Hemiptera*: (24) *Calocoris bipunctatus* F., s. h. Rasc. Rd. 30. 8. (25) *C. fulvomaculatus* De G., s. h. freq. Cl. and Rasc. 7-10. 9. 94. (26) *Anthocoris* sp.?, s. h. freq. Rasc. 4. 9. 94.

6. *Aster Tripolium* L. [Class B', Lit. 4, 11, 14, 15, 24, 339 b.] Abundant on the beach of Auchencairn bay, where its only competitors (except *Statice*) were at some distance

away (see above). During the spring tides, the flowers were covered twice daily by the sea, but it did not seem to do them any harm. All were fully fertile; autogamy probably often occurs. The flowers were visited by great numbers of Syrphidae and by a good many bees.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Polyommatus phloea* L., s. h. 18. 8. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Apis mellifica* L., do. (3) *Bombus lapidarius* L., s. h. 18-23. 8. 94. (4) *B. muscorum* L., do. (5) *B. pratorum* L., do. (6) *B. terrestris* L., do. **Diptera.** *Syrphidae*: (7) *Platychirus manicatus* Mg., s. h. 18. 8. 94. (8) *Eristalis aeneus* Scop., s. h. freq. do. (9) *E. tenax* L., do. (10) *E. horticola* Deg., do. *Muscidae*: (11) *Lucilia cornicina* F., do. (12) *Calliphora sepulchralis* Mg., s. h. 21. 8. 94. *Anthomyiidae*: (13) *Hyetodesia incana* W., s. h. and f. p. freq. 18. 8. 94. (14) *Anthomyia radicum* L., s. h. and f. p. freq. 18-21. 8. (15) *A. sp.?*, s. h. 21. 8. *Cordyluridae*: (16) *Scatophaga stercoraria* L., s. h. freq. 18. 8. *Tripetidae*: (17) *Tephritis vespertina* Lw., s. h. 21. 8. 94. **Coleoptera**: (18) *Meligethes aeneus* F., s. h. and f. p. ab.

CAMPANULACEAE: 7. *Jasione montana* L. [Class B', Lit. 1, 3, 4, 11, 12, 14, 17, 18, 48 b. See also below, No. 44.] Only occasional plants were to be met with in the neighbourhood.

Visitor. **Lepidoptera.** Rhopalocera: (1) *Pieris napi* L., s. h. Rasc. 4. 9. 94.

8. *Campanula rotundifolia* L. [Class H, Lit. 1, 2, 3, 4, 11, 14, 17, 18, 287 b.] Abundant, but not much visited except by small insects which shelter and feed in the flowers.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Vanessa urticae* L., s. h. Rasc. Rd. 10. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus terrestris* L., s. h. freq. Rasc. 29. 8. 94. **Diptera.** *Anthomyiidae*: (3) *Anthomyia radicum* L., s. h., freq. 24-29. 8. 94. **Coleoptera**: (4) *Meligethes sp.?*, s. h. ab., do. **Thysanoptera**: (5) *Thrips sp.?*, do.

DIPSACEAE: 9. *Scabiosa succisa* L. [Class B', Lit. 1, 3, 8, 14, 18; see also articles 36, 46, below.] Thinly scattered over the district.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris napi* L., s. h. Rasc. 4. 9., F. H. Rd. 10. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus muscorum* L., s. h. ab. Rasc. and F. H. Rd. 7-12. 9. 94. (3) *B. pratorum* L., s. h. freq. F. H. Rd. 12. 9. 94. (4) *B. terrestris* L., s. h. freq. Cl. 10. 9. 94. (5) *Psithyrus campestris* Pz., s. h. Rasc. 7. 9. 94. (6) *Halictus rubicundus* Chr., s. h. Cl. 10. 9. 94. (7) *H. cylindricus* F., s. h. ab. F. H. Rd. 5. 9. 94. **Diptera.** *Syrphidae*: (8) *Melanostoma scalare* F., f. p. freq. F. H. Rd. 12. 9. 94. (9) *Syrphus balteatus* Deg., s. h. Cl. 10. 9. and f. p. F. H. Rd. 12. 9. 94. (10) *Eristalis intricarius* L., s. h. Cl. 10. 9. 94. (11) *E. tenax* L., do. (12) *Helophilus pendulus* L., do. *Anthomyiidae*: (13) *Mydaea* sp.?, do. (14) *Anthomyia* sp.?, do.

CAPRIFOLIACEAE: 10. *Lonicera Periclymenum* L. [Class F, Lit. 1, 8, 11, 14, 14*, 18, 131 b.] Abundant at Rascarrel. It was not watched at night and no *Lepidoptera* were seen upon it in the day time.

Visitor. **Hymenoptera.** Aculeata: *Acutilingues*: (1) *Bombus hortorum* L., s. h. freq. Rasc. 29. 8. to 10. 9. 94.

SCROPHULARIACEAE: 11. *Digitalis purpurea* L. [Class H, Lit. 1, 4, 9, 244 b, 316 b, 518 b.] Frequent, but not abundant.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris* sp.?, s. h. Rasc. 14. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus muscorum* L., s. h. Rasc. 8-12. 9. 94. (3) *B. terrestris* L., s. h. Rasc. 4-12. 9. 94. (4) *B. hortorum* L., do. **Coleoptera**: (5) *Meligethes* sp.?, ab. The bees alone were of use in fertilization.

LABIATAE: 12. *Mentha aquatica* L. [Class B, Lit. 1, 14, 18, 21, 410 b. See also No. 37, below.] Abounds on Rascarrel beach and was studied there. It was in full flower about Sept. 4, 1894.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris napi* L., s. h. 5. 9. (2) *Vanessa urticae* L., s. h. 14. 9. (3) *Polyommatus phloea* L., s. h. 4. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (4) *Bombus muscorum* L., s. h. ab. 5-10. 9. (5) *Psithyrus campestris* Pz., s. h.

5. 9. (6) *Halictus rubicundus* Chr., do. **Diptera.** *Syrphidae*: (7) *Volucella pellucens* L., s. h. 4. 9. (8) *Eristalis aeneus* Scop., freq. s. h. 5. 9. (9) *E. tenax* L., do. (10) *E. horticola* Deg., do. *Empidae*: (11) *Rhamphomyia* sp.?, s. h. 10. 9. *Anthomyiidae*: (12) *Mydaea* sp.?, f. p. 12. 9. (13) *Trichophthicus cunctans* Mg., s. h. freq. 5. 9. (14) *Anthomyia radicum* L., s. h. and f. p. 5-12. 9. (15) *A.* sp.?, do. **Coleoptera**: (16) *Crepidodera ferruginea* Scop., ab. (freq. in copulâ) f. p. and devouring the anthers 5-12. 9. (17) *Meligethes* sp.?, freq. f. p. and s. h.

13. *Stachys palustris* L. [Class H, Lit. 1, 4, 8, 14, 18, 19.] This plant abounds in one place on the Rascarrel Road and was watched there; it occurs, however, in several other places in the district. The number of individual visits of humble-bees was probably ten times as many as those of all other insects put together. It does not seem to fertilize itself at all, or very little, but the number of visits received ensures a fair amount of seed being set. On one spike examined, 21 flowers had set 54 seeds.

Visitors. **Hymenoptera.** *Aculeata*: *Acutilingues*: (1) *Bombus muscorum* L., s. h. very ab. 24-31. 8. 94. (2) *B. hortorum* L., do. (3) *B. terrestris* L., do. (4) *Anthidium manicatum* L., s. h. 23. 8. 94. **Diptera.** *Syrphidae*: (5) *Melanostoma scalare* F., f. p. 31. 8. 94. (6) *Platychirus albimanus* F., s. h. (?) ab. f. p. 24-31. 8. 94. (7) *P. manicatus* Mg., f. p. 31. 8. 94. (8) *Rhingia rostrata* L., s. h. and f. p. ab. 24-31. 8. 94. *Anthomyiidae*: (9) *Anthomyia radicum* L., f. p. freq. 24-30. 8. 94. **Coleoptera**: (10) *Meligethes* sp.?, f. p. ab. 23-31. 8. 94. **Hemiptera**: (11) *Anthocoris* sp.?, 28. 8. 94.

14. *Galeopsis Tetrahit* L. [Class H, Lit. 1, 2, 4, 5, 17, 18.] Frequent in the district. It varies considerably in colour from red to pure white.

Visitors. **Hymenoptera.** *Aculeata*: *Acutilingues*: (1) *Bombus muscorum* L., s. h. Rasc. Rd. 5. 9. 94. (2) *B. terrestris* L., s. h. freq. Rasc. Rd. 31. 8. 94.

Five of the eight visitors observed by Müller in Low Germany, and all of those recorded by other observers, were humble-bees.

15. *Prunella vulgaris* L. [Class H, Lit. 1, 2, 4, 9, 11, 14,

17, 18, 19, 21, 332 a, 258 b, 339 b.] Common in the district, but somewhat past its best flowering season. The female form was not observed.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris napi* L., s. h. Rasc. 24. 8. and 14. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus muscorum* L., s. h. ab. 27. 8. to 14. 9. 94. (3) *B. terrestris* L., freq., do.

16. *Teucrium Scorodonia* L. [Class H, Lit. 1, 4, 9, 17, 18, 337 b, 338 b, 342 b.] Abundant on Rascarrel beach and frequent elsewhere.

Visitors. **Hymenoptera.** Aculeata: *Acutilingues*: (1) *Bombus muscorum* L., s. h. ab. 24. 8 to 10. 9. 94. (2) *B. hortorum* L., do. (3) *B. terrestris* L., s. h. freq., do. (4) *Psithyrus campestris* Pz., s. h. Rasc. 10. 9. 94.

PLUMBAGINACEAE: 17. *Statice Limonium* L. [Class B, Lit. 4, 14, 15, 339 b.] Frequent on the shore of Auchencairn bay, but being placed in competition with a much larger mass of flowers of *Aster* (see above) it was practically left unvisited. Self-fertilization seemed to occur in some specimens examined. During the spring tides in August, 1894, the flowers, like those of *Aster*, were submerged twice daily.

Visitors. **Hymenoptera.** Aculeata: *Acutilingues*: (1) *Bombus hortorum* L., s. h. 23. 8. 94. **Coleoptera.** (2) *Meligethes* sp.?, f. p., do.

ERICACEAE: 18. *Calluna vulgaris* Salisb. [Class B, Lit. 1, 2, 4, 9, 11, 14, 17, 18, 25, and see No. 48, below.] This species abounds in the district, there being numerous moors covered with it. It was in full flower when studied. An important point, apparently only noticed by one previous observer (Kerner), is the *anemophily* of this plant. It possesses the characteristic 'loose-pollen' mechanism of *Erica*; but whilst in the latter the flower hangs almost vertically downwards and has a deep tubular corolla almost covering the stigma and quite covering the anthers, in *Calluna* the flower stands out more nearly horizontally, and has an open

mouthed corolla, so that the stamens and stigma are freely exposed. To anyone accustomed to the Scottish moors, the dust that rises from the heather when one walks through it on a hot day, more especially if it has been calm beforehand, is a familiar phenomenon. On examination, this dust is found to be the pollen of the *Calluna*; it often rises in dense clouds after a few days of warm still weather, when one shakes the plants by walking through them. If after such weather a breeze spring up, the pollen blows about from flower to flower on a large scale, and the freely exposed and rather large stigmas will be, almost certainly, pollinated. This anemophily of the heather combined with its social growth, must be of considerable importance to it, and probably as much cross fertilization takes place in this way as by insect aid.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Polyommatus phloceas* L., s. h. Rasc. 7 and 14. 9. 94 [also at Scarborough]. Heterocera: *Tortricidae*: (2) *Peronea aspersana* Hub., s. h. Rasc. 31. 8. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (3) *Bombus muscorum* L., s. h. ab. F. H. 6 and 7. 9. 94. (4) *B. pratorum* L., s. h. Rasc. 31. 8. 94. (5) *B. scrimshirani* Kirb., s. h. F. H. 7. 9. 94. (6) *B. terrestris* L., s. h. ab. 30. 8 to 7. 9. 94. (7) *Apis mellifica* L., s. h. very ab., F. H., Rasc., and on summit of Screel (1,120 ft.), 30. 8 to 7. 9. 94. **Diptera.** *Syrphidae*: (8) *Sericomyia borealis* Fln., f. p., freq. F. H. 6 and 7. 9. 94. (9) *Platychirus albimanus* F., s. h. and f. p. freq. Rasc. 31. 8 and F. H. 6. 9. 94. (10) *P. manicatus* Mg., s. h. freq. F. H. 6. 9. 94. *Anthomyiidae*: (11) *Limnophora* sp.?, f. p. Rasc. Rd. 31. 8. 94. (12) *Anthomyia radicum* L., s. h., do. (13) *A.* sp.?, f. p. do. *Cordyluridae*: (14) *Scatophaga stercoraria* L., f. p. freq. F. H. 6. 9. 94. *Sepsidae*: (15) *Themira minor* Hal., s. h. ab., do.

19. Erica cinerea L. [Class H, Lit. 1, 4, 18, 21, 633 a, 467 b, 478 b. See also Art. 49, below.] Abundant on the moors, though not equal to *Calluna*. The base of the corolla was often found to be perforated (presumably by Bombi). On the summit of Screel (1,120 ft.) nearly all the flowers were in this condition, but were being visited by great numbers of *Apis*, sucking honey in the proper manner.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Epinephele janira* L., s. h. freq. F. H. 22-24. 8. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Apis mellifica* L., s. h. very ab. F. H. and Rasc. 22. 8. to 6. 9. 94. (3) *Bombus lapidarius* L., s. h. ab. F. H. and Rasc. 22. 8. to 14. 9. 94. (4) *B. muscorum* L., s. h. very ab. F. H. and Rasc. 22. 8. to 10. 9. 94. (5) *B. terrestris* L., s. h. ab. F. H. 22. 8. to 6. 9. 94. (6) *B. pratorum* L., s. h. freq. F. H. 22. 8. 94. (7) *B. latreillellus* Kirb. var. *distinguendus* Mor., s. h. F. H. 12. 9. 94. (8) *Psithyrus campestris* Pz., s. h. Rasc. 10. 9. 94. **Diptera.** *Syrphidae*: (9) *Platychirus albimanus* F., s. h. F. H. 22. 8. 94. *Anthomyiidae*: (10) *Trichophthicus cunctans* Mg., f. p.?, do.

20. E. Tetralix L. [Class H, Lit. 1, 4, 11, 12, 14, 17, 21. See also Art. 50, below.] Common on the moors, but less so than *E. cinerea*. The corolla was frequently found perforated.

Visitors. **Hymenoptera.** Aculeata: *Acutilingues*: (1) *Apis mellifica* L., s. h. ab. F. H. 6. 9. 94. (2) *Bombus muscorum* L., s. h. very ab. F. H. 6-12. 9. 94. (3) *B. hortorum* L., s. h. freq., do.

UMBELLIFERAE: 21. Caucalis Anthriscus Huds. [Class A, Lit. 1, 2, 4, 21.] Common in all parts of the district except Rascarrel beach. It was in full flower during the time of these observations, but was not very much visited.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Epinephele janira* L., s. h. A. B. 2. 9. 94. Heterocera: *Noctuidae*: (2) a moth (? *Plusia gamma* L.), s. h. F. H. Rd. 8. 9. 94. *Tortricidae*: (3) *Simaëthis fabriciana* L., s. h. F. H. Rd. 7. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (4) *Halictus* sp.?, s. h. Rasc. Rd. 10. 9. 94. Terebrantia: *Ichneumonidae*: (5) to (7) three unnamed species, freq. Sept. 94. *Proctotrupidae*: (8) one unnamed species, do. **Diptera.** *Syrphidae*: (9) *Platychirus albimanus* F., s. h. Cl. 31. 8. 94. *Muscidae*: (10) *Stomoxys calcitrans* L., s. h. F. H. Rd. 6. 9. 94. *Anthomyiidae*: (11) *Hylemyia strigosa* F., s. h. Rasc. Rd. 31. 8. and Cl. 1. 9. 94. (12) *Anthomyia radicum* L., s. h. F. H. Rd. 9. 9. 94. (13) *Phorbia floccosa* Mcq., do. *Agromyzidae*: (14) *Agromyza flaveola* Fln., do. **Hemiptera**: (15) *Anthocoris* sp.?, do.

22. Angelica sylvestris L. [Class A, Lit. 1, 2, 4, 8, 17, 288 b.] Abundant in the district, and in full flower.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Polyommatus phloea* L., s. h. Cl. 3. 9. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus terrestris* L., s. h. twice Rasc. 5 and 10. 9. 94. (3) *Halictus rubicundus* Chr., s. h. Rasc. 4. 9. 94. *Obtusilingues*: (4) *Prosopis brevicornis* Nyl., do. *Vespidæ*: (5) *Vespa sylvestris* Scop., s. h. ab. Rasc. 4. 9. 94. Terebrantia: *Tenthredinidæ*: (6) *Selandria serva* F., s. h.? Rasc. 1. and 4. 9. 94. *Ichneumonidæ*: (7) to (13) seven unnamed species, freq. Rasc. 1-10. 9. 94. *Proctotrupidæ*: (14) one unnamed species, do. **Diptera.** *Syrphidæ*: (15) *Chilosia oestracea* L., s. h. Cl. 3. 9. 94. (16) *Platychirus peltatus* Mg., s. h. Rasc. 4. 9. (17) *Syrphus topiarius* Mg., s. h. F. H. Rd. 13. 9. 94. (18) *Eristalis pertinax* Scop., s. h. freq. Cl. 3. Rasc. 4. 9. 94. (19) *E. horticola* Deg., s. h. Cl. 3. 9. 94. *Mycetophilidæ*: (20) *Sceptonia nigra* Mg., do., 2. 9. (21) *Glaphyrop-tera fasciola* Mg., do. *Chironomidæ*: (22) *Chironomus* sp., s. h. Cl. 3. 9. 94. (23) *Cricotopus tremulus* L., s. h. Cl. 2. 9. *Tachinidæ*: (24) *Myobia inanis* Fln., s. h. Rasc. 4. 4. 94. *Sarcophagidæ*: (25) *Sarcophaga* sp., do. *Muscidæ*: (26) *Lucilia caesar* L., s. h. ab. Cl. 3. Rasc. 4. and 5. 9. 94. (27) *L. sericata* Mg., s. h. freq. Cl. 3. 9. (28) *Morellia curvipes* Mcq., s. h. freq. Cl. 3. 9., Rasc. 4. 9. *Anthomyiidæ*: (29) *Hyetodesia lucorum* Fln., s. h. Rasc. 4. 9. (30) *H. incana* W., s. h. Cl. 3. 9. (31) *Mydaea* sp., s. h. Rasc. 4. 9. (32) *Spilogaster communis* Dsv., s. h. Rasc. 10. 9. (33) *Anthomyia radicum* L., s. h. Rasc. 4. 9. (34) *A.* sp., s. h. Cl. 3. 9. 94. (35) *Caricea tigrina* F., s. h. Rasc. 10. 9. *Cordyluridæ*: (36) *Scatophaga stercoraria* L., s. h. Cl. 3. Rasc. 4. 9. 94. *Phoridæ*: (37) *Phora* sp., s. h. Cl. 3. 9. 94. **Hemiptera**: (38) *Calocoris fulvo-maculatus* De G., s. h. Cl. 1. 9. (39) *Anthocoris* sp., s. h. Rasc. 4. 9. 94.

23. Pimpinella Saxifraga L. [Class A, Lit. 1, 4, 12, 14, 17, 21, 160 b, 288 b.] Abundant, and in full flower.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris napi* L., s. h. Cl. 31. 8. 94. **Hymenoptera.** Terebrantia: *Ichneumonidæ*: (2) to (5) four unnamed species. *Braconidæ*: (6) to (8) three species. *Chalcididæ*: (9) one species. *Proctotrupidæ*: (10) one species; all freq. **Diptera.** *Syrphidæ*: (11) *Orthoneura nobilis* Fln., s. h. Cl. 10. 9. 94. (12) *Chrysogaster splendida* Mg., do. (13) *Chilosia* sp., do. (14) *Syrphus ribesii* L., s. h. freq. Cl. 10. 9. 94. (15) *Sphaerophoria scripta* L., s. h. Cl. 1. and 10. 9. 94. (16) *Eristalis tenax* L., s. h. Cl. 10. 9. 94. (17) *E. aeneus* Scop., s. h. freq. Cl. 10. 9. 94. (18) *E. horticola* Deg.,

do. (19) *Syritta pipiens* L., s. h. Cl. 1. 9. 94. *Mycetophilidae*: (20) *Sciara* sp.?, s. h. ab. Cl. 10. 9. 94. (21) *Sceptonia nigra* Mg., s. h. F. H. Rd. 8. 9. 94. (22) *Boletina* sp.?, do. *Empidae*: (23) *Rhamphomyia tenuirostris* Fln., s. h. Cl. 1. 9. 94. *Muscidae*: (24) *Lucilia caesar* L., s. h. Cl. 10. 9. 94. (25) *Morellia curvipes* Mcq., do. *Anthomyiidae*: (26) *Hyetodesia incana* W., do. (27) *Trichophthicus cunctans* Mg., s. h. Cl. 1. 9. (28) *T.* sp.?, s. h. Rasc. 4. 9. 94. (29) *Anthomyia radicum* L., s. h. freq. Cl. and Rasc. 1-10. 9. 94. (30) *A.* sp.?, s. h. Cl. 10. 9. 94. (31) *Phorbia floccosa* Mcq., do. *Sepsidae*: (32) *Themira minor* Hal., freq. s. h. Cl. 1-10. 9. 94. *Drosophilidae*: (33) *Scaptomyza graminum* Fln., s. h. Cl. 10. 9. 94. *Phoridae*: (34) *Phora* sp.?, do. **Coleoptera**. (35) *Rhagonycha fulva* Scop., s. h. Cl. 1. 9. 94. (36) *Epuraea melina* Er., do. (37) *Meligethes* sp.?, do., ab. **Hemiptera**. (38) *Anthocoris* sp.?, s. h. F. H. Rd. 8. 9. and Cl. 10. 9. 94.

CISTACEAE: 24. *Helianthemum vulgare* Gaertn. [Class Po, Lit. 1, 2, 4, 11, 17.] Very abundant on the tops of the cliffs along this coast, but its flowering season was nearly over and but few flowers were out.

Visitor. Diptera. Anthomyiidae: (1) *Anthomyia radicum* L., f. p. very ab. Rasc. 4-10. 9. 94.

HYPERICACEAE: 25. *Hypericum perforatum* L. [Class Po, Lit. 1, 4, 11, 14, 17.] Frequent in the district: large masses on the Forest Hill Road, where all the observations were made.

Visitors. Hymenoptera. Aculeata: Acutilingues: (1) *Bombus muscorum* L., 28 and 29. 8. 94. Three times this bee visited and probed several flowers for honey, and finding none in any, flew off to other flowers. *Terebrantia*: (2) 1 sp. of *Braconidae*, 28. 8. 94. **Diptera. Syrphidae**: (3) *Platychirus albimanus* F., f. p. 28. 8. 94. (4) *P. peltatus* Mg., freq., do. (5) *Syrphus balteatus* Deg., do. 28 and 29. 8. 94. (6) *S. topiarius* Mg., f. p. 28. 8. 94. (7) *Eristalis pertinax* Scop., f. p. freq. 24. 8. to 13. 9. 94. (8) *Syritta pipiens* L., f. p. freq. 31. 8. to 10. 9. 94. *Empidae*: (9) *Tachydromia* sp.?, f. p. 28. 8. 94. (10) *T.* sp.?, f. p. 30. 8. 94. *Muscidae*: (11) *Calliphora erythrocephala* Mg.,

f. p. 31. 8. 94. (12) *C. vomitoria* L., f. p. 13. 9. 94. (13) *Morellia* sp.?, f. p. 6. 9. 94. (14) *Stomoxys calcitrans* L., do. *Anthomyiidae*: (15) *Mydaea* sp.?, f. p. freq. 24-31. 8. 94. (16) *Anthomyia radicum* L., f. p. very ab. 24. 8. to 13. 9. 94. (17) *A.* sp.?, f. p. 28. 8. 94. **Coleoptera**: (18) *Meligethes aeneus* F., f. p. ab. 24. 8. to 13. 9. 94. **Hemiptera**: (19) One species.

GERANIACEAE: 26. *Geranium Robertianum* L. [Class B, Lit. 1, 3, 4, 11, 17, 21.] Abundant on open stony places on Rascarrel beach.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris napi* L., s. h. 28. 8. 94. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus muscorum* L., s. h. ab. 2-12. 9. 94. **Diptera.** *Syrphidae*: (3) *Syrphus* sp.?, s. h. 5. 9. 94.

LEGUMINOSAE: 27. *Ononis arvensis* L. [Class H, Lit. 1, 4, 9, 11, 14, 17, 258 b.] Frequent, but rarely visited. Small flies were often seen sunning themselves on the flowers.

Visitor. **Hymenoptera.** Aculeata: *Acutilingues*: (1) *Apis mellifica* L., (twice) A. B. 18. 8. 94.

28. *Lotus major* Sm. [Class H, Lit. 1, 2, 3, 4, 9, 12, 14, 17, 258 b.] This plant abounds in the district, but, apparently from the competition of other plants, receives very few visits indeed.

Visitor. **Hymenoptera.** Aculeata: *Acutilingues*: (1) *Bombus muscorum* L., s. h. A. B. 2. 9. 94.

ROSACEAE: 29. *Potentilla Tormentilla* Sibth. [Class A B, Lit. 1, 2, 4, 21.] Everywhere common: the flowers are larger and more rich in pollen at low levels and in sheltered places.

Visitors. **Diptera.** *Syrphidae*: (1) *Sphaerophoria scripta* L., f. p. Rasc. 5. 9. 94. (2) *Syrpita pipiens* L., do. *Muscidae*: (3) *Morellia curvipes* Mcq., s. h. Rasc. Rd. 31. 8. 94. *Anthomyiidae*: (4) *Hylemyia lasciva* Ztt., f. p., do. (5) *Anthomyia radicum* L., s. h. and f. p. very ab. Rasc., &c. 31. 8. to 6. 9. 94. *Ephydridae*: (6) *Hydrellia griseola*

Fln., f. p. Rasc. Rd. 31. 8. 94. *Chloropidae*: (7) *Oscinis frit* L., do. *Aphodius contaminans* Herbst. (Coleoptera) was observed settled on the flowers in one case.

30. *Rubus fruticosus* L. [Class B, Lit. 1, 2, 3, 4, 11, 339 b, &c.] Abundant everywhere, but the flowering season was nearly over. It was still, however, largely visited.

Visitors. Lepidoptera. Rhopalocera: (1) *Pieris napi* L., s. h. freq. 24. 8 to 12. 9. 94. Rasc. F. H. Rd. &c. Heterocera: *Tortricidae*: (2) *Simaëthis fabriciana* L., s. h. freq. F. H. Rd. 29. 8. and 6. 9. Rasc. Rd. 12. 9. 94. *Hymenoptera.* Aculeata: *Acutilingues*: (3) *Bombus muscorum* L., s. h. ab. 24. 8 to 10. 9. 94. all stations. (4) *B. hortorum* L.?, s. h. ab. 24. 8. 94. F. H. Rd. *Diptera.* *Syrphidae*: (5) *Platychirus albimanus* F., s. h. A. B. 2. 9. 94. (6) *Syrphus balteatus* Deg., f. p. F. H. Rd. 29. 8. 94. (7) *S. topiarius* Mg., s. h. F. H. Rd. 12. 9. 94. (8) *Eristalis pertinax* Scop., s. h. freq. 24. 8. 94. *Anthomyiidae*: (9) *Anthomyia radicum* L., freq. 29. 8 to 12. 9. 94. *Coleoptera*: (10) *Meligethes viridescens* F., s. h. and f. p. ab., do.

31. *Spiraea Ulmaria* L. [Class Po, Lit. 1, 2, 3, 4, 8, 9, 11, 17, 21, 288 b.] Abundant on Forest Hill Road and Collin Road, but past its best season.

Visitors. Diptera. *Syrphidae*: (1) *Melanostoma scalare* F., f. p. F. H. Rd. 29. 8. 94. (2) *Eristalis aeneus* Scop., f. p. Cl. 3. 9. 94. (3) *E. tenax* L., do. (4) *E. horticola* Deg., do. *Chironomidae*: (5) *Corynoneura* sp.?, f. p. F. H. Rd. 28. 8. 94. *Anthomyiidae*: (6) *Mydaea* sp.?, do. (7) *Trichophthicus hirsutulus* Ztt., do. (8) *Anthomyia radicum* L., very ab., do. *Coleoptera*: (9) *Epuraea melina* Er., f. p. F. H. Rd. 30. 8. 94. (10) *Meligethes viridescens* F., f. p. ab. 24. 8 to 10. 9. 94. (11) *M. aeneus* F., do.

PAPAVERACEAE: **32. *Corydalis claviculata* DC.** [Class H, Lit. 4, 9, 13.] Abundant on the Rascarrel Road. The flowers are visited only by bees.

Visitors. Hymenoptera. Aculeata, *Acutilingues*: (1) *Bombus muscorum* L., s. h. ab. 31. 8 to 5. 9. 94. (2) *B. terrestris* L., s. h. 31. 8. 94. Both these effect fertilization. Every flower seems to set seed.

CARYOPHYLLACEAE: 33. *Lychnis diurna* Sibth. [Class F, Lit. 1, 2, 4, 9, 11, 14, 117 b, 288 b.] Common in the district, but its flowering season was getting over.

Visitors. Hymenoptera. Aculeata: *Acutilingues*: (1) *Bombus terrestris* L., s. h. freq. 31. 8 to 13. 9. 94. Diptera. *Syrphidae*: (2) *Platychirus albimanus* F., f. p. Cl. 31. 8. 94, and so only going to male flowers.

As the above observations are all made at one period and place, and cover the important flowers of the local flora, it will be best to sum them up independently of those which follow.

Summing up first of all the total number of visits received by each class of flower, we get the following table:—

TABLE I.

Class.	No. of Flowers.	Lepidoptera.	Long-tongued Bees.	Short-tongued Bees.	Other Hymenoptera.	Long-tongued Flies.	Short-tongued Flies.	Coleoptera.	Other insects.	Total.
Po	3	—	1	—	1	10	14	4	1	31
A	3	5	1	3	23	15	38	3	4	92
AB	1	—	—	—	—	2	5	—	—	7
B	5	8	11	1	—	12	11	4	—	47
B'	8	31	27	10	6	45	53	9	15	196
H	11	4	30	—	—	5	3	3	2	47
F	2	—	2	—	—	1	—	—	—	3
Total	33	48	72	14	30	90	124	23	22	423
% of Total		11.3	17.0	3.3	7.1	21.2	29.3	5.4	5.4	

Next, adopting the percentage method, and using as a reference line the percentage number of visits of *all* insects to each class of flower (see 341 b), we get this table:—

TABLE II.

Class.	Per cent. of total visits.	Per cent. of Lepidoptera visits.	Per cent. of Long-tongued Bees.	Per cent. of Short-tongued Bees.	Per cent. of other Hymenoptera.	Per cent. of Long-tongued Flies.	Per cent. of Short-tongued Flies.	Per cent. of Coleoptera.	Per cent. of others.
Po	7.32	—	1.4	—	3.33	11.11	11.29	17.39	4.54
A	21.74	10.4	1.4	21.43	76.66	16.66	30.64	13.04	18.18
AB	1.65	—	—	—	—	2.22	4.03	—	—
B	11.11	16.66	15.28	7.14	—	13.33	8.87	17.39	—
B'	46.33	64.6	37.5	71.43	20.0	50.0	42.74	39.12	68.18
H	11.11	8.33	41.66	—	—	5.55	2.42	13.04	9.09
F	.71	—	2.8	—	—	1.11	—	—	—

These two tables at once show the enormous share of visits obtained by class B', which is practically the order Compositae. The figures will be seen to support the Müllerian theory of flowers very well. Taking first the Lepidoptera, they show a very great preference¹ (64.6–46.33) for Class B', which is the usual result shown in similar statistical tables (see Lit. 341 b). They do not appear to visit their own special class F, but these flowers were not watched at night, when the long-tongued moths, to which they are specially adapted, are on the wing. The only other class to which they show any preference is B. Most other observers have found them rather to avoid this class. They avoid, more or less, all the remaining classes. The long-tongued bees, as usual, show a very marked preference (41.66–11.11) for class H, and a small avoidance of B'. The short-tongued bees prefer especially B'. The long-tongued flies show very slight preferences for B', B, Po; they rather avoid A, a result at variance with those of other workers. The short-tongued

¹ Preference of a particular class of flowers, X, by a particular group of insects, Y, is shown by the per cent. of Y visiting X exceeding the per cent. number of the total insect visitors to X.

flies give results agreeing with previous ones, except that the avoidance of Class B' is very slight, instead of, as usual, very great.

Taken as a whole, then, we may say that these results support the Müllerian theory of flowers very well. Further facts in support of it may be obtained by taking note of the flowers visited by each particular insect. One or two cases may be given. Among the butterflies *Pieris napi* was the most frequent visitor, going to 10 flowers, all but one (*Pimpinella*) in Classes B, B', H. *Polyommatus phloea*s, the next commonest, went to 7 flowers in these classes, and 1 other (*Angelica*). These two, with *Epinephele janira*, *Pieris rapae*, and *Vanessa urticae*, were the only butterflies common in the district.

Taking next the long-tongued bees, of which there are 12 species—*Apis mellifica*, *Anthidium manicatum*, and 10 *Bombi* (incl. *Psithyrus*)—the bulk of the visits were made by the humble-bees (62 out of 72). *Bombus muscorum* L. was the commonest bee, and visited, usually in abundance, 19 flowers, all but one (*Hypericum*) in the higher classes (B, B', H). *B. terrestris* was nearly as common (16 flowers), whilst *B. latreillellus* var. *distinguendus*, *B. cognatus*, and *Psithyrus quadricolor* were seen only on 1 flower each. The hive bee offers an interesting list. The district is famous for its honey, and in the small village of Auchencairn there are over 100 hives. The heather was then in full bloom (*Calluna* and two species of *Erica*) and attracted very nearly all the bees, which were abundant on it, even up to the highest hill-tops in the district (Ben Gairn, 1,250 feet). The only other plant that received any particular attention from them was *Senecio Jacobaea*, the most conspicuous and abundant plant, next to the heather. On this they were usually to be seen, especially in dull or cold weather, when they seemed disinclined to go to the moors.

The short-tongued bees—6 species: 3 of *Halictus*, 1 each of *Andrena*, *Prosopis*, *Sphecodes*—paid nearly all their visits to Class B'. On the *Senecio* they abounded, but they are

distinctly scarce in the district. It must be remembered that, as Macleod has shown (18), they become less numerous as the season advances. Of the other Hymenoptera, *Vespa sylvestris* was abundant on *Angelica*, but was never seen on any other plant. The Ichneumonidae and their allies were found in great numbers on the Umbellifers, and on *Senecio*, &c. Whether or not they visit the flowers for floral food they must be of some importance in fertilization.

Of the Syrphidae, 25 species were observed, making 89 (species-) visits. The commonest were (in order) *Eristalis tenax* (on 9 flowers), *E. pertinax* (8), *Platychirus albimanus* (8). *Rhingia rostrata* was abundant on *Centaurea* and *Stachys*, but was never seen on any other flower. Altogether the number of visits made by these flies forms more than a fifth of the total, but it is known that they increase in (proportionate) number in late summer (see 341 b and 18).

The short-tongued flies number 50 species with 124 visits (the largest number for any group). The commonest species belong to the genera *Lucilia* (esp. *L. sericata*), *Trichophthicus*, *Anthomyia* (*A. radicum* on 22 flowers), *Hyetodesia*, *Mydaea*, *Scatophaga*. No species of any other genus was seen on more than 4 flowers. In individuals, these flies far outnumber the other groups, and must be of considerable importance in fertilization.

Of the Coleoptera (11 species, 23 visits) the only common ones are species of *Meligethes* (abundant in nearly every flower) and *Crepidodera ferruginea*. Of the Hemiptera (6 species, 22 visits) *Anthocoris* was common.

If we compare the percentages of visitors of each class of insects (foot of Table I) with those given by Müller (Fert. of Flrs. p. 654), it will be seen that considerable differences exist between the composition of the flower-visiting insect fauna in Germany and in South Scotland, as shown in the figures. The Lepidoptera (11.3 per cent. against 6.9 per cent.), Syrphidae (21.2 to 19.6), other Diptera (29.3 to 10.9) and miscellaneous insects (Hemiptera, &c.) (5.4 to 0.9) are more numerous *in proportion* in Scotland, whilst the long-tongued

bees (17.0 to 23.1), short-tongued bees (3.3 to 18.0), other Hymenoptera (7.1 to 10.6) and Coleoptera (5.4 to 8.9) are proportionately less numerous.

Allowing for the season of the year at which the Scotch observations were made (late summer, when Lepidoptera and Syrphidae are more numerous, short-tongued bees and flies less numerous in proportion than earlier in the year), we may perhaps conclude that as regards the composition of the flower-visiting fauna, there is in Scotland, as compared with Low Germany, a great proportionate preponderance of short-tongued flies, compensated for by a diminution of the Hymenoptera (more especially the short-tongued bees). This fact of the greater proportion of flies in Britain is, of course, already known to entomologists, but it is still worthy of mention here, as it comes out in a different way and gives a quantitative result for comparisons. From the great preponderance of flies in the country it does not follow that the composition of the group of visitors to flowers of high type (Classes B, B', H) will necessarily be correspondingly altered; we might rather expect to find a greater proportionate number of flowers of low type (Classes Po, A, AB), whilst those of higher type would have fewer visitors than in Germany, and perhaps have more self-fertilization or vegetative reproduction. This, however, hardly seems to be the case. (It will be discussed in full in Part II.)

3. OBSERVATIONS AT SCARBOROUGH, 1893-4,

BY I. H. BURKILL.

Though further south, Scarborough, being on the east coast, has a rather colder climate than Auchencairn, and as the insect observations were made chiefly upon the cliffs, exposed to the east winds and not receiving much sun, these facts must be borne in mind in comparing the two places.

COMPOSITAE: 34. *Eupatorium cannabinum* L. [Class

B', Lit. 1, 2, 3, 4, 9, 11, 17, 18.] Observed Aug. 27 to Sept. 26, 1894.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Vanessa urticae* L., s. h. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus lapidarius* L., s. h. *Myrmicidae*: (3) *Myrmica rubra* L., running about on heads. **Diptera.** *Syrphidae*: (4) *Platychirus manicatus* Mg. (5) *Syrphus ribesii* L. (6) *Sphaerophoria scripta* L. (7) *Eristalis tenax* L., s. h. (8) *E. pertinax* Scop., s. h. (9) *E. horticola* Deg., s. h. (10) *Syritta pipiens* L. *Tachinidae*: (11) *Siphona geniculata* Deg. *Muscidae*: (12) *Lucilia cornicina* F., s. h. (13) *Calliphora erythrocephala* Mg., s. h. (14) *C. sepulchralis* Mg. *Anthomyiidae*: (15) *Anthomyia radicum* L., s. h. and f. p. (16) *A. brevicornis* Ztt., f. p. *Cordyluridae*: (17) *Scatophaga stercoraria* L. *Phoridae*: (18) *Phora* sp.? **Coleoptera**: (19) *Meligethes picipes* Sturm, f. p.

35. *Inula dysenterica* L. [Class B', Lit. 1, 2, 3, 4, 9, 11, 18, 163 b.] Observed Sept. 20 to Sept. 30, 1893, and Aug. 27 to Sept. 26, 1894.

Visitors. **Lepidoptera.** Heterocera: *Tortricidae*: (1) *Simaëthis fabriciana* L., s. h. *Tineidae*: (2) *Plutella cruciferarum* Zel., s. h. **Hymenoptera.** Aculeata: *Acutilingues*: (3) *Bombus lapidarius* L., s. h. *Terebrantia*: *Ichneumonidae*: (4) one species. *Braconidae*: (5) one species. **Diptera.** *Syrphidae*: (6) *Platychirus manicatus* Mg. (7) *P. albimanus* F. (8) *Syrphus ribesii* L. (9) *Sphaerophoria scripta* L. (10) *Eristalis tenax* L., s. h. (11) *E. arbustorum* L. (12) *E. pertinax* Scop., s. h. (13) *Syritta pipiens* L. *Tachinidae*: (14) *Siphona geniculata* Deg., ab. s. h. and f. p. *Muscidae*: (15) *Lucilia cornicina* F. (16) *Calliphora erythrocephala* Mg. (17) *Morellia* sp.? *Anthomyiidae*: (18) *Drymia hamata* Fln., f. p. and s. h. (19) *Hylemyia strigosa* F. (20) *Anthomyia radicum* L., very ab. f. p. (21) *A. brevicornis* Ztt., f. p. (22) *Phorbia lactucae* Bouché, f. p. *Cordyluridae*: (23) *Scatophaga stercoraria* L. *Phycodromidae*: (24) *Coelopa* sp.?, f. p. **Coleoptera**: (25) *Meligethes picipes* Sturm. (26) *M. obscurus* Er. (27) *M. viridescens* F., devouring pollen and almost covered with it. (28) *M. aeneus* F., do., f. p. **Thysanoptera**: (29) *Thrips* sp.

DIPSACEAE: 36. *Scabiosa succisa* L. [See No. 9, Auchencairn.] Observed Aug. 27 to Sept. 26, 1894. The species was observed to be gynodioecious.

Visitors. **Lepidoptera.** Heterocera: *Noctuidae*: (1) *Plusia gamma* L., s. h. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Bombus lapidarius* L., s. h. and c. p. (3) *B. muscorum* L., s. h. and c. p. very ab. (4) *B. hortorum* L., s. h. *Myrmicidae*: (5) *Myrmica rubra* L., s. h. **Diptera.** *Syrphidae*: (6) *Melanostoma scalare* F. (7) *Platychirus manicatus* Mg. (8) *Syrphus balteatus* Deg. (9) *S. ribesii* L., s. h. (10) *Sphaerophoria scripta* L. (11) *Eristalis tenax* L., s. h. *Tachinidae*: (12) *Siphona geniculata* Deg., s. h. *Muscidae*: (13) *Lucilia cornicina* F., s. h. (14) *Calliphora erythrocephala* Mg., s. h. *Anthomyiidae*: (15) *Anthomyia radicum* L., f. p. (16) *A. brevicornis* Ztt., s. h. *Cordyluridae*: (17) *Scatophaga stercoraria* L., s. h. **Coleoptera**: (18) *Crepidodera ferruginea* Scop., s. h. (19) *Meligethes picipes* Sturm, s. h. (20) *M. viridescens* F., s. h.

LABIATAE: 37. *Mentha aquatica* L. [See No. 12, Auchencairn.] Observed Sept. 20 to Oct. 7, 1893. This species is largely visited on the Scarborough cliffs. It is gynodioecious, the two forms occurring in almost equal numbers and both freely visited. [In the list of visitors, the letters in brackets denote the form visited; H = hermaphrodite, F = female.] In the dusk, *Plusia gamma* was observed seeking for flowers on a flowerless plant, and so had probably been attracted thither by the smell. If this be so, the diminished conspicuousness of the female flowers may not be much of a disadvantage. The style in these flowers lies close under the upper lip, scarcely being touched by insects until mature. The flowers are protandrous. *Thrips* and small parasitic Hymenoptera are common, lounging in the flowers. The larva of *Eupithecia centaureata* S. V. was observed destroying a large number of flowers by devouring the style and stamens.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Vanessa urticae* L., s. h. (H). Heterocera: *Noctuidae*: (2) *Plusia gamma* L., s. h. (H). *Crambidae*: (3) *Chilo furcatellus* Ztt., s. h. (H). *Pterophoridae*: (4) *Pterophorus fuscus* Retz., s. h. (H, F). *Tineidae*: (5) *Plutella cruciferarum* Zel., s. h. (H, F). **Hymenoptera.** Aculeata: *Acutilingues*: (6) *Bombus hortorum* L., s. h. (H). (7) *B. lapidarius* L., s. h. (H). (8) *B. muscorum* L., s. h. (H). Terebrantia: *Ichneumonidae*: (9) one

species. *Braconidae*: (10) to (12) three species. *Chalcididae*: (13) to (16) four species. *Proctotrupidae*: (17) to (20) four species. All these parasites wandering from flower to flower (H and F equally) and often remaining long inside the tubes. **Diptera.** *Syrphidae*: (21) *Platychirus manicatus* Mg. (H, F). (22) *P. albimanus* F. (H). (23) *P. scutatus* Mg., s. h. (H). (24) *Syrphus balteatus* Deg. (H). (25) *S. corollae* F. (H, F). (26) *S. ribesii* L. (H). (27) *Arctophila mussitans* F., s. h. (H). (28) *Eristalis tenax* L., s. h. (H, F). (29) *E. pertinax* Scop., s. h. (H, F). (30) *E. arbustorum* L., s. h. (H). (31) *E. horticola* Deg., s. h. (H, F). (32) *Helophilus pendulus* L., s. h. (H). (33) *Syritta pipiens* L., s. h. (H). *Mycetophilidae*: (34) *Sciara* sp.? (H). *Bibionidae*: (35) *Scatopse brevicornis* Mg., s. h. et in copulâ (H, F). (36) *Bibio lepidus* Lw. (H). *Psychodidae*: (37) *Pericoma* sp.? (F). *Culicidae*: (38) *Anopheles* sp.?, four times, seemingly s. h. (F). *Lonchopteridae*: (39) *Lonchoptera* sp.? (F). *Tachinidae*: (40) *Siphona geniculata* Deg., s. h. and f. p. (H, F, most often on latter). *Sarcophagidae*: (41) *Sarcophaga carnaria* L., s. h. (H). (42) *S.* sp.?, s. h. (H). *Muscidae*: (43) *Lucilia cornicina* F., s. h. and f. p. (H, F). (44) *Calliphora erythrocephala* Mg., s. h. (H). (45) *Morellia importunata* Hal., s. h. (H). (46) *Stomoxys calcitrans* L., f. p. and s. h. (H, F). *Anthomyiidae*: (47) *Anthomyia radicum* L., f. p. and s. h. (H, F). (48) *A. brevicornis* Ztt., s. h. (H, F). *Cordyluridae*: (49) *Scatophaga stercoraria* L. (H). *Phycodromidae*: (50) *Coelopa* sp.?, s. h.? and f. p. (H, F). *Trypetidae*: (51) *Ensina sonchi* L. (H). *Sepsidae*: (52) *Sepsis cynipsea* L. (H). *Chloropidae*: (53) *Oscinis frit* L., s. h. (H, F). *Phoridae*: (54) *Phora* sp.? (H). **Coleoptera**: (55) *Meligethes picipes* Sturm, (H). (56) *M. aeneus* F., s. h. (H, F). (57) *Pria dulcamarae* Scop., s. h. (H, F). (58) *Cercus rufilabris* Latr., s. h. (F). **Hemiptera**: (59) *Heterocordylus* sp.?, freq. running about the heads. **Thysanoptera**: (60) *Thrips* sp.?, very ab. (H, F).

UMBELLIFERAE: 38. *Daucus Carota* L. [Class A, Lit. 1, 2, 3, 4, 8, 11, 14, 17, 21, 50 b, 365 b, 528 b, &c.] Observed Aug. 27 to Sept. 26, 1894. The flowers are often thronged with ants or parasitic Hymenoptera, as many as 35 of the latter having been seen together on a single umbel. The single visit of *Bombus* was of very short duration.

Visitors. **Hymenoptera.** Aculeata: *Acutilingues*: (1) *Bombus*

hortorum L., s. h., once. *Pompilidae*: (2) *Priocnemis pusillus* Schiödte, 31. 8. 94. *Formicidae*: (3) *Formica fusca* L., s. h. *Myrmicidae*: (4) *Myrmica rubra* L., s. h. *Terebrantia*: *Tenthredinidae*: (5) *Allantus arcuatus* Fors., s. h. *Ichneumonidae*: (6) to (11) six species. *Braconidae*: (12) to (20) nine species. *Chalcididae*: (21) to (29) nine species. *Proctotrupidae*: (30) one species. **Diptera.** *Syrphidae*: (31) *Paragus* sp.? (32) *Melanostoma scalare* F. (33) *Platychirus albimanus* F. (34) *Syrphus barbifrons* Fln. (35) *S. ribesii* L., s. h. (36) *Sphaerophoria scripta* L. (37) *Eristalis tenax* L., s. h. (38) *E. arbustorum* L., s. h. (39) *E. pertinax* Scop., s. h. (40) *Syritta pipiens* L., s. h. *Mycetophilidae*: (41) *Sciara* sp.?, freq. *Chironomidae*: (42) *Ceratopogon niger* Wimm. *Psychodidae*: (43) *Pericoma* sp.? *Sarcophagidae*: (44) and (45) *Sarcophaga*, two species. *Muscidae*: (46) *Lucilia cornicina* F. (47) *L. sylvarum* Mg. (48) *L. splendida* Mg. (49) *Calliphora erythrocephala* Mg., s. h. (50) *C. vomitoria* L., s. h. (51) *Pollenia rudis* F. (52) *Morellia* sp.? *Anthomyiidae*: (53) *Anthomyia radicum* L., very ab. (54) *A. brevicornis* Ztt. *Cordyluridae*: (55) *Scatophaga stercoraria* L., s. h. *Sepsidae*: (56) *Sepsis cynipsea* L. *Ephydriidae*: (57) *Hydrellia griseola* Fln. *Drosophilidae*: (58) *Scaptomyza graminum* Fln. *Chloropidae*: (59) *Oscinis frit* L. *Phoridae*: (60) *Phora* sp.? **Coleoptera**: (61) *Tachyporus obtusus* L. (62) *Cercus rufilabris* Latr. (63) *Meligethes picipes* Sturm. (64) *Crepidodera ferruginea* Scop.

SAXIFRAGACEAE: 39. *Parnassia palustris* L. [Class A, Lit. 1, 2, 4, 9, 14, 17, 25, 48 b, 244 b, 287 b, &c.] Abundant on Scarborough cliffs. Observed Aug. 27 to Sept. 26, 1894.

Visitors. **Hymenoptera.** *Aculeata*: *Formicidae*: (1) *Formica fusca* L., s. h. *Myrmicidae*: (2) *Myrmica rubra* L., s. h. *Terebrantia*: *Chalcididae*: (3) and (4) two species. *Proctotrupidae*: (5) one species. **Diptera.** *Syrphidae*: (6) *Melanostoma scalare* F. (7) *Platychirus albimanus* F. (8) *Sphaerophoria scripta* L., s. h. (9) *Eristalis tenax* L. (10) *Helophilus pendulus* L., s. h. *Mycetophilidae*: (11) *Sciara* sp.? *Bibionidae*: (12) *Scatopse brevicornis* Mg. *Sarcophagidae*: (13) *Sarcophaga* sp.? *Muscidae*: (14) *Calliphora erythrocephala* Mg., s. h. *Anthomyiidae*: (15) *Anthomyia radicum* L., freq. s. h. (16) *A. brevicornis* Ztt., f. p. *Phycodromidae*: (17) *Coelopa* sp.? f. p. *Sepsidae*: (18) *Sepsis cynipsea* L. *Ephydriidae*:

(19) *Hydrellia griseola* Fln. *Phytomyzidae*: (20) *Phytomyza* sp.? *Phoridae*: (21) *Phora* sp.? **Coleoptera**: (22) *Meligethes picipes* Sturm, s. h. **Hemiptera**: (23) one sp.,? probing nectary.

Summing up as before we have:—

TABLE III.

Class.	No. of Flowers.	Lepidoptera.	Long-tongued Bees.	Short-tongued Bees.	Other Hymenoptera.	Long-tongued Flies.	Short-tongued Flies.	Coleoptera.	Other Insects.	Total.
A	2	—	1	—	34	15	31	5	1	87
B	1	5	3	—	12	13	21	4	2	60
B'	3	4	5	—	4	21	25	8	1	68
Total	6	9	9	—	50	49	77	17	4	215
Low Ger.	6	22	12	25	25 +	62	21	20	4	191 +

The percentage method cannot be employed here, as the figures are too small, and the observations do not cover the whole flora of the district (though they do cover most of the conspicuous part of the flora of the cliffs). In the bottom line of the table are given the totals of visitors to the same plants observed in Low Germany by Müller, and it is at once seen that, as at Auchencairn, the proportion of short-tongued flies is much larger at Scarborough, whilst that of the bees is smaller. The figures agree pretty well with those obtained from Scotland, except for Lepidoptera, which form here only 4·3 per cent. of the total, and thus fall below the proportion for Germany. The same result appears if we compare the lists of visitors to *Mentha* and *Scabiosa*, examined both at Auchencairn and Scarborough.

An attempt was made to determine, for each flower, during one month (see dates above), the proportionate number of

individuals of each insect group that visited the flowers. This gives :—

TABLE IV.

	Lepidoptera.	Hymenoptera.					Diptera.		Coleoptera.	Hemiptera.	Total.
		Acutilingues (Bees) (long-tongued only).	Formicidae & Myrmicidae.	Fossores.	Phytophaga (Tenthredinidae).	Entomophaga.	Syrphidae.	Short-tongued Flies.			
Parnassia.....	—	—	38	—	—	5	13	124	7	2	189
Daucus	—	1	27	1	16	184	45	378	13	—	765
Mentha	44	6	—	—	—	51	272	900	15	2	1290
Scabiosa	1	182	1	—	—	—	50	92	3	—	329
Inula	17	3	—	—	—	2	10	272	6	—	310
Eupatorium ..	1	1	—	—	—	1	47	64	2	—	116
Total	63	193	166	1	16	243	437	1830	46	4	2999
Percentage	2.10	6.43	5.53	0.03	0.53	8.10	14.57	61.0	1.53	0.13	—

Thrips is not included.

This table is of course only a very rough approximation, but it serves to show, approximately, the relative numbers of visits received by the different flowers, or paid by the different groups of insects. It brings out, even better than the preceding tables, the enormous preponderance in Britain of short-tongued flies. Even in *Scabiosa*, the flower of highest type in the above list, they form a large proportion of the total visitors. We must remember also that the efficacy in cross-fertilization of a group of insects depends, for any locality, much more on the number of individuals visiting than on the number of species.

The list is also of interest as showing the choices made by the various insect groups in an extremely limited flora (note e.g. the bees).

4. OBSERVATIONS AT CAMBRIDGE, 1892-4.

I. H. B. AND J. C. W.

Only four flowers were carefully watched, and their visitors are noted below.

LABIATAE: 40. *Origanum vulgare* L. [Class B, Lit. 1, 2, 3, 4, 17, 18, 21, 26, &c.] A great mass of this plant was growing in the Botanic Garden (for the experiments described in 26) and the insects visiting it were noted, during the years 1892-3-4 (middle of July to about Aug. 20).

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris brassicae* L., s. h. freq. (2) *P. napi* L., do. (3) *P. rapae* L., do. (4) *Vanessa urticae* L., do. (5) *Polyommatus phloea* L., do. **Heterocera:** *Pyralidae*: (6) *Pyrausta ntrinalis* Hb., s. h. **Hymenoptera.** Aculeata: *Acutilingues*: (7) *Apis mellifica* L., s. h. ab. (8) *Bombus hortorum* L., do. (9) *B. pratorum* L., do. (10) *B. terrestris* L., do. (11) *Psithyrus vestalis* Fourc., s. h. (12) *P. quadricolor* Lep., s. h. (13) *Andrena* sp.?, s. h. (14) *Halictus minutissimus* Kirby, s. h. *Eumenidae*: (15) *Odynerus* sp.?, s. h. **Diptera.** *Syrphidae*: (16) *Syrphus balteatus* Deg. (17) *S. ribesii* L. (18) *S. vitripennis* Mg. (19) *Eristalis tenax* L. (20) *E. pertinax* Scop. (21) *E. horticola* Deg. (22) *Myiatripa florea* L. *Tachinidae*: (23) *Siphona geniculata* Deg. *Anthomyiidae*: (24) *Anthomyia* sp.? (25) *Homalomyia canicularis* L. *Cordyluridae*: (26) *Scatophaga stercoraria* L. **Coleoptera**: (27) *Meligethes aeneus* F., f. p. **Hemiptera**: (28) *Calocoris bipunctatus* F. (29) *Anthocoris* sp.? (30) *A.* sp.?

41. *Ballota nigra* L. [Class H, Lit. 1, 3, 4, 11, 17, 18, 21, &c.] Abounds in the district. The observations were mostly made at Grantchester, in Aug. 1893.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris rapae* L., s. h. **Heterocera:** *Noctuidae*: (2) *Plusia gamma* L., s. h. Shelford, Oct. 7, 1894. **Hymenoptera.** Aculeata: *Acutilingues*: (3) *Bombus cognatus* Steph., s. h. (4) *B. muscorum* L., s. h. (5) *B. latreillellus* Kirby, s. h. (6) *Halictus* sp.?, s. h. **Diptera.** *Syrphidae*: (7)

Syrphus sp.?, s. h. (8) *Rhingia rostrata* L., s. h. (9) *Syritta pipiens* L., s. h.

VERBENACEAE: 42. *Verbena officinalis* L. [Class B, Lit. 1, 2, 3, 4, 11, 17, 18, &c.] Observed in the Botanic Garden, on a mass of plants growing wild beside the marjoram, July, 1892-3.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Lycaena icarus* Rott., s. h. freq. **Hymenoptera.** Aculeata: *Acutilingues*: (2) *Apis mellifica* L., s. h. freq. (3) *Bombus muscorum* L., s. h. freq. **Diptera.** *Syrphidae*: (4) *Syrphus* sp.?, s. h. (5) *Platychirus* sp.?, s. h.

ARALIACEAE: 43. *Hedera Helix* L. [Class A, Lit. 1, 3, 4, 10, 11, 18, 258 b, 471 a, 599 A b, &c.] Observed in the Botanic Garden, on a large bed of ivy, and at Grantchester, Nov. 1894.

Visitors. **Lepidoptera.** Heterocera: *Tortricidae*: (1) one spec. unnamed. **Hymenoptera.** Aculeata: *Vespidæ*: *Vespa vulgaris* L., s. h. ab. Terebrantia: (3) to (7) five species. **Diptera.** *Syrphidae*: (8) *Eristalis tenax* L., s. h. freq. *Mycetophilidae*: (9) *Sciara* sp.? (10) *Bolitophila fusca* Mg. *Chironomidae*: (11) *Orthocladus* sp.? (12) *Metriocnemus* sp.? *Tachinidae*: (13) *Siphona geniculata* Deg., s. h. *Muscidae*: (14) *Lucilia* sp.?, s. h. (15) *Calliphora erythrocephala* Mg., very ab., s. h. (16) *C. sepulchralis* Mg., s. h. (17) *Pollenia rudis* F., ab. s. h. *Anthomyiidae*: (18) *Polistes lardaria* F. (19) *Hyetodesia lucorum* Fln. (20) *Limnophora* sp.? (21) *Trichophthicus cunctans* Mg. (22) and (23) *Anthomyia*, two sp. *Cordyluridae*: (24) *Scatophaga stercoraria* L., s. h. *Ephydridae*: (25) *Hydrellia griseola* Fln. *Drosophilidae*: (26) *Scaptomyza graminum* Fln. *Chloropidae*: (27) *Chloropisca ornata* Mg. *Phytomyzidae*: (28) *Phytomyza* sp.?

To these visitors may be added those of *Medicago sativa*, *falcata*, and *lupulina*, determined by one of us at Cambridge (Literat. No. 6). We thus obtain the following table:—

TABLE V.

Class.	No. of Flowers.	Lepidoptera.	Long-tongued Bees.	Short-tongued Bees.	Other Hymenoptera.	Long-tongued Flies.	Short-tongued Flies.	Coleoptera.	Other Insects.	Total.
A	1	1	—	—	6	1	20	—	—	28
B	2	7	8	2	1	9	4	1	3	35
H	4	13	12	5	4	22	18	1	2	77
Total	7	21	20	7	11	32	42	2	5	140
Low Ger.	7	35	47	25	6	31	9	1	—	154

As before, Müller's totals are given for comparison; the result is much the same as for the Scarborough observations, but the Lepidoptera are in larger proportion.

5. OBSERVATIONS IN MID WALES, 1893.

I. H. B. AND J. C. W.

These were made during a residence of three weeks in the uplands of NE. Cardiganshire (Plynlimmon district), from Aug. 26 to Sept. 16, 1893. A full description of the flora of this wild and barren district will be found in our paper upon it¹. Observations were made both at alpine and sub-alpine levels. We have taken as a dividing line for this purpose the upper limit of cultivation (about 1,100 feet above sea-level). *Pteris aquilina* ceases at about 1,250 feet. The highest point in the district is the summit of Plynlimmon (2,460 feet).

¹ 'Botanical Notes from North Cardiganshire.' Journ. of Bot., 1894, Jan., Feb.

CAMPANULACEAE: 44. *Jasione montana* L. (See No. 7, Auchencairn.) This plant is common up to 1,000 feet.

Visitors. **Lepidoptera.** (1) *Pieris rapae* L., 800 ft. 3. 9. 93. (2) *Polyommatus phloas* L., 750 ft. 30. 8. 93; 600 ft. 10. 9. **Hymenoptera.** *Aculeata: Acutilingues:* (3) *Bombus terrestris* L., s. h. 500 ft. 30. 8. 93. (4) *B. muscorum* L., s. h. 600 ft. 5. 9. 93. *Formicidae:* (5) *Formica fusca* L., do., 4. 9. 93. **Diptera.** *Syrphidae:* (6) *Melanostoma scalare* F., s. h. 800 ft. 6. 9. 93. (7) *Platychirus manicatus* Mg., 800 ft. 2. 9. 93. (9) *Eristalis tenax* L., s. h. 800 ft. 5. 9. 93. (8) *Helophilus pendulus* L., 700-800 ft. 3. 9. 93. *Muscidae:* (10) *Lucilia cornicina* F., f. p.?, do. *Anthomyiidae:* (11) *Anthomyia radicum* L., do., abund. (12) *A. sp.?* freq., do. *Cordyluridae:* (13) *Scatophaga stercoraria* L., s. h. 800 ft. 3. 9. 93. *Chloropidae:* (14) *Oscinis sp.?*, 700 ft. 3. 9. 93. **Coleoptera:** (15) *Meligethes viridescens* F., f. p. 800 ft. 2. 9. 93.

45. *Wahlenbergia hederacea* Rchb. [4, p. 268.] The flower faces vertically upwards. The tubular-campanulate corolla is about 10 mm. deep and 3 or 4 mm. wide at the mouth. The corolla is pale blue, veined with deep blue, and there is no scent. The stamens do not possess the broad flat base and narrow filament characteristic of *Campanula*, but widen gradually downwards, and are hairy below. The mechanism is much the same as in *Campanula*, but only the anthers wither after the pollen is shed upon the style; the filaments remain standing up as a cage over the honey. The flower has a chance of cross-fertilization and is occasionally visited, but the stigmas always ultimately bend so far back that they touch the pollen on their own style and so effect autogamy.

Visitors. **Diptera.** *Muscidae:* (1 and 2) two species, unnamed, s. h.; one was just large enough to touch the style as it entered. **Thysanoptera:** (3) *Thrips sp.* very ab. s. h. **Hemiptera:** (4) One species, creeping about in the flowers.

DIPSACEAE: 46. *Scabiosa succisa* L. [See No. 9, Auchencairn, and No. 36, Scarborough.] Abundant up to 1,200 feet (reaches a height of 1,640), and largely visited.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Pieris rapae* L., s. h. 700 ft. 5. 9. 93. (2) *Vanessa C-album* L., s. h. 700 ft. 3 and 5. 9. (3) *V. atalanta* L., s. h. 700 ft. 12. 9. 93. (4) *V. urticae* L., s. h. freq. 700–1,150 ft. 28. 8 to 5. 9. 93. (5) *Coenonympha pamphilus* L., s. h. 700–900 ft. 3 to 5. 9. 93. (6) *Polyommatus phloea* L., s. h. 700 ft. 30. 8.–3. 9. 93. (7) *Lycaena icarus* Esp. do. **Heterocera:** *Noctuidae*: (8) *Plusia gamma* L., s. h. 800 ft. 5. 9. 93. (9) *Celaena haworthii* Cuc., do. (10) *Charaeeas graminis* L., s. h. 800 to 1,000 ft. 31. 8. 93. **Hymenoptera.** Aculeata: *Acutilingues*: (11) *Bombus terrestris* L., s. h. 500–1,100 ft. 28. 8 to 6. 9. 93. (12) *B. lapidarius* L., s. h. freq. 700 ft. 28. 8 to 5. 9. 93. (13) *B. hortorum* L., s. h. 700 ft. 28. 8. 93. (14) *B. pratorum* L., s. h. 700 ft. 3. 9. 93, on *Plym-limmon*. (15) *B. scrimshirani* Kirby, s. h. 700 ft. Hafod. 31. 8. 93. (16) *B. muscorum* L., s. h. ab. 300–1,100 ft. 27. 8 to 15. 9. **Diptera.** *Syrphidae*: (17) *Melanostoma scalare* F., 700–1,100 ft. 31. 8 to 2. 9. 93. (18) *Platychirus manicatus* Mg., s. h. 700 ft. 5. 9. 93. (19) *Volucella pellucens* L., s. h. 500 ft. 30. 8. (20) *Sericomyia borealis* Fln., s. h. 800–1,100 ft. 21–31. 8. 93. (21) *Helophilus pendulus* L., s. h. 700 ft. 28. 8 to 5. 9. (22) *Eristalis tenax* L., s. h. very ab. 300–1,100 ft. 27. 8 to 8. 9. 93. (23) *E. intricarius* L., 30. 8. 93. (24) *E. rupium* F., s. h. 700 ft. 27. 8. 93. (25) *E. pertinax* Scop., do. 30. 8. 93. (26) *E. horticola* Deg., s. h. 800 ft. 3. 9. 93. *Empidae*: (27) *Rhamphomyia* sp.?, f. p., do. (28) *Pachymeria palparis* Egg., 630–1,000 ft. 3. 9. 93. *Tachinidae*: (29) *Siphona geniculata* Deg., ab. 700–1,000 ft. 8 and 9. 93. *Muscidae*: (30) *Lucilia cornicina* F., f. p. 700 ft. 5. 9. 93. *Anthomyiidae*: (31) *Hyetodesia incana* W., ab. 300–1,000 ft. 30. 8 to 8. 9. 93. (32) *Trichophthicus cunctans* Mg.; freq. 600 ft. 30. 8. 93. (33) *Hylemyia lasciva* Ztt., 600 ft. 8. 9. 93. (34) *H. strigosa* F., freq. 900 ft. 31. 8. 93. (35) *Anthomyia* sp.?, s. h.? 800 ft. 8. 9. 93. *Cordyluridae*: (36) *Scatophaga stercoraria* L., s. h. 1,100 ft. 31. 8. 93. **Coleoptera**: (37) *Meligethes viridescens* F., freq. 500–800 ft. 28. 8 to 4. 9. **Thysanoptera**: (38) *Thrips*, sp. ab. 800 ft. 5. 9. 93.

Of these visitors, the only ones found at alpine levels were Nos. 4, 11, 16, 17, 20, 22, 36. All of these, except the last, were also observed at lower levels.

PLANTAGINACEAE: 47. *Littorella lacustris* L. [Anemophilous, Lit. 4, 14, 18.] This plant is abundant on the shores

of the many small lakes in the district. It was never found more than a few yards back from the edge of the water, and consequently it must often become submerged, in which case, as is well known, it ceases to bear flowers and propagates itself extensively by runners, at the same time producing a new type of leaf. The flowers are in groups of three, a male in the centre, on the end of a peduncle, and two sessile female flowers at the base of it. The stamens are long and flexible with large versatile anthers, and the stigmas long and brush-like. The flowers are anemophilous, and the female flowers come out before the male to which they are attached, thus hindering self-fertilization. Nearly all the specimens we examined had set a full complement of seed. No insect visitors were seen.

ERICACEAE: 48. *Calluna vulgaris* Salisb. [See No. 18, Auchencairn.] Frequent in the drier parts of the hills, but not abundant in the district.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Coenonympha pamphilus* L., s. h. 800–1,050 ft. (on Plynlimmon) 28. 8 to 5. 9. (2) *Polyommatus phloea* L., s. h. 800 ft. 30. 8 to 10. 9. 93. (3) *Lycaena icarus* Rt., s. h. 700 ft. 30. 8. 94. (4) *Vanessa urticae* L., s. h. 800–1,150 ft. 28. 8 to 10. 9. 93. Heterocera: (5) Moth unnamed, s. h. 1,050 ft. 28. 8. 93. **Hymenoptera.** Aculeata: *Acutilingues*: (6) *Bombus terrestris* L., s. h. freq. 300–1,100 ft. 28. 8 to 5. 9. 93. (7) *B. lapidarius* L., s. h. 600–1,800 ft. 28. 8. 93. (8) *B. lapponicus* F., s. h. 1,800 ft. 29. 8. 93. (9) *B. scrimshirani* Kirby, s. h. 800 ft. 10. 9. 93. (10) *B. hortorum* L., s. h. 600–1,800 ft. 28. 8 to 4. 9. 93. (11) *B. muscorum* L., s. h. 300–800 ft. do. *Vespidæ*: (12) *Vespa vulgaris* L., s. h. 400 ft. 1. 9. 93. *Formicidæ*: (13) *Formica fusca* L., do. **Diptera.** *Syrphidæ*. (14) *Melanostoma scalare* F., s. h. 300 ft. 30. 8. 93. (15) *Platychirus manicatus* Mg., 700 ft., do. (16) *Sericomyia borealis* Flin., s. h. 200 ft. 30. 8 to 1. 9. 93. (17) *Eristalis tenax* L., s. h. freq. 600 ft. Aug. *Muscidæ*: (18) *Lucilia cornicina* F., freq. 800–1,800 ft. 28. 8 to 10. 9. 93. (19) *Calliphora erythrocephala* Mg. (20) *C. cognata* Mg. (21) *C. sepulchralis* Mg., 800–1,000 ft. 9. 93. (22) *Pollenia rudis* F., 700 ft. 30. 8. 93.

Of these visitors, Nos. 4, 6, 7, 8, 10, 18, occur at alpine levels (No. 8 only observed at 1,800 ft.).

49. *Erica cinerea* L. [See No. 19, Auchencairn.] Frequent in the drier regions.

Visitors. Lepidoptera. Rhopalocera: (1) *Vanessa urticae* L., s. h. 800 ft. 10. 9. 93. (2) *Polyommatus phloea* L., do. *Hymenoptera.* Aculeata: *Acutilingues*: (3) *Bombus muscorum* L., do. 4 to 10. 9. 93. (4) *B. terrestris* L., do. 27. 8 to 7. 9. 93. No alpine observations could be made, as the higher parts of the mountains are too boggy for the growth of heather.

50. *E. Tetralix* L. [See No. 20, Auchencairn.] Frequent.

Visitors. Lepidoptera. Rhopalocera: (1) *Coenonympha pamphilus* L., s. h. 800 ft. 28. 8. 93. *Hymenoptera.* Aculeata: *Acutilingues*: (2) *Bombus lapidarius* L., s. h. 600 ft. 26. 8. 93. (3) *B. muscorum* L., s. h. 500–1000 ft. 26. 8 to 5. 9. 93. (4) *B. terrestris* L., s. h. 900 ft. 4. 9. 93. No alpine observations.

51. *Vaccinium Myrtillus* L. [Class H, Lit. 1, 2, 3, 4, 17, 18, &c.] Frequent in the hills, but the flowering season nearly over.

Visitors. Hymenoptera. Aculeata: *Acutilingues*: (1) *Bombus muscorum* L., s. h. ab. 900 ft. 3. 9. 93. (2) *B. terrestris* L., do.

LYTHRACEAE: 52. *Peplis Portula* L. [Lit. 330 a, 264 b, 4, 9, 14, 28.] Abundant near Pont Erwyd, both on land and in shallow running water. The flower is small (3 mm. diam.) sessile and very inconspicuous; the 6 minute white petals are very fugacious. The stigma is ripe a little before the stamens; these are bent inwards in the opening flower and pollinate it. All the flowers set their full complement of seed. No insect visitors were observed.

VIOLACEAE: 53. *Viola lutea* Huds. [Class H.] Abundant in the hills (except *Potentilla*, almost the only flower).

Visitors. Diptera. Tachinidae: (1) *Siphona geniculata* Deg., s. h.? 800 ft. 15. 9. 93. *Anthomyiidae*: (2) *Hylemyia lasciva* Ztt., do. 5. 9. 93. (3) *Anthomyia* sp.? do. 29. 8. 93. No visitors seen at alpine levels.

ROSACEAE: 54. *Potentilla Tormentilla* L. [See No. 29, Auchencairn.] This plant abounds on all the hills, reaching

a height of 2380 feet on Plynlimmon. It is almost the only plant to be seen in flower in late summer above 1200 feet, the Ericaceae being rare on account of the very boggy soil.

Visitors. **Lepidoptera.** Rhopalocera: (1) *Polyommatus phloea* L., s. h. 600 ft. 10. 9. 93. **Diptera.** *Syrphidae*: (2) *Sphaerophoria scripta* L., do. 5. 9. 93. (3) *Eristalis horticola* L., s. h. 800 ft. 3. 9. 93. *Tachinidae*: (4) *Siphona geniculata* Deg., s. h. 800 ft. 3. 9. 93. *Muscidae*: (5) *Lucilia cornicina* F., do. *Anthomyiidae*: (6) *Anthomyia radicum* L., do. (7) *A. sp.?* do. to 1000 ft.

RANUNCULACEAE: 55. *Ranunculus hederaceus* L. [Lit. 4, 14.] Abundant in the district. The flowers are very small (5 mm. diam.) and inconspicuous; no insects were observed to visit them. The stamens are few in number, the carpels fairly numerous with well-marked stigmas. The tissue at the base of the petals, where the nectary is usually found in this genus, is glandular-looking, but no free honey could be found. The anthers dehisce while the flower is opening and cover themselves all round with pollen, at the same time pollinating the stigmas. The stamens move outwards after dehiscence. The peduncle bends downwards after flowering, to ripen the fruit. All flowers examined were fully productive.

LILIACEAE: 56. *Narthecium ossifragum* Huds. [Class Po, Lit. 3, 14, 18.] Abundant up to 1200 feet. The mechanism agrees with Knuth's description (14), but frequently we found autogamy occurring by the flower opening so late that the anthers had already dehisced and pollinated the stigma. The fact of the plant being near the end of its flowering season may have had something to do with this (27). The tissue at the base of the stamens is juicy and may perhaps be pierced by bees, if they visit the flower (cf. *Brodiaea*, in No. 27).

Visitors. **Hymenoptera.** Aculeata: *Myrmicidae*: (1) *Myrmica rubra* L., f. p. 800 ft. 5. 9. 93. Terebrantia: *Chalcididae*: (2) One species, 800 ft. 3. 9. 93. **Diptera.** *Syrphidae*: (3) *Platychirus manicatus* Mg., f. p. 600 ft. 15. 9. 93. *Anthomyiidae*: (4) *Hylemyia lasciva* Ztt., f. p. freq. 800 ft. 5. 9. (5) *Anthomyia radicum* L., do., ab. (6) *Anth. sp.?* do. *Ephydriidae*: (7) *Hydrellia griseola* Fln., do. freq. **Hemiptera.**

(8) One species, do., rare. **Thysanoptera.** (9) Thrips sp. freq. No alpine observations.

The above are almost the only flowers which form any conspicuous part of the flora above 650 feet, in September. We rarely went into lower levels, and generally were at high ones (1000–2000 feet). The following flowers were, however, present in noteworthy numbers besides those described: *Brassica Sinapis*, Visiani (common in fields), *Polygala serpyllacea*, Weihe (on the hills, frequent), *Cerastium glomeratum*, Thuill., *Hypericum quadrangulum*, *H. pulchrum*, *Lotus corniculatus*, *Rubus fruticosus* (nearly over), *Circaea lutetiana*, *Pimpinella Saxifraga*, *Solidago Virgaurea*, *Achillea Millefolium*, *Chrysanthemum Segetum* (abundant in fields and in full flower), *Cnicus palustris*, *Hieracium Pilosella*, *Euphrasia officinalis*, besides other wind-fertilized or very inconspicuous flowers. These plants must have affected the numbers (though probably not the proportions) of visitors to the flowers we have considered. Only rarely did any of them occur above the limit of the Bracken (*Pteris*).

Summing up as before the subalpine visitors, we get:—

TABLE VI.

Class.	No. of Flowers.	Lepidoptera.	Long-tongued Bees.	Short-tongued Bees.	Other Hymenoptera.	Long-tongued Flies.	Short-tongued Flies.	Coleoptera.	Other insects.	Total.
Po	1	—	—	—	2	1	4	—	2	9
AB	1	1	—	—	—	2	4	—	—	7
B	2	5	5	—	2	4	7	—	2	25
B'	2	12	6	—	1	14	14	2	1	52
H	4	3	7	—	—	—	3	—	—	13
Total	10	21	20	—	5	21	32	2	5	106
%		19.8	18.8	—	4.7	19.8	30.19	1.88	4.7	—

Ranunculus, Peplis, and Littorella, are not included.

The percentages are much the same as at Auchencairn, but the Lepidoptera show a large rise (from 11.3 to 19.8). This result is similar, but not so marked, to that found by Müller in comparing the Alps with Low Germany; but no stress at all can be laid upon it here, considering (1) the very small total of visitors; (2) the fact that the observations were made in late summer; (3) the great heat of the summer of 1893; and (4) the general favourableness of the year to Lepidoptera. Müller gives no list of visitors to *Wahlenbergia*, *Viola*, or *Erica cinerea*. If we subtract these from our list, the comparison gives

	Lepidoptera.	Long-tongued Bees.	Short-tongued Bees.	Other Hymenoptera.	Long-tongued Flies.	Short-tongued Flies.	Coleoptera.	Other insects.	Total.
Wales	19	18	—	5	21	27	2	3	95
Germany ...	17	38	62	23	48	11	5	2	206

This shows a great preponderance in Wales of Lepidoptera and short-tongued-flies, a total lack of short-tongued bees (note the season of the year, however), and a great deficiency in the other short-tongued Hymenoptera. The long-tongued bees and the long-tongued flies are as usual about equal.

Above the cultivation limit, the Plynlimmon district is exceedingly desolate. Almost the only flowers in late summer on the open mountain sides are *Potentilla Tormentilla* and *Viola lutea*, with occasional small patches of the various Ericaceae, and almost the only insects to be seen are various *Bombi*, a few flies, and an occasional butterfly or moth. The bulk of our time in the district (3 weeks) was spent at high levels, and the weather was fine throughout (and had been so since April), but the only visitors observed were those given above, 13 in all, on *Scabiosa* and *Calluna*. These insects are *Vanessa urticae* (to 1150 feet, not above

the limit of *Pteris*), *Bombus terrestris* (common to 1100 feet, and was seen at higher levels, though not visiting), *B. lapidarius* (to 1800 feet), *B. hortorum* (do.), *B. muscorum* (freq. at 1100 feet), *B. lapponicus* (1800 feet on *Calluna*, the only record of this insect visiting flowers in Britain, that we possess), *Melanostoma scalare* (1100 feet), *Sericomyia borealis* (do.), *Eristalis tenax* (do.), *Lucilia cornicina* (to 1800 feet), and *Scatophaga stercoraria* (1100 feet). With the exception of *Lucilia* and the humble bees, none of these insects were noted above the limit of *Pteris* (1270 feet). So far, therefore, as these observations go, the flower-visiting insect fauna of our British hill-districts at alpine levels resembles rather that of northern Scandinavia and Arctic countries than that of corresponding zones in the mountains of central Europe. This side of the subject we hope to consider in detail in Part II. The flowers too seem on the whole to resemble those of Arctic regions in their great development both of autogamy and vegetative reproduction.

6. SUMMARY.

The chief conclusions to be drawn from this work have been already given at the ends of the different sections, but we may add a few notes here.

In all, 51 species of the British flora are treated of (including the three species of *Medicago* at Cambridge). Several figure more than once, viz. *Fasione* (Auch. Cardig.), *Scabiosa* (Auch. Scarb. Card.), *Mentha* (Auch. Scarb.), *Calluna* (Auch. Card.), *Erica cinerea* (do.), *E. Tetralix* (do.), *Potentilla* (do.). If each of these be counted separately the total amounts to 59. Three of these (*Littorella*, *Ranunculus*, *Peplis*) have no insect visitors recorded. Adding up those of the remaining 56 (counting the plants named above as often as they occur), we get:—

TABLE VII.

Class.	No. of Flowers.	Lepidoptera.	Long-tongued Bees.	Short-tongued Bees.	Other Hymenoptera.	Long-tongued Diptera.	Short-tongued Diptera.	Coleoptera.	Other insects.	Total.	%
Po	4	—	1	—	3	11	18	4	3	40	4.52
A	6	6	2	3	63	31	89	8	5	207	23.10
AB	2	1	—	—	—	4	9	—	—	14	1.58
B	10	25	27	3	15	38	43	9	7	167	18.89
B'	13	47	40	10	11	80	92	19	17	316	35.75
H	19	20	49	5	4	27	24	4	4	137	15.50
F	2	—	2	—	—	1	—	—	—	3	0.34
Total	56	99	121	21	96	192	275	44	36	884	
%		11.20	13.69	2.37	10.86	21.72	31.11	4.98	4.0		
% Low Germany		6.9	23.1	18.0	10.6	19.6	10.9	8.9	0.9		

Müller's total recorded visits in Low Germany (Fert. of Flrs. p. 654) amount to 5231, almost six times as many as ours, and cover the whole flower season. Ours are chiefly made in August and September (a few in July at Cambridge, and *Hedera* in November). Allowing, however, for the effect of this factor, it is still evident from these figures as well as from those given previously that in the British flower-visiting insect fauna we have, as compared with Low Germany.

(1) A larger *proportion* of *Lepidoptera* (especially in the west) and *short-tongued Diptera*, especially the latter.

(2) A smaller *proportion* of *Hymenoptera*, especially the short-tongued bees and other short-lipped species (other than the Ichneumonidae and their allies).

Scott-Elliot's observations (22, 23) support these conclusions. They are rather fragmentary, as the insects are not always named or the exact number of species given, and are as yet not all published. On about 76 flowers, chiefly Ranunculaceae, Cruciferae, Caryophyllaceae, Geraniaceae, &c. (and thus mainly of the lower flower classes), about 200

visitors in a total of about 425 are short-tongued flies, a proportion even greater than in our lists.

As regards actual number of species of each group, our lists are very small as compared with Müller's. E.g. of Lepidoptera we have 26 species (against 79), of bees 22 (against 205), of Syrphidae 35 (against 89), of other flies 75 (against 164), of Coleoptera 13 (against 129). Of these species many occur in all four districts studied, others in only one or two. We have made up an index of insects, from the tables given here, which we shall be happy to lend to any one interested in the distribution of insects in Britain. Our observations are not nearly sufficient to enable us to draw any conclusions upon this subject.

Neither is it possible from these few data to make any comparison in detail with other European countries; a reference to the literature will show what has been done in this direction (see especially 4 and 18). It may be noted, however, that the composition of the flower-visiting insect fauna in Schleswig-Holstein (Knuth) and in Flanders (Macleod) is far more like that of Low Germany than like our own as here presented. The nearest resemblance is found in Norway (Lindman) [and also in New Zealand, it may be observed (Thomson, 720 a)]. The figures, &c., given in this paper afford, however, a rough test of the composition of the flower-visiting insect fauna of the lowland districts, which will serve as data for further work in this direction and for comparison with observations at alpine levels. In the second portion of this paper we hope to discuss the plants of the Grampians and their biological characters, with especial reference to those more strictly alpine or arctic species which are cut off by large areas of lowland from all other plants of the same species. We hope also to give a more general discussion of the British flora as a whole, and a comparison of its general biological characters with those of the continental flora.

ADDENDUM.

SINCE the above paper was finished, one of us (I. H. B.) has made observations upon the early spring flowers near Scarborough—from March 15 to April 11, 1895. Details cannot here be given, but the following table shows the total number of species of insects visiting each class of flower. All the open flowers (thirty-seven in number) in the district were studied. To five anemophilous plants and to three of the class A B no visitors were observed; the other twenty-nine flowers were visited as follows:—

TABLE VIII.

Class.	No. of Flowers.	Lepidoptera.	Long-tongued Bees.	Short-tongued Bees.	Other Hymenoptera.	Long-tongued Flies.	Short-tongued Flies.	Coleoptera.	Other Insects.	Total.
Anemoph.	1	—	—	—	—	1	—	—	—	1
Po	1	—	1	—	—	1	2	—	—	4
A	6	1	2	4	4	6	41	3	7	68
AB	7	1	1	4	8	4	22	3	5	48
B	2	1	—	3	2	—	4	1	2	13
B'	6	2	3	6	4	10	28	4	4	61
H	6	1	—	2	—	1	6	3	5	18
Total	29	6	7	19	18	23	103	14	23	213
% of total		2·81	3·29	8·92	8·45	10·80	48·36	6·57	10·80	

A comparison of these numbers with those given in the other tables may be made. We may call attention to the increased proportion of short-tongued bees and flies.

In addition to those entomologists whose services have been acknowledged earlier, we desire to thank also Messrs. Edward Saunders and C. Warburton for their very kind assistance.



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