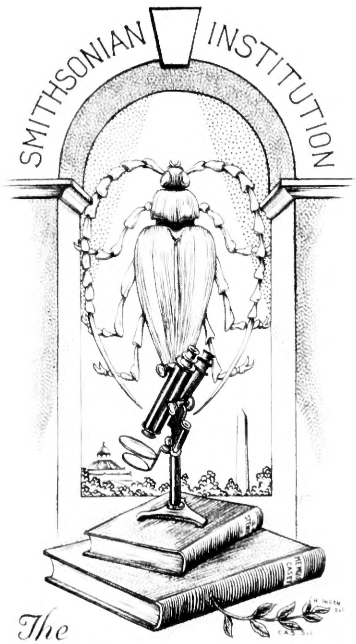
SMITHSONIAN INSTITUTION

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OF THE

ENTOMOLOGICAL SOCIETY

OF

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THE

TRANSACTIONS

OF THE

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OF

LONDON

FOR THE YEAR

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ERRATA.

TRANSACTIONS.

On p. 207, for "48," read "38"; on p. 211, for "16 moderate, 23 light," read "25 moderate, 37 light"; for "5 moderate," read "7 moderate."

PROCEEDINGS.

Page iii. — For *Iridomyrmex purpureus* read *I. purpurens;* for *E. nudatam* read *E. nudatum;* for "Varieté toute noire" read "Varieté voute noire." P. ix. (sixth line from top).—For *Meramplus bicolor* read *Meranoplus bicolor;* for *Crematogaster* read *Cremastogaster;* for (fifth line from bottom) *Pseudomyrme* read *Pseudomyrma.*

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1892 Leslie, J. H., 44 *Cheriton-square, Upper Tooting*, S.W.

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1885 Lloyd, Robert Wylie, *St. Cuthberts, Thurleigh-road, Nightingale-lane, Clapham Common.*

1850 Lowe, W. H., M.D., *Woodcote Lodge, Inner Park-road, Wimbledon Park*, S.W.

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1887 M'Dougall, James Thomas, *Dunolly, Morden-road, Blackheath*, S.E.

1851 † M'Intosh, J.

1888 Mackinnon, P. W., *Lynndale, Mussoorie, N. W. P., India.*

1892 Mackonochie, The Rev. J. A., B.A. (Chaplain to the Earl of Home), *Douglas Castle, Lanarkshire;* and *The Hirsel, Coldstream.*

1858 McLachlan, Robert, F.R.S., F.L.S., F.Z.S., Treasurer, *Westview*, 23 *Clarendon-road, Lewisham*, S.E.

1887 Manders, Surgeon-Captain Neville, L.R.C.P., M.R.C.S., *Agincourt House, Yorktown, Surrey.*

1891 Manger, William T., 100 *Manor-road, Brockley*, S.E.

1892 Mansbridge, William, 21 *Rosenau-crescent, Battersea*, S.W.

1865 Marshall, The Rev. Thos. Ansell, M.A., *Botusfleming Rectory, Hatt, Cornwall.*

1856 † Marshall, William, *Auchinraith, Bexley, Kent.*

1874 † Mason, Philip Brooke, M.R.C.S., F.L.S., *Trent House, Burton-on-Trent.*

1865 Mathew, Gervase F., R.N., F.L.S., F.Z.S., F.R.G.S., *Lee House, Dovercourt, Essex.*

1887 Matthews, Coryndon, *Erme Wood, Ivybridge, South Devon.*

1860 May, John William, K.N.L., *Blenheim House, Parson's Green-lane, Fulham*, S.W.

1872 † Meldola, Professor Raphael, F.R.S., F.R.A.S., F.C.S., 6 *Brunswick-square*, W.C.

1885 Melvill, James Cosmo, M.A., F.L.S., &c., *Kersal Cottage, Prestwich, Lancashire.*

1887 Merrifield, Frederic, 24 *Vernon-terrace, Brighton.*

1888 Meyer-Darcis, care of Sogin & Meyer, *Wohlen, Switzerland.*

1880 Meyrick, Edward, B.A., F.Z.S., *Ramsbury, Hungerford, Berkshire.*

1883 Miles, W. H., *The New Club, Calcutta.*

1879 Monteiro, Senhor Antonio Augusto de Carvalho, 72 *Rua do Alecrion, Lisbon.*

1853 Moore, Frederic, F.Z.S., A.L.S., *Claremont House, Avenue-road, Croydon-road, Penge,* S.E.

1886 Morgan, A. C. F., F.L.S., *Villa Nova de Gaya, Oporto, Portugal.*

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1878 Newman, Thomas P., F.Z.S., 54 *Hatton Garden,* E.C.; and *Hazelhurst, Haslemere, Surrey.*

1890 Newstead, R., *The Museum, Chester.*

1882 Nicéville, Lionel de, F.L.S., C.M.Z.S., *Indian Museum;* and 13 *Kyd-street, Calcutta.*

1886 Nicholson, William E., *School Hill, Lewes, Sussex.*

1886 Norris, Herbert E., 15 *Market Place, Cirencester.*

1878 Nottidge, Thomas, *Ashford, Kent.*

1869 Oberthür, Charles (fils), *Rennes, France.*

1877 Oberthür, René, *Rennes, France.*

1883 Oldfield, George W., M.A., F.L.S., F.Z.S., 21 *Longridge-road, Earls Court,* S.W.

1873 Olivier, Ernest, *Ramillons, près Moulins (Allier), France.*

1886 Olliff, Arthur Sidney, *Government Entomologist, Department of Agriculture, Macquarie-street, Sydney, N. S. Wales.*

1878 Ormerod, Miss Eleanor A., F.R.Met.S., *Torrington House, Holywell Hill, St. Albans, Herts.*

1880 Ormerod, Miss Georgiana, *Torrington House, Holywell Hill, St. Albans, Herts.*

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1888 Pennington, F., jun., *Broome Hall, Holmwood, Surrey.*

1883 Péringuey, Louis, *South African Museum, Cape Town, South Africa.*

1879 Perkins, Vincent Robt., *Wotton-under-Edge, Gloucestershire.*

1887 Phillips, Charles Edmund Stanley, *Castle House, Shooter's Hill, Kent.*

1891 Pierce, Frank Nelson, 143 *Smithdown Lane, Liverpool.*

1885 Poll, J. R. H. Neerwort van de, *Heerengracht* 476, *Amsterdam.*

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1851 Preston, The Rev. Thomas Arthur, M.A., F.L.S., *Thurcaston Rectory, Leicester.*

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1886 Ragonot, E. L. (Ex-President Ento. Soc. France), 12 *Quai de la Rapée, Paris.*

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1890 Rendlesham, The Right Honble. Lord, *Rendlesham Hall, Woodbridge, Suffolk.*

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1890 Robson, John Emmerson, *Hartlepool.*

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1875 Sallé, Auguste, 13 *Rue Guy de la Brosse, Paris.*

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1887 Sidgwick, A., M.A. (Fellow of Corpus Christi College, Oxford), 64 *Woodstock-road, Oxford.*

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1866 † WALSINGHAM, The Right Hon. Lord, M.A., LL.D., F.R.S., F.L.S., F.Z.S., VICE-PRESIDENT, High Steward of the University of Cambridge, *Eaton House,* 66 A *Eaton-square,* S.W.; and *Merton Hall, Thetford, Norfolk.*

1886 WARREN, Wm,, M.A., *British Museum, Cromwell-rd.,* S.W.

1869 WATERHOUSE, Charles O., *Ingleside, Avenue Gardens, Acton,* W.; and *British Museum, Cromwell-road,* S.W.

1891 † WATSON, Capt. E. Y., F.Z.S., Indian Staff Corps, care of Messrs. King & Co., 45 *Pall Mall,* S.W.

1845 WEIR, John Jenner, F.L.S., F.Z.S., *Chirbury, Beckenham, Kent.*

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1882 WEYMER, Gustav, *Sadowa-strasse* 21 *a, Elberfeld, Rhenish Prussia.*

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1884 WHITE, William, *The Ruskin Museum, Meersbrook Park, Sheffield.*

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1881 WOOD, The Rev. Theodore, *Merton Cottage, Baldock, Herts.*

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THE

TRANSACTIONS

OF THE

ENTOMOLOGICAL SOCIETY

OF

LONDON

For the Year 1892.

I. *New species of Heterocera from the Khasia Hills.* Part II. By Colonel Charles Swinhoe, F.L.S., F.Z.S., &c.

[Read July 1st, 1891.]

Plate I.

Eupithecia, *Curt.*, Lep.

39. *Eupithecia filicata*, n. sp.

♂. Palpi, head, and body yellowish flesh-colour; abdomen with a greenish grey tuft of hairs at the base. Wings of a dark greenish grey. Fore wings yellowish flesh-colour at the base, a double broad blackish band in the centre, the outer margin dentated, the central tooth large and prominent; three dark greenish patches in a transverse row in the disk, on costa, centre, and hinder margin, traversed by a whitish sinuous indistinct line; marginal border of same colour as the patches; a blackish mark on costa at the base, with indications of a basal band; some whitish marks on costa towards apex. Hind wings with the basal half pale, and tinged with ochreous flesh-colour; a thick mass of hairs on the submedian and internal veins, partly yellowish, and terminating in greyish black tufts; cilia of both wings with a faint whitish base and whitish ends. Under side pale greyish; fore wings with a blackish spot at end of cell, and crossed by central, discal, submarginal, and marginal blackish bands; the central band angled outwardly and continued in a similar form across the hind wings; fore wings with a large oblong space near the hinder margin, edged with black on the upper portion; body flesh-colour, legs whitish, fore tarsi with broad brown bands. Expanse of wings, 1 in.

Three specimens.

Allied to nothing I know of. A pretty insect with a peculiar greenish gloss.

40. *Eupithecia rigida*, n. sp. (Pl. I., fig. 6).

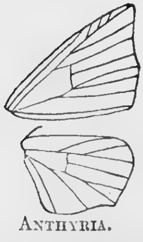
♂. Antennæ, palpi, head, body, and fore wings of a uniform dark brown pink colour; abdomen with a whitish dorsal line. Fore wings with ante-medial and discal very fine white sinuous transverse lines with white points, the first rather near the base, the second terminating on the costa in a small white patch; a submarginal indistinct sinuous line of white points, with a white spot near the hinder angle. Hind wings paler, with a discal whitish band, most distinct hindwards, and with some white marks at the anal angle; marginal line of both wings brown, with white points, and an interlined pale pinkish cilia. Under side pale greyish brown; costa pinkish up to the white spot, ending the outer band; the white spot near hinder angle distinct, and the other bands faintly visible. Expanse of wings, $\frac{8}{10}$ in.

Two specimens.

Allied to nothing I know of.

Anthyria, *Warren MS.*, gen. nov.

Type. *A. grataria*, Walker (*Hyria*), xxii., p. 663.



Anthyria.

♂ ♀. Antennæ heavily bipectinated in the male, simple in the female; palpi slight and upturned. Fore wing with the outer margin slightly angled at second median veinlet, the five subcostals stalked together, the fifth being emitted nearest the angle of cell, the first, second, and third at intervals before the apex; upper disco-cellular from the upper radial, lower from the middle of disco-cellular; second and third median from end of cell, first from before the end. Hind wing slightly angled at the second median veinlet, costal vein anastomosing with subcostal to near end of cell, the two subcostals stalked, radial from middle of disco-cellular, second and third medians stalked, the first from before the angle.

41. *Anthyria iole*, n. sp. (Pl. I., fig. 7).

♂. Ochreous; so densely irrorated with dark reddish brown atoms as to make the body and fore wings look of a dark reddish brown colour; abdomen with yellow segmental thin bands. Wings crossed by yellow lines, which are formed by the absence of irrorations; hind wings with the irrorations thick at the base and outer marginal portions. Fore wings with a straight inner line, inclining rather inwards from the hinder margin, a largish indistinct blackish spot at the end of the cell; a discal line, which runs from the costal third to the outer margin below the middle, then inwards to an angle, and then to the hinder margin near the hinder angle; submarginal and marginal lines in both wings close together, the former running inwards between the veins, forming large reddish brown marginal spots, the latter running in a little on the veins. Hind wings with a subbasal outwardly angled line and a discal line from abdominal margin at its outer third to outer margin below the middle, then up to costa near apex; nearly the whole space between these lines semidiaphanous, with a faintly marked spotted central band running through it; cilia of both wings pale yellow, with reddish brown patches. Under side with the portions of the wings that are irrorated above of a dull deep pink, an outer marginal band pale yellow, and the other more or less showing of that colour; body and legs pale yellowish, legs pink above. Expanse of wings, $1\frac{1}{10}$ in.

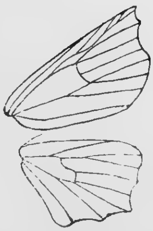
One example.

Allied to *A. grataria*, Guen., but very differently marked.

GONANTICLEA, gen. nov.

Type. *G. aversa*, mihi.

♂. Antennæ simple; palpi long, slender, and porrect. Fore wing highly excised below the apex, which is blunt; the first subcostal arises before the end of the cell, and gives off the second to anastomose with the third, fourth, and fifth; upper radial from end of cell, lower from middle of disco-cellulars; second and third medians from lower angle of cell, the first median from before the angle. Hind wing angled at the second median veinlet, the costal vein anasto-



GONANTICLEA.

moses with the subcostal to near end of cell, the subcostals stalked, the disco-cellulars angled, and giving off the radial from the angle, second and third medians from lower angle of cell, the first median from before the angle.

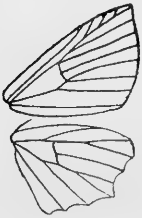
42. *Gonanticlea aversa*, n. sp.

♂. Pale pinkish brown. Fore wings irrorated with brown, and with brown bands; a broad band at the base, outwardly edged with whitish; a narrow band before the middle, upright, with its lower end nearly touching the basal band; a discal band, dark only towards the costa, limited on its outer side by a whitish line with blackish outer edge, which is elbowed outwardly below the costa, is somewhat sinuous, and curves inwardly below to the hinder margin; beyond this line, and rather close to it, is a discal sinuous and semidentated black line, which in some parts is double, a black mark at apex of wing, a brown marginal line, and an interlined cilia. Hind wings uniform pinkish brown, with a brown marginal line and an interlined cilia. Under side pinkish grey, striated with brown; the lower portion of fore wings and outer portion of hind wings suffused with brown. Expanse of wings, $1\frac{2}{10}$ in.

Twenty-nine specimens.

Polynesia, *Warren MS.*, gen. nov.

Type. *P. sunandeva*, Walker (*Pomasia*), xxii., p. 657.



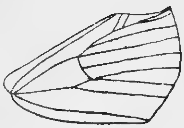
Polynesia.

♂ ♀. Antennæ of the male almost simple, palpi short and porrect. Fore wing pointed at apex, the five subcostals stalked together, the fifth being emitted nearest end of cell, the others at intervals before the apex; upper radial from the upper angle of cell, lower radial from the middle of disco-cellulars; the second and third medians from the angle of the cell, the first from before the angle. Hind wing somewhat triangular, the outer margin lunulate, and angled at the lower subcostal and second median, the costal anastomosing with the subcostal to near end of cell, the two subcostals stalked, the radial from the middle of disco-cellulars, the second and third median stalked, the first median from before the angle. Hind tibiæ with two pairs of spurs in both sexes.

43. *Polynesia truncapex*, n. sp.

♂. Yellow; thorax marked with chocolate-brown; abdomen banded with the same colour. Fore wings with the apex just as if it were cut off and convex. Both wings spotted with chocolate-brown, thickest on costa, where there is a dark ochreous tinge; smaller spots covering both wings in a fairly uniform manner in a number of irregular transverse rows; a spot or patch larger than the others in the middle of the truncated apex, one near the outer margin at its middle in the fore wings, and one on the centre of abdominal margin of hind wings. Under side whitish, with some of the spots on the outer margin showing through. Expanse of wings, $1\frac{1}{10}$—$1\frac{3}{10}$ in.

Fourteen specimens.



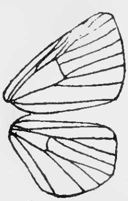
T. TRUNCAPEX.

Differs from the typical form, in the male having the apex of fore wing cut off, and the third and fourth subcostals bent downwards at the distortion; the first subcostal also arises separately, quickly to anastomose with the others, and the fifth subcostal is emitted near the angle of the cell, the disco-cellulars being also more oblique; the hind leg is weak and smaller than the others, and the tibiæ are without spurs.

GEOMETRIDÆ.

ŒNOSPILA, *Warren MS.*, gen. nov.

Type. *Œ. flavifusata*, Walker (*Thalera*), xxii., p. 596.



ŒNOSPILA.

♂ ♀. Antennæ bipectinated in the male, simple in the female; palpi porrect, the third joint very short. Wings broad, rounded, the outer margin scalloped; hind wing slightly angled at third median veinlet; fore wing with the first subcostal emitted before end of cell, the others stalked together, the second and fifth arising almost at the same point, the third near the apex; upper radial from the angle of cell, lower radial from above middle of disco-cellulars; the second and third medians from lower angle of cell, the first from before the angle; hind wing with the two subcostals stalked, the radial from just below upper angle of cell, the second and third medians stalked, the first from before the angle. The tibia of the male is swollen, and has only the median pair of spurs.

44. *Œnospila lyra*, n. sp.

♂. Grass-green, palpi testaceous; shaft of the antennæ white, plumes testaceous. Wings and body of a uniform grass-green. Fore wings with a large brown spot at the hinder angle, containing a white spot on the margin, but in some specimens this brown spot is small, and the inner white spot absent; costa silvery, with an inner brown border; both wings with a brown marginal line, whitish cilia with small brown patches opposite the veins, and two outwardly curved sinuous indistinct pale lines, with reddish brown points on the veins, the inner line of points including the dots at the end of each cell are always more indistinct than the outer or discal line of points. Hind wing with a small elongated brown mark on the outer margin at the apex, but this also varies, and is absent in some examples. Under side pale, nearly whitish, the patches visible; otherwise unmarked. Expanse of wings, $1\frac{2}{10}$—$1\frac{3}{10}$ in.

Many specimens; all males.

Allied to *Œ. (Agathia) scutuligera*, Butler.

HEMITHEA, *Dup.*, Lep., iv., p. 106 (1823).

45. *Hemithea idæa*, n. sp.

♂. Dull green; antennæ grey, whitish at base, top of head white; abdomen pinkish grey. Fore wings with a brown spot at end of cell, costal line reddish brown; three indistinct darker greenish grey transverse sinuous and semidentate bands; the first ante-medial, not visible on hind wings, second discal, third submarginal. Hind wings with a large discoidal white lunular mark, with a black dot in its centre on the inner side; both wings with a dark green marginal line, and with white dots on the veins. Under side whitish; both wings with a pink costa, and with pinkish suffusion on parts, and with a brown prominent marginal line disconnected by the veins; legs grey, fore legs brown above. Expanse of wings, $1\frac{2}{10}$ in.

Twenty-six specimens.

THALERA, *Hübn.*, Verz. bek. Schm., p. 285 (1816).

46. *Thalera acte*, n. sp. (Pl. I., fig. 13).

♂. Dull pale green; top of head and shaft of antennæ white, pectinations pinkish grey, and of this colour is also the abdomen. Fore wings with an indistinct white, outwardly curved, subbasal line of lunules; a submarginal white band of lunules, and between this and the margin are many short white streaks, and also a marginal series of white marks. Hind wings with an inner line, as on fore wings; a large white patch in the upper part of the disc, and submarginal lunular white line and white inner and marginal marks as in fore wings, but larger and more prominent. Under side pale greenish white, unmarked; legs and body pinkish grey. Expanse of wings, $1\frac{2}{10}$ in.

One specimen.

THALASSODES, *Guén.*, Phal., i., p. 356 (1857).

47. *Thalassodes liliana*, n. sp. (Pl. I., fig. 2).

♀. Of a uniform pale bluish green; antennæ and abdomen grey. Fore wings with the chief veins and veinlets broadly grey. Hind wing with the median vein and veinlets thinly grey. Both wings crossed by a post-medial, transverse, dentated grey line, more distinct in the hind than in the fore wings; costa of fore wings grey; ciliæ of both wings grey, with reddish brown base and tips. Under side pale greenish grey, unmarked; body and legs grey; fore legs reddish brown, with pale bands. Expanse of wings, $2\frac{1}{10}$ in.

One specimen.

AGATHIA, *Guén.*, Phal., i., p. 380 (1857).

48. *Agathia codina*, n. sp. (Pl. I., fig. 3).

♂. Bright pale emerald-green; palpi purple above, grey beneath, frons grey, head purple, antennæ purplish grey; thorax, abdomen, and wings bright green. Wings sparsely striated with pale purplish. Fore wings with the costa pinkish grey. Both wings with a dark purplish patch at the base, a purplish spot at end of each cell, and a broad purplish border with irregular inner margin, which occupies more than the outer third of the wings, is striated with dark brown, leaving a small green patch at apex of fore wings, and a large green space at apex of hind wings, where, the limit of the band inwards is indicated by a prominent thick blackish brown line; marginal line of both wings brown, cilia pinkish grey. Under side greenish white, with the cell-spots indistinct, and the outer purplish band, submarginal only, striated throughout, and widening on to the margin at the anal angle of hind wings; body and legs pinkish grey. Expanse of wings, $2\frac{3}{10}$ in.

Three specimens.

Allied to *Agathia gigantea*, Butler.

49. *Agathia gemma*, n. sp.

♂. Bright green; antennæ pinkish grey; thorax, basal half of abdomen, and both wings of a uniform bright green colour; apical half of abdomen brown. Fore wings with the costa pale pinkish, a dark purplish patch at the base; an upright slightly distorted medial band, another similar discal band, both purplish brown, the latter from the hinder angle to the costa, one-fourth from apex, and joined to the margin in the centre by a fine line, and similarly in two places below it. Hind wings with a discal straight band from the apex to the outer margin near anal angle, thickened at the two extremities outwardly, a small white patch below the lower thickening just above the tail; marginal line of both wings purplish brown; cilia pinkish grey, interlined with brown. Under side pale greenish white, with some of the bands showing through the wings; body and legs grey, fore legs striped with brown above. Expanse of wings, $1\frac{7}{10}$ in.

Three specimens.

This beautiful insect is allied to *A. hilarata*, Guén., is larger, and can easily be distinguished by the difference in the position and shape of the outer bands.

EPHYRIDÆ.

Anisodes, *Guén.*, Phal., i., p. 415 (1857).

50. *Anisodes lichenaria*, n. sp.

♂. Sand-colour, with a slight ochreous tinge. Fore wings with brown costa. Both wings sparsely irrorated with sandy colour, and with transverse irregular bands of the same colour on the fore wings; there is an internal band on both wings, a medial and discal band, followed by two submarginal bands; these bands are sinuous, and in some specimens are fairly regular, the outer ones being more or less dentated; but in other examples the bands are diffuse, and it is difficult to follow them; a pale dot at end of each cell, encircled by sandy brown; a pale brown marginal line and black marginal points. Under side whitish sandy colour; medial and discal lines or thin bands and marginal points. Expanse of wings, $1\frac{4}{10}$ in.

Five specimens.

Allied to *A. monetaria*, Guén.

51. *Anisodes intermixtaria*, n. sp.

♂. Pale sandy, tinged with pale pinkish grey, irrorated with minute brown atoms; a white dot in a brown ring at the end of each cell. Fore wings with an interior, both wings with middle and discal pale grey bands, all more or less outwardly dentated with black points at the tips of the dentations; submarginal and marginal similar bands without the black points, but there are black points on the outer margins, and black points at the base of the cilia opposite the centres of the interspaces. Under side whitish, with the central and discal bands thin, like lines, and with the black points to the discal band, and marginal and cilia points as above. Expanse of wings, $1\frac{2}{10}$ in.

Eleven specimens.

PERIXERA, *Meyrick,* Trans. Ent. Soc. Lond., 1889, p. 487.

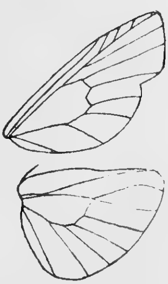
52. *Perixera pulverulenta,* n. sp. (Pl. I., fig. 8).

♂. Ochreous grey, irrorated with brown atoms, the irrorations packed together in the upper centre of fore wings, forming a suffused pale brown patch. Both wings crossed by an indistinct and incomplete grey sinuous discal line, with dentations and black points at their tips; a more or less dentated submarginal line; marginal black points and black points, at the base of the cilia; a small black ringlet at end of each cell. Under side whitish, with the cell-ringlets, discal and marginal points, and lines showing through. Expanse of wings, $1\frac{2}{10}$ in.

One specimen.

Allied to *P. obrinaria,* Guén.

STREPTOPTERON, *Hampson MS.,* gen. nov.



STREPTOPTERON.

♂. Antennæ heavily bipectinated; palpi with the third joint of moderate length and porrect. Fore wing with the apex rather pointed, the outer margin distorted and cut off, so that the lower radial reaches the apparent outer angle, and the three median veinlets reach the margin of a lobe formed by the inner half of the wing; the five subcostals are given off considerably beyond the cell, the fifth nearest the angle, the first, second, and third at intervals shortly before the apex; the upper disco-cellular is given off from the upper radial, the lower radial from above the middle of the disco-cellular, the third median from the lower angle of the cell, the first and second medians at intervals before the angle, and all three rather short and recurved to the distorted inner portion of the wing forming the lobe on the inner margin, submedian vein short. Hind wing very broad and ample, the costal vein somewhat curved, the two subcostals from the upper angle of the cell, the upper one being much curved, radial from the middle of disco-cellular, third median from lower angle of cell, the second and first median at intervals before the angle. Hind tibia with one medial and two distal spurs. The female will probably be found to have the normal shape, but the second median veinlet of fore and hind wings being given off before the end of the cell distinguishes this genus from any of the other forms which have the five subcostals of the fore wing emitted together, and which are at present included with many forms having a different venation in the genus *Anisodes*, which consists of a group of genera having similar palpi to the form described above.

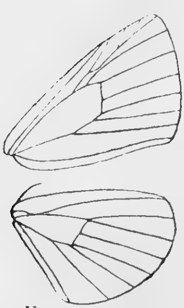
53. *Streptopteron posticamplum*, n. sp. (Pl. I., fig. 12).

♂. Of a uniform pale pinkish grey, thickly and uniformly irrorated with very minute pink atoms, with the exception of the disco-cellular area of the hind wing, which is white and unmarked. Fore wings with a curved prominent black patch near centre of hinder margin. Both wings with outwardly curved discal and marginal rows of black points on the veins; cilia slightly paler than the colour of the wings and unmarked. Under side pinkish white, not irrorated; some darker pinkish spaces on the costal and upper portions of both wings, with both rows of dots, the inner row with the points joined by a faint sinuous line; legs and body unmarked. Expanse of wings, $1\frac{3}{10}$ in.

One example.

A very curious-looking insect.

Erythrolophus, *Hampson MS.*, gen. nov.



Erythrolophus.

♂. Antennæ heavily bipectinated; palpi with the third joint short and porrect. Fore wing with the first and second subcostals arising together, the second anastomosing with the third and fourth to form the accessory cell, the fifth from the end of the accessory cell; the upper disco-cellular arising from the upper radial, the lower radial from the middle of the disco-cellular, the third median from the lower angle of the cell, the second from just before the angle, the first from two-thirds the length of the cell. Hind wing with the normal venation of *Ephyra* and *Idæa.* Hind leg aborted and small, the femur very slight, the tibia with only traces of a terminal pair of spurs, the tarsus short and weak, a tuft of long hairs arising from the femoro-tibial joint; this is a form of hind leg found in the males of many of the species of *Idæa*, such as *remotata* and *fibulata*, Guén., which have, however, no trace of terminal spurs; the palpi, however, of these species are small and upturned, and the antennæ fasciculated.

54. *Erythrolophus fascicorpus*, n. sp.

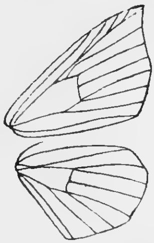
♂. Ochreous grey, with a pale pinkish tinge, irrorated with grey atoms; abdomen with a broad subbasal brown prominent band. Fore wings with a black spot at end of cell; hind wing with a black ringlet; fore wings with an internal outwardly curved sinuous thin grey band. Both wings with medial and discal dentated thin grey bands, the latter with black points at the tips of the dentations, submarginal and marginal bands, all the bands indistinct, marginal black points and black points at the base of the cilia. Under side paler than above, without irrorations, the inner portions of fore wings smeared with darker pinkish colour, all spots and bands visible, the outer margins having a prominent black line disconnected by the veins, with black spear-shaped prominent points in the cilia opposite the ends of the veins. Expanse of wings, $1\frac{4}{10}$ in.

Two specimens.

SYNEGIODES, gen. nov.

Type. *S. diffusaria*, Moore (*Anisodes*), P.Z.S., 1867, p. 641.

♂. Antennæ pectinated to three-quarters its length; palpi short and porrect; hind tibia with two pairs of spurs; fore wing pointed at apex; both wings slightly angled at the first median branch; fore wing with the first subcostal arising before end of cell, and emitting the second to anastomose with the third, fourth, and fifth; venation otherwise as in typical *Ephyridæ*.



SYNEGIODES.

55. *Synegiodes diffusifascia*, n. sp. (Pl. I., fig. 9).

♂. Ochreous grey, covered with grey irrorations; a white dot with black rings at end of each cell. Both wings crossed by two broad sandy-brown bands, first just before the middle, second discal, the latter has some black spots here and there on its inner edge, and two black spots or patches outwardly, one just above the middle, extending almost to the outer margin, and accompanied sometimes by a small spot or two near the margin above it, and the other within the band near the hinder margin, also occasionally accompanied by smaller spots near it; cilia with black points at its base opposite the ends of the veins. Under side whitish, tinged with yellow, irrorated with grey, with the bands blacker and more prominent than they are above. Expanse of wings, $1\frac{6}{10}$ in.

Many specimens.

Allied to *S. hyriaria*, Walker.

56. *Synegiodes histrionaria*, n. sp.

♂. Dark ochreous; shaft of antennæ and top of head pure white, as also is the frons; a white spot in a purplish ring at the end of each cell. Both wings irrorated with purplish-red atoms, and with red blotches and spots of the same colour. Fore wings with a subcostal streak of that colour from the base to beyond middle; a spot near hinder margin at its centre; two large discal oval blotches, one just above the middle, the other touching the hinder margin, connected together by a discal thin band; a marginal thin diffuse band, and all that portion of the wing smeared with reddish. Hind wings with an inner indistinct band passing the cell-spot; a discal row of dots, and the marginal space with many reddish marks, including two large spots, one near the centre, the other at the abdominal margin; cilia of both wings pale yellowish, with reddish spots at its base opposite the ends of the veins. Under side paler, with the bands and blotches showing. Expanse of wings, $1\frac{1}{2}$ in.

Many specimens.

Allied to *S. sanguinaria*, Moore; marked in a somewhat similar pattern, but of quite a different colour, *S. sanguinaria* being luteous, not ochreous, and all its blotches and markings are dull blood-red.

FIDONIDÆ.

Phyletis, *Guén.*, Phal., ii., p. 169 (1857).

57. *Phyletis prasonaria*, n. sp.

♂. Reddish, rather densely irrorated with very minute brown atoms; base of the shaft of the antennæ whitish. Fore wings rather broadly brown at the costa, with a broad smooth thin line which is slightly outwardly curved. Both wings with a similar medial line, and a sinuous submarginal line, also a brown and thin marginal line. Under side pale pinkish grey, with the central and outer lines. Expanse of wings, $1\frac{3}{10}$ in.

Twenty-one specimens.

CABERIDÆ.

ASTHENA, *Hübn.*, Verz. bek. Schm., p. 310 (1816).

58. *Asthena prasina*, n. sp. (Pl. I., fig. 10).

♂. Pale yellow, plumes of the antennæ grey, thorax grey, abdomen with grey bands. Wings with purplish grey markings. Fore wings most densely marked on the costal space, where there is also a suffusion of this colour. Both wings crossed by three irregular bands of distorted outwardly curved marks, the band in the disc being apparently double; a submarginal row and a marginal row of spots. Under side whitish, with some of the markings showing through. Expanse of wings, $1\frac{1}{2}$ in.

Forty-four specimens.

TERPNOMICTA, *Led.*, Verh. Zool.-bot. Ges. Wien., iii., pp. 175, 196, 199 (1853).

59. *Terpnomicta lala*, n. sp.

♂. Reddish ochreous; antennæ and costa of fore wings reddish brown. Fore wings with a faint interior transverse reddish brown line, not far from the base, and outwardly curved; another similar line before the middle, angled slightly outwards above its centre; a discal similarly coloured line from hinder angle to costa, one-fifth from apex, nearly upright, and connected with the outer margin by two similar lines, one near the hinder angle, and the other above the middle. Hind wings with two indistinct lines corresponding to the second and third lines of the fore wing. Both wings with brown marks on the outer margin; cilia long, with some indistinct brown patches. Under side paler, with the second and third lines distinct in both wings. Expanse of wings, $\frac{8}{10}$ in.

Five specimens.

With the second and third lines disposed somewhat as in *T. subtessellata*, Walker, but otherwise very distinct.

STEGANIA, *Guén.*, Dup. Cat. Lep., p. 270 (1844).

60. *Stegania crina*, n. sp. (Pl. I., fig. 14).

♂. Sand-colour, slightly tinged with ochreous, and irrorated with minute red atoms; antennæ and top of head reddish. Fore wings with the costa reddish, and both wings crossed by three reddish bands; first near the base, like a very fine line, nearly upright on fore wings, oblique on hind wings; second and third broader and more distinct; second in the middle, upright on fore wings, curving inwards near the outer margin on the hind wings to the abdominal margin just above the angle; third only on fore wings extending from hinder angle to costa one-fourth from apex; marginal line reddish, with brown points, darkest on hind wings. Under side as above, but without irrorations; a pinkish suffusion on fore wings, costal and marginal lines dark and prominent. Expanse of wings, 1 in.

One specimen.

IDÆIDÆ.

IDÆA, *Treitschke*, Schm. Eur., v., 2, p. 446 (1825).

61. *Idæa hampsoni*, n. sp.

♂. Varying from a uniform reddish colour tinged with ochreous to a uniform purplish red colour, irrorated with minute brown atoms; base of antennæ and space on head between pure white. Fore wings with a brown dot at end of cell. Hind wings with the spot at end of cell, varying in nearly every specimen as follows:— A, a simple brown spot, like in the fore wings; B, the white dots in a brown spot; C, three pure white similar spots; D, a large white spot ringed with brown; E, a very large white crown-shaped patch, marked internally with reddish; transverse lines grey and indistinct; a faint indication in some specimens of an interior line on fore wings. Both wings crossed by medial and discal sinuous lines; in one specimen the medial line is broad like a band, the discal line is more or less dentated, and in some specimens the dentations have blackish points to the tips; a pale submarginal line of lunular marks, marginal black points, and cilia with a pale basal line. Under side paler, without irrorations; lines visible. Expanse of wings, $1\frac{4}{10}$ in.

Seven specimens.

Mr. Hampson, after whom I have named this curious species, informs me that he has recently seen specimens from Sikkim with still larger white crown-shaped stigma to hind wings.

62. *Idæa albivertex*, n. sp.

♂. Pale reddish, irrorated with grey atoms; vertex of head white. Wings with a brown dot at end of each cell, transverse lines brown, sinuous, and indistinct. Fore wings with an interior line. Both wings with medial and discal lines, the latter also dentated; also a marginal brown line. Under side very pale grey, slightly tinged with reddish; wings with the cell-dots, discal, and marginal lines distinct, the discal line with black points at the tips of the dentations. Expanse of wings, $1\frac{3}{10}$ in.

Three specimens.

Allied to the preceding, also found in Sikkim; apparently does not vary.

TRICHOCLADA, *Meyrick*, Trans. Ent. Soc. Lond., 1886, p. 209.

63. *Trichoclada opsinaria*, n. sp.

♂. Pale greyish sandy colour, with a slight ochreous tinge, irrorated with grey; head black, vertex sandy, collar purplish. Both wings with a brown dot at end of each cell, bands pale reddish grey, an indistinct one before the middle on fore wings; both wings crossed by a central band, slightly sinuous from costa of fore wings beyond the middle to abdominal margin of hind wings, one-third from base; a discal sinuous band, which is dark and thin, and slightly dentated on fore wings, and indications of submarginal and marginal bands, marginal black points, and pale cilia. Under side pale, without irrorations; a brown suffusion on basal portion of fore wings, limited by a middle straight line, which extends on to the hind wings; cell-dots, discal line, and marginal line distinct. Expanse of wings, $1\frac{4}{10}$ in.

Nine specimens.

Allied to *T. externaria*, Walker, xxiii., p. 794, nec p. 782.

DESMOBATHRIDÆ.

TOSAURA, gen. nov.

Type. *T. falcipennis*, Moore.

♂. Antennæ with fasciæ of cilia; palpi short and porrect. Fore wing somewhat falcate at apex, the first subcostal emitted from the second, anastomosing with the costal, and then again with the second subcostal, which also gives off the third and fourth subcostals; upper disco-cellular from the fifth subcostal, one radial from the middle of the disco-cellular, third median from the lower angle of the cell, second and first medians at intervals before the end, submedian nearly straight. Hind wing with apex and outer margins rounded, the costal widely separated from the subcostal, and with the bar near the base slight, the two subcostals from the end of the cell, radial from the middle of the disco-cellular, third median from lower angle of cell, second and first medians at intervals before the end, a submedian veinlet.

Closely allied to (*Acidalia ?*) *impedita*, Walker, and more distantly to the genus *Zarmigethusa*, Walker.

64. *Tosaura falcipennis.*

Metabraxas falcipennis, Moore, Descr. Ind. Lep. Atk., iii., p. 266, pl. 8, f. 29 (1887).

Many specimens.

65. *Tosaura picaria*, n. sp. (Pl. I., fig. 16).

♂. Head and body ochreous; antennæ brown, thorax marked with blackish brown, abdomen with blackish brown bands. Wings white. Fore wings with cupreous brown bands, more or less macular; first at the base; second very broad before the middle, almost complete; third consisting of a large patch on the costa at the middle, and two or three small spots below it; fourth discal, composed of three rows of spots, suffused into a whitish patch near hinder margin, separated in the middle, the spots mostly connected together above; fifth marginal, similarly disposed, but consisting only of two rows. Hind wings with a few spots on costa, one at end of the cell, one or two small ones in the disc, and a number on or near the outer and abdominal margins; the spots largest by the anal angle. Under side as above, but paler. Expanse of wings, $1\frac{1}{2}$ in.

Numerous specimens.

ZERENIIDÆ.

HALTHIA, *Mén.*, Bull. Acad. Sci. St. Pet., iii., p. 107 (1859).

66. *Halthia nigripars*, n. sp. (Pl. I., fig. 1).

♂. Palpi, head, and body ochreous; antennæ, upper side of palpi, last joint, and both wings black; collar and thorax spotted with black; abdomen with centre and side rows of large black spots. Fore wings with some white marks at the base, and two small white patches, two large squarish white patches before the middle, and a band of six smaller ones across the disc. Hind wings with a large white space from the base filling the cell, an adjoining spot beyond, a basal space below median vein, and a discal band of squarish white spots, larger than those on the fore wings. Under side: wings as above, ochreous at their immediate base; body ochreous, abdomen with black bands, legs greenish grey. Expanse of wings, $2\frac{4}{10}$ in.

One specimen.

The wings are somewhat of the pattern of *Cystidia stratonice*, Cram, from Japan, with the outer band broken up into spots.

RHYPARIA, *Hübn.*, Verz. bek. Schm., p. 305 (1816).

67. *Rhyparia hamiltonia*, n. sp. (Pl. I., fig. 5).

♂. Antennæ, head, body, and fore wings purplish brown; abdomen with ochreous bands. Fore wings with pale veins, and with some transverse pale marks; a prominent white discal band, which does not quite touch the costa. Hind wings ochreous, with four bands of large round purplish brown spots, the spots smallest on the margin, and a similar band of spots on the ochreous cilia. Under side: wings as above; the band on fore wings is, however, ochreous, and not white, and the entire wing inwards from this band has an ochreous ground colour, with large purple-brown spots thickly disposed all over it; body ochreous, legs brown. Expanse of wings, $2\frac{4}{10}$ in.

One specimen.

Allied to *R. transectata*, Walker, but easily distinguishable by the broad white band on fore wings above.

ABRAXAS, *Leach*, Edinburgh Encycl., ix., p. 134 (1815).

68. *Abraxas khasiana*, n. sp.

♂. Antennæ and palpi brown, top of head and body ochreous, thorax with black spots, abdomen with two rows of black spots down each side, and two elongated black spots at the tip. Wings white. Fore wings with seven transverse bands of pale black spots, large and small, the first five rather close together, the fifth submarginal, with the fourth close to it, composed of large spots, leaving a small space across the disc free from spots; there is also a marginal row of spots touching the submarginal row, each spot touches a similar spot in the white cilia. Hind wings with a spot at end of cell, two or three on the abdominal margin, a discal row of larger spots, one near apex, one in the centre, and two or three near anal angle, and a marginal row of small spots; cilia white and unmarked. Under side: wings as above, abdomen with black spots down the centre, middle legs with a tuft of black hairs at their base, all the legs with black stripes. Expanse of wings, $2\frac{1}{10}$ in.

Three specimens.

The pattern is somewhat as in the *A. leopardina* group, but the wings are entirely devoid of ochreous markings.

PYRALES.

SICULIDÆ.

PHARAMBARA, *Walker*, xxxiv., p. 1274 (1865).

69. *Pharambara sphoraria*, n. sp. (Pl. I., fig. 17).

♂. Reddish, tinged with ochreous. Fore wings with some black costal marks. Both wings with fine reddish brown transverse striations, which in some places form indistinct transverse lines; a broad yellow marginal band, occupying the outer third of the wings, broader on the fore than on the hind wings, striated with reddish brown, and on the fore wings with a reddish brown tip at apex and a reddish brown subapical streak. Expanse of wings, $\frac{9}{10}$ in.

One specimen.

BOTYDIDÆ.

COPTOBASIS, *Led.*, Wien. Ent. Mon., vii., p. 429 (1863).

70. *Coptobasis ridopalis*, n. sp.

♂ ♀. Cupreous brown. Fore wing with a white spot ringed with brown in the middle of the cell, and a white lunule ringed with brown at the end; two transverse brown sinuous lines, one before the middle, somewhat near the base and nearly upright, the other discal, semidentate, curving deeply inwards below the middle and downwards, and slightly outwards on to the hinder margin. Hind wings with a small central white spot, touching the end of an inner brown line, which is a continuation of the inner line of fore wings; also a discal recurved semidentate line corresponding to the discal line of fore wings; cilia of both wings with white dots at its base. Under side pale greyish, shining; the outer line of both wings and lunular discoidal mark of fore wings visible; cilia with pale basal line and basal dots; legs silvery white, fore tibiæ with brown marks. Expanse of wings, $1\frac{2}{10}$—$1\frac{3}{10}$ in.

One pair.

Allied to *C. lunalis*, Guén.; differs in the outer semi-dentate lines on both wings, in the central white spot on hind wings, and differs altogether in the cilia.

MARGARONIDÆ.

GLYPHODES, *Guén.*, Delt. et Pyral., p. 292 (1854).

71. *Glyphodes prothymalis*, n. sp. (Pl. I., fig. 15).

♂. Antennæ, palpi, and body bright cupreous brown; palpi white beneath, and with some white marks above; head and collar with a white stripe along each side; fore part of thorax white; abdomen entirely white below, merely the upper portion brown, making it look as if it had a white stripe on each side. Fore wings cupreous brown, a large triangular white space at the middle, a larger triangular discal space, with a small white streak between, and another on the inner side of the first white space, a sub-marginal white thin band not touching the costa, and a white interlined cilia. Hind wings white, with a cupreous brown marginal band, and a white interlined cilia; all the white portions of both wings semihyaline. Under side: wings as above, but paler; body and legs white. Expanse of wings, 1½ in.

Eleven specimens.

PYGOSPILA, *Guén.*, Delt. et Pyral., p. 312 (1854).

72. *Pygospila tyres*, var. *cuprealis*. (Pl. I., fig. 4).

♂. Cupreous black; top of the head with some white marks; collar with a white mark on each side; thorax with some whitish hairs; abdomen with two rows of white spots above, and a row on each side. Fore wings with a white spot near base, two before the middle, four, sometimes five, discal, the uppermost the largest, and two subapical near the costa; these spots all semitransparent, and in transverse rows. Hind wings with an indistinct similar spot in the upper centre of the wing, another in the upper disc beyond, and some small indistinct spots in a submarginal row. Both wings with pale marginal line, dark grey cilia, tipped with white at the abdominal angle and margins of the hind wings. Under side pale greyish; wings with the spots showing through; body and legs nearly white. Expanse of wings, $1\frac{6}{10}$—2 in.

Five specimens.

A var. of *P. tyres*, Cram., the colour browner, the spots much smaller and fewer, and without any submarginal spots on fore wings.

HYDROCAMPIDÆ.

CATACLSYTA, *Hübn.*, Verz. Schm., p. 263 (1816).

73. *Cataclysta hapilista*, n. sp. (Pl. I., fig. 11).

♂. Reddish ochreous. Fore wings with the base grey, a subbasal spot, another parallel to it before the middle, both rather indistinct; a whitish indistinct longitudinal streak, a silvery white angled space at the costa, one-third from apex, a broad submarginal silvery white band, which stops short of the hinder margin, both margined with a fine black line; marginal line black; cilia pale, with a brownish band and white tips. Hind wings with the base grey, followed by a broad silvery white band, outwardly bordered by a brownish line; a fine black slightly sinuous discal line, a similar marginal line; cilia white, interlined near its base by a black line, forming two complete and two half-complete black ringlets above the middle. Expanse of wings, 1 in.

One specimen of this pretty little insect.

EXPLANATION OF PLATE I.

1. *Halthia nigripars*, ♂, n. sp., p. 16.
2. *Thalassodes liliana*, ♀, n. sp., p. 7.
3. *Agathia codina*, ♂, n. sp., p. 7.
4. *Pygospila cuprealis*, ♂, n. sp., p. 19.
5. *Rhyparia hamiltonia*, ♂, n. sp., p. 17.
6. *Eupithecia rigida*, ♂, n. sp., p. 2.
7. *Anthyria iole*, ♂, n. sp., p. 3.
8. *Perixera pulverulenta*, ♂, n. sp., p. 9.
9. *Synegiodes diffusifascia*, ♂, n. sp., p. 11.
10. *Asthena prasina*, ♂, n. sp., p. 13.
11. *Cataclysta hapilista*, ♂, n. sp., p. 20.
12. *Steptopteron posticamplum*, ♂, n. sp., p. 10.
13. *Thalera acte*, ♂, n. sp., p. 6.
14. *Stegania crina*, ♂, n. sp., p. 14.
15. *Glyphodes prothymalis*, ♂, n. sp., p. 19.
16. *Tosaura picaria*, ♂, n. sp., p. 16.
17. *Pharambara sphoraria*, ♂, n. sp., p. 18.

II. *Additional notes and observations on the life-history of* Atypus piceus. By Frederick Enock, F.E.S.

[Read November 4th, 1891.]

Since I had the honour of bringing before the Entomological Society my notes on this most interesting spider, I have been enabled to confirm all my previous observations, and to add a few additional facts.

The most difficult point in the life-history is to settle the age to which the female arrives before and after maturity, for, owing to various changes, I have not yet succeeded in keeping and watching one colony of spiders beyond seven years; but I am in hope of having a chance of establishing a fresh colony this spring in a locality where the spiders will not be disturbed, and where I can label and keep exact record of each nest.

One very interesting fact I have established in connection with the age of the female. On October 15th, 1883, I dug up a large tube containing female and her family, which I carefully reset in a large flower-pot, where, on March 16th, 1884, the young spiderlings commenced to emerge, and look about for suitable sites for their future dwellings. The maternal home or tube had been put into thorough repair in October, and no doubt the walls had been relined from top to bottom with new silken tapestry, a task a spider seems to manage better than the "British workman," in spite of having a family of upwards of a hundred baby spiders to look after. After this mother had started her brood on their own account, she repaired the small aperture made by the exit of the family, and then settled down to apparent ease, comfort, and perfect health, enjoying an occasional meal of a blow-fly, until May 1st, 1886, when I could not rouse her; and, on breaking open the tube, and digging up the lower part, I found her dead, after having lived in solitude for more than two years since turning her brood out. On October 29th, 1886, I put six females, with their broods of young, into various pots, the youngsters making their appearance on a warm, bright morning, April 20th, 1887, and the last widowed mother died April 14th, 1890, or close on three years after, a time sufficiently long for most spiders to become great-great-grandmothers.

Several of the offspring of these venerable females lived in health and strength for about two years, during which time they deepened their tubes several times in warm, moist weather, increasing the original diameter of a sixteenth of an inch to a bare eighth, also adding to the aerial part. One or two, after living in their tubes for two years, were found wandering about, and on May 9th had formed fresh tubes. The following August one colony was reduced to six tubes, and in another month the occupants had succumbed to the poisonous fumes from various ballast-heaps, which had been burning for several months. On digging up the tubes I found them to range from four to five inches long, and a little over an eighth of an inch in diameter.

On August 10th, 1888, I found one of the spiderlings, turned out April 25th, 1887, had thrown out from the aerial part of the tube its cast-skin, the first one seen after making its own tube; but the first *moult* of the young takes place in the hammock just before they break out into the maternal tube.

August 14th, 1888. Another of this brood had pushed out its cast-skin. May 16th, 1889, a two-year-old spiderling, in response to a *Chironomus* held to and kicking against the walls of the tube, came up, struck at and pulled the fly through, coming up a minute and a half later to repair the rent, which it did in a most finished manner.

May 23rd, 1889. Another two-year-old spiderling became dissatisfied with its abode, left it, and soon formed another of somewhat larger dimensions; and, later on, several of this brood did the same. I imagine the ground had become sour from imperfect drainage. Quite a number of the spiderlings commenced to deepen and enlarge their tubes in April; in fact, a general "spring cleaning" seemed to be going on all round.

On March 28th, 1890, I was pleased to find the young colony which I had established at Hampstead in 1886 were doing well, some of the tubes measuring a quarter of an inch in diameter, the forsaken mothers still in good health, and with wonderful appetites for blow-flies whenever held against the tubes. One of the ancient spinster females, which I placed in a bell-glass April 8th, 1885, actually pushed out a cast-skin, apparently quite a recent one.

June 1st, 1890. One mother of 1887 had made a beautiful new aerial portion to her tube, and took a blow-fly for lunch. On the 9th all were exposed to very heavy rain, which flattened their tubes down. Next day each one had added a brand new top part, some of their brood doing the same, fully confirming my previous observation, that rain induces the spiders to strengthen and lengthen their tubes.

One of these females had carried her tube against and up the side of the bell-glass, and this one I kept covered and darkened, so that I could occasionally watch her movements; and I frequently noticed that, when a blow-fly was held outside her tube, she approached in the most stealthy and cat-like manner, seeming to glide rather than walk along; but, if disturbed, she pressed her legs against her sides, and literally shot back and down the tube with lightning-like rapidity; this spider, on being exposed to the rain and light the next day, had so thickened the silken lining of the tube against the glass as to completely shut out further observations.

August 25th. Heavy rain again battered and flattened down all the tubes, which remained in this condition until the middle of September, when several commenced to deepen and throw out the sand, afterwards improving the aerial portions, no doubt in anticipation of the male's visit; but whether those females, which had already had one family, could produce another, is one of the facts I am anxious to settle. Some of these females had carried the aerial portions of their tubes to a length of 4 in. up the sides of the pots, but these were far surpassed by some found at Hampstead on September 7th, 1891, measuring respectively 4, 5, and 6, and one no less than 7½ in. above ground, carried up the almost perpendicular sand-bank, and quite resembling Dr. McCook's tree purse-web spider, *Atypus niger*.

On July 6th, 1891, I paid a visit to Portland Island, where the Rev. O. Picard Cambridge had found *Atypus Blackwallii*, or what was considered to be the British type. After a long ramble and search I was fortunate in finding a few tubes, which I dug up after considerable trouble, for the spiders carry them under the stones in old disused quarries, and then down for some depth among the grass-roots, rendering digging up without injury a most trying task. I examined the occupants most carefully, but could not satisfy myself that they were different to *Atypus piceus;* so sent some on to the Rev. O. P. Cambridge, who kindly replied, expressing his opinion that they were not *Atypus Blackwallii*, but agreed in every respect with his Bloxworth *A. piceus*, as well as with the specimens which I had sent to him from Hampstead. Some days after I had a good day's sport, and found this hitherto considered *rare* spider in the greatest profusion, the tubes in some spots surrounding every piece of loose stone; in one instance as many as fifteen large tubes around one piece of stone not more than a foot square! I also found quite a number of tubes containing the beautiful hammock of eggs, in every case slung up in the cavity on the upper side, never on the *lower*, a wise provision of Nature, for the lower side is the main thoroughfare, up and down which the spider runs to and from the aerial portion, thus avoiding treading upon the fragile hammock of eggs. Many of the eggs were found just hatching, others were more forward, and the young spiderlings had left their first suit of baby clothes in the hammock.

I was fortunate in finding a number of immature males in their own tubes, all of which were of one character—of about three-eighths of an inch diameter, seven or eight inches long, and parallel from top to bottom. The spiders, when turned out, were of a much lighter colour, and far more active than the females. These I placed in various pots, where they very soon settled down, making fresh tubes amongst the moss. On Sept. 6th I examined them, and found five had matured, one having only just cast its skin, being quite white and weak. All appeared much smaller than those found at Woking and Hampstead. I sent one to Rev. O. P. Cambridge for further identification; he replied that he was sorry to say they were identical with the others, viz., *Atypus piceus* of Sulzer. The following day (Sept. 7th) I went up to Hampstead, and found the largest mature male I have ever seen; besides the largest tube of a female, *viz.*, $15\frac{1}{2}$ in. long from top to bottom.

As regards the feeding habits of this spider, I have not much to add; but one interesting experiment might be mentioned:— On July 22nd, 1888, a warm, sultry morning, after heavy rain the previous night, all my home colony had distended their tubes, and made them as attractive as possible to all inquisitive flies. I caught one, and held it to the longest tube; the spider came up, seized it, and dragged it through and down. I quickly caught another blow-fly—held it to the same tube; the spider, coming up to repair the hole, but finding another fly there, she seized it and dragged it through the hole already made, and down to her larder. I immediately caught another blow-fly, and as quickly held it to the hole; and again the spider came up, seized it, and disappeared. I did the same up the garden for another blow-fly, and before the spider had returned another fly was ready for her, which she soon observed and seized. I returned to look for another blow-fly, and ran back with it, and for the fifth time the spider seized and dragged her prey down; and for the sixth time I ran to look for another meal, and back again in double-quick time. The spider did not keep me waiting long, and was evidently getting a little puzzled, and, like myself, *excited;* however, she took the fly, and I departed once more and managed to capture another victim, reaching the tube just in time to offer it. It was not refused, but snapped at and pulled down; and I hurried away and back again with one more fly, and the spider again accepted it with a snap of her jaws, retiring gracefully backwards, and I forwards to catch another blow-fly; this I did, and once more was in time for the spider, who seized this the ninth blow-fly with lightning-like rapidity, and disappeared. I ran and searched for another fly, but, as may be imagined, they had been so frequently disturbed that I had difficulty in obtaining one; and when I returned to the tube the wily spider had completely covered in the rent. I continued to knock with the blow-fly, and the spider came up, pulled the tube in, and *held* it, as much as to say, "I have had enough, go away"; and I went, wondering much what she would do with nine blow-flies. Next morning she had thrown five sucked skins out! The time occupied in this great repast was just 45 minutes.

On Sept. 7th, 1891, one of the very large tubes dug up contained a living beetle (*Nebria* —— ?) without any elytra, both apparently having been bitten off by the large female *Atypus*, which was dead, and its abdomen a heaving mass of minute maggots. I am inclined to think the *Nebria* had forced its way into the tube, and, not agreeing with the owner, they had come to, not blows, but *bites;* and I imagine the spider had managed to pinch off the elytra, and in return the *Nebria* had given the spider a fatal nip in its abdomen.

The various photographs illustrative of the life-history of *Atypus piceus* I have made from my original drawings.

III. *Notes on* Lycæna (*recte* Thecla) rhymnus, tengstrœmii, *and* pretiosa. By George T. Bethune-Baker, F.L.S.

[Read November 4th, 1891.]

Plate II.

Who that has worked at the Palæarctic *Lycænidæ* has not been struck by the anomalous position of *rhymnus*, *tengstrœmii*, and *pretiosa*. For some time the question has been in my mind, do they belong to *Lycæna* proper (as Staudinger's catalogue has it) at all? but until recently I have not had time to investigate the subject.

Rhymnus was described by Eversmann as *Lycæna rhymnus* in the Nouv. Mem. de la Soc. Imp. de Nat. de Moscou, Tom. ii., p. 350, tab. 19, 12, from the Ural district; Erschoff then followed suit, when he described *tengstrœmii* as a *Lycæna* in Fedtschenkoi Reise, p. 11; whilst, lastly, Dr. Staudinger did likewise with his *pretiosa*, in Stt. Ent. Zeit., xlvii. (1886), p. 209.

Now, a little careful examination of these species, and especially of *tengstrœmii*, should at once raise the thought, surely these are close allies of *Thecla lunulata;* in Erschoff's insect the white crescent-shaped spots of the under surface have only to be evenly joined to form the precise lunulated band found in that species, which is figured on the same page with *tengstrœmii.* The same remark applies equally to *pretiosa*, Stgr., specially to those specimens that have the markings somewhat reduced. In this respect the pattern of *rhymnus* is not quite so similar, though it does not require much imagination to trace it up; whilst it is most obviously a close ally of the other two insects, and is also totally diverse from the markings of any of the genus *Lycæna*.

A further link more recently came in my path in my examination of the ♂ generic organs of both these genera. When I first examined my preparations of *Thecla*, I was at once reminded of the three curious divergencies in *Lycæna* now under consideration, and leisure was the only thing required to enable me to make the necessary drawings, and so place the species in their correct genus. I have shown, at fig. 1, a profile view of the genitalia of *Lycæna pheretes;* this is very fairly typical of the shape of the majority of this genus, a distinctive feature of which is the well-developed clasp, from which arises a sort of forked guide or support, whilst the tegumen is developed into an eared hood at the extremity, attached to two longish slender arms, which arise at their juncture with the clasps. The hooks in this species are somewhat short and thick, but in many species of the genus they are rather longer and more attenuated, but never, in any of the specimens I have examined, are they so long and conspicuous as in *Thecla.* In this latter genus, or rather, perhaps, in the *w-album*, and the *sassanides, lunulata* groups, the clasps are reduced to a very considerable extent, it being most doubtful if they can be of any service in holding the consort; whilst the tegumen is largely developed, being rather tunnel-shaped, excavated at the top both back and front, whilst from front of the base arise the two hooks (one on each side), which are remarkably conspicuous in all these species. Moreover, in the genus *Lycæna*, there is always a kind of forked guide or support, having its origin in the clasps near their source, as already mentioned; this, I suppose, acts as a support or guide to the intromittent organ, and is quite wanting in *Thecla*, as also in *rhymnus, tengstrœmii*, and *pretiosa.* Again, the penis itself in *Lycæna*, after the style of that shown at fig. 1*a* (*pheretes*), is always short and thick, whilst in the group of *Thecla* we are now discussing it is long, rather elegant in outline, and with trumpet-shaped lips; in this respect also the three species herein specially considered follow the latter precisely.

At figs. 2 to 3*b* the genitalia of *Thecla sassanides* and *lunulata* are represented, the former a profile, the latter vertical from above; and before proceeding further it may be well to describe these organs, and also those of *Lycæna*, more in detail.

At fig. 2*a* will be seen the clasps of *Thecla sassanides*, which are quite diminutive, and probably of but little use for the function they are supposed to perform; they are roughly isosceles triangular in shape, with the base slightly bowed outwards.

The tegumen is figured alone at fig. 2; it is very considerably developed laterally, and is tunnel-shaped, excavated considerably at the top behind (*i. e.*, towards the head of the insect), and slightly in the front the sides are full, so that it might be described as being saddle-shaped; it is supported on, or more correctly arises in, two slender horizontally-inclined arms, and the clasp reaches but little further than to where these suddenly expand into the ample sides of this part of the organ. At the front of the base of the tegumen two large hooks (*c*) have their origin, which are bent backwards, and then make a bold curve to the front; they must be, I believe, freely moveable, and have probably been evolved to their present extent to compensate for the lack of power in the clasps.

The penis (fig. 2*b*) in this group of *Thecla* is extraordinarily long; it is, of course, tubular, becoming larger for the first third, from whence it rapidly tapers to its extremity, where it suddenly expands into a trumpet-shaped orifice.

The genitalia of *Lycæna* are shown at fig. 1, in profile; the lower portion *c* represents the clasps with the forked guide rising near their juncture with the arms of the tegumen (see also fig. 1*a*, showing them in a vertical position under pressure). It will be seen at once what an important part these clasps must play during the act of copulation; what a powerful grasp they would have. The tegumen *d* is very diverse from that of *Thecla*, being much more complicated; it arises in two somewhat vertical and slender arms, longer than the genus just named, and not horizontally inclined, whilst it is developed in the front into two longish projecting lobes *e* (= the uncus of Goss), at the base of which lobes the hooks *f* have their origin; these are in this genus, particularly in this species, very much stouter, broader, and shorter than in *Thecla*.

The penis (fig. 1*b*) is short and thick, slightly bulbous near the end, the tip of which tapers rapidly into a blunt point. Two strong teeth are emitted backwards from the bulbous portion of this instrument. At fig. 4 I have drawn the same organs of *tengstrœmii* in profile; they are from a large specimen designated by Staudinger v. *maxima*, and really require no explanation. They follow very closely the shape of *Thecla sassanides*, but are, of course, larger; they are also deeper and less excavated. The clasp 4 *a* is also very similar when compared with 2 *a*, whilst the intromittent organ 4 *b* assimilates in like manner to the *Thecla* shape.

At figs. 5 *a* and *b* appear these organs of *rhymnus*, which might almost be mistaken for unusually small organs of the preceding species. The clasp 5 *a* is not quite so like that of *T. sassanides*, but is curiously similar to that of *lunulata* (fig. 3 *a*). The penis is also the same shape as those we have already considered.

Pretiosa now alone remains to be examined, and in this species these organs bear an even closer resemblance to *T. sassanides* and *lunulata* than do the preceding, as will be seen on comparing fig. 6 with 2 and 3. The general outline of all these three species is very similar. The clasps of *pretiosa* (6 *a*) are very similar to *lunulata* (3 *a*), whilst the penis of the former (6 *b*) is very like both the two *Theclæ* just mentioned.

If it is considered necessary to produce further evidence to prove that all these species are congeneric, the neuration will do so. In the genus *Lycæna* there are eleven nervules in the fore wings, of which seven and eight (counting German fashion) are forked from a common stem. In *Thecla* there are but ten veins, none of which are forked. In *rhymnus*, *tengstrœmii*, and *pretiosa* the latter obtains, each having ten veins, all of which are unforked.

From these three facts I think we shall be amply justified in moving these three species from the genus *Lycæna*, and placing them in that of *Thecla*, their position in which will be immediately following *lunulata*.

Perhaps I may be allowed to take this opportunity to make an appeal to collectors of exotic Rhopalocera. I feel sure that the generic organs will often help in clearing up difficulties, where they occur, between species, and they are probably destined to play a not unimportant part in future classification. If, therefore, those who receive large collections of exotic butterflies would be so good as to let me have otherwise useless specimens, no matter how bad, so that they are absolutely correctly named (this is imperative), they would confer a great benefit on me, and just possibly on lepidopterists in general. I want to obtain some specimens of the various genera which might form a basis on which to work, and see if my conclusions, formed after examining nearly every species of Palæarctic *Lycæna*, and many other genera also, are correct; as, if so, there is no doubt but that the generic organs will prove of much value both generic and specific.

Explanation of Plate II.

Fig. 1.	*Lycæna pheretes;*	genitalia (less penis), profile *in situ.*
1 *a.*	,,	clasps, vertical under pressure.
1 *b.*	,,	penis.
1 *c.*	,,	clasps.
1 *d.*	,,	tegumen.
1 *e.*	,,	uncus.
1 *f.*	,,	hooks.
2.	*Thecla sassanides;*	genitalia (less penis and clasps), profile *in situ.*
2 *a.*	,,	clasps, profile.
2 *b.*	,,	penis, profile.
3.	*Thecla lunulata;*	genitalia (less penis and clasps), vertical view.
3 *a.*	,,	clasps, vertical.
3 *b.*	,,	penis, profile.
4.	*Tengstrœmii;*	genitalia (less penis), profile *in situ.*
4 *a.*	,,	clasps, profile.
4 *b.*	,,	penis, profile.
5.	*Rhymnus;*	genitalia (less penis), profile *in situ.*
5 *a.*	,,	clasps, profile.
5 *b.*	,,	penis, profile.
6.	*Pretiosa;*	genitalia (less clasps and penis), profile *in situ.*
6 *a.*	,,	clasp, profile.
6 *b.*	,,	penis, profile.

All the figures were magnified uniformly 38 diameters, but they have been reduced by one-half linear measurement to get them on to one plate.

IV. *The effects of artificial temperature on the colouring of several species of Lepidoptera, with an account of some experiments on the effects of light.* By Frederic Merrifield, F.E.S.

[Read December 2nd, 1891.]

I have on previous occasions proved that both the spring and the summer emergence of *Selenia illustraria*, and the one emergence of *Ennomos autumnaria*, are materially influenced in their *colouring* by exposure of the pupa in its penultimate stage,—that is, in the one immediately preceding that in which the colouring of the perfect insect begins to show,—to a moderate difference of temperature, *i. e.*, within the limits of 57° and 80° F., the lower causing the greater darkness, and an exposure for a few days at the higher temperature being sufficient for its purpose. I have also proved that the *markings* of the former of these species, and probably those of the latter, may be very materially affected by long-continued exposure of the pupa in its earlier stages to a much lower temperature, one of about 33°.

Similar experiments have now been made on both emergences of the other two English species of *Selenia*, viz., *S. illunaria* and *S. lunaria*, with entirely similar results as regards colouring. These results are least marked in *lunaria*, as perhaps might have been expected from the fact that that species is in England generally single-brooded, and, where double-brooded, does not manifest as much dimorphism as its congeners do.

With respect to these *Selenias*, I now exhibit examples taken from as many as fifteen separate "families"—a term which I here use, not in its zoological sense, but as a convenient one for describing the offspring of a single pair. As the facts have now been established, and it would be exceedingly inconvenient and perhaps tiresome to show the very long series that these fifteen separate families have given me—more than 500 individuals—I have on the present occasion limited myself, in the case of the *Selenias*, to a selection of typical examples. But, for the satisfaction of those who may not be conversant with all that has previously been established, it may be expedient to make the observations which follow, and which show the impossibility of ascribing the effects produced to any other cause than the temperature applied. I preface them with the remarks :—

(1). That the results lose much of their effect in consequence of being seen by artificial light. This reduces the effect in nearly all cases, and in some, where colour, and especially yellowish colouring, is concerned, makes a very great difference.

(2). That in all the *Selenias*, and in *autumnaria*, the under side is more affected than the upper; possibly this may have some significance in connection with the fact that these species, when at rest, expose only, or partly, their under sides.

(3). That in most of the species experimented on the male is more affected than the female; this, however, does not seem to be the case with *illustraria.*

(4). That the more vigorous and healthy the insect experimented on, the more strongly are the effects manifested on it.

Lunaria.—Two families, one of the spring, the other of the summer, emergence; 24 individuals. The markings of every one of those at the lower temperature are darker than those of any one at the higher temperature.

Illunaria.—Two families, one of the spring and one of the summer emergence, the former comprising 44 individuals, the latter rather more than 100. As to the former, I am not sure that all were from a single pair, but I think it nearly certain that they were so, for they came to me as a single lot, and where similarly treated show a close resemblance in appearance. These two families were exposed to several different temperatures—about 80°, 60°, 51°, and a somewhat lower temperature, *viz.*, that of the open air in winter and spring, emerging about April, when the temperature averaged little over 42°. Unless where the range of temperature was such as to cause little difference in colouring, which was the case as between some of the classes at the lower ranges, every individual which was kept at the lower temperature is darker than any which was kept at the higher temperature, with the exception of a few females, and these form no exception, if the under sides are looked to.

Moreover, when a considerable number of individuals, say, 10 to 20, were brought out at the moderately low temperature, the colouring as a whole, but not regularly, gradually darkens in proportion to the length of the exposure. I do not ascribe this directly to retardation, but to the fact that the physiological changes go on very slowly at the lower temperature; so that several weeks are necessary to produce as great an effect as several days at a forcing temperature would be sufficient for. A striking illustration of the delicacy with which the colouring responds when the temperature is applied precisely at the right time is afforded by the following circumstance. I had about a dozen of the summer emergence, which had been brought out at 80°, and, on looking them over after they were set, I noticed that three were decidedly deeper in colour than the rest. This perplexed me, until I remembered—and I found, on referring to my record, that I was right—that these three had been placed in the forcing-box at a separate time, and must have been more advanced when placed there, and consequently had been less exposed to the influence of the high temperature; for they occupied only from 3 to 5 days in emerging, instead of occupying 6 to 8 days, as the others did.

Of the spring emergence, it will be noticed that the first one was for as much as 14 days at a temperature of 80°, and it is much lighter than the rest of the family, which were not forced till February and March. It was one of six which were forced in November, the other five having died, an event which usually happens when the spring emergence is forced early in autumn.

Illustraria.—Five families, two of them (Families "T" and "R") of the spring emergence, comprising about 80 individuals. These were placed during their penultimate pupal stage at three different temperatures, *viz.*, at 80°, at about 60°, and out of doors (emerging April and early in May at a temperature averaging, during April, about 42°, or a little over). These last were generally darker than those at 60°. Every one of those at either of the lower temperatures is darker than any one of those at 80°, with the exception of one imperfectly developed specimen.

Three families ("I," "J," and "Red C") are of the summer emergence, and comprise more than 80 individuals. Each of these families was divided, and the divisions respectively placed at two different temperatures, *viz.*, at 80°, and at about 46°. Every one of those (rejecting a few cripples), mostly among those at the higher temperature, at 46°, is darker than any of those at 80°.

A sixth family, of the spring emergence (Family "U"), numbering about 20 individuals, was exposed to several different temperatures for varying periods. These show the same general results, but of course not so definitely as the others; moreover, they proved to be an unhealthy family, of which many died, or came out in a crippled condition. I exhibit typical specimens of each of these 6 families, also of 5 others, showing the same general results when exposed to similar conditions.

P. falcataria.—With an experiment on this I will conclude my summary of recent results, so far as concerns double-brooded *Geometræ.* I was supplied during the winter with a number of pupæ, which were very small and poor, as well as much tenanted by parasites, so that only 7 emerged. Three of these were placed, on the 19th April, at 80°, emerging in from 5 to 9 days, the others, left out of doors, appearing between the 21st and 29th May. With one doubtful exception those which emerged in the open air are manifestly darker and more strongly marked than any of those at 80°. I exhibit all.

V. urticæ.—In December, 1890, I exhibited a very dark specimen of this insect, the appearance of which I then thought, and have now no doubt, resulted from the exposure of its pupa to a temperature of about 47° for 5 weeks. I again exhibit this specimen, with a fair sample of 4 others of the same lot, all brought out at 80°, and emerging in about 6 days (Family "Y"). During the last summer I have experimented on three different families (or rather batches, each collected at the same time, and in similar localities). The first two, which I will call "V" and "L," were very kindly given to me by Mr. Vine; "V" about the end of June, to the number of more than 100. I was under the impression, derived from my experiments with the *Geometræ*, that any change in colouring would be produced during one of the later pupal stages, and therefore took no pains to place the pupæ while quite fresh in the refrigerator; and this may have been the cause of the comparatively slight effect produced on most of them, that effect becoming, however, decided when the exposure had been of long continuance. Twelve were forced, of which eleven, of very uniform appearance, emerged in from 5 to 6 days. I exhibit four of these, which are not extreme, but a fair sample. From 42, which emerged after an exposure to about 47° of from 2 to 58 days, and which, though varying *inter se* in a moderate degree, are in general but slightly darker than the forced ones, I have selected the five darkest, each of which is darker than any of those forced. Nine others, which emerged after an exposure of from 60 to 67 days, present a very different appearance from the rest, mostly darker. I exhibit four typical specimens of these.

The next family, which I call "L," were given to me at the beginning of September. These were mostly exposed within a few hours after pupation, eight of them were forced, and of these I have selected four fair samples. Of the remainder, placed at 47° for about 20 to 42 days, 17 emerged, and the great majority of these present a peculiar appearance, mostly in the direction of darkness. I exhibit the 10 most peculiar out of the 17.

Another family, fine pupæ not more than a few days old, were given to me by Mr. Fletcher on the 22nd September; a very late brood. These I call the "M" family. Five were placed at 80°, emerging in from 6 to 7 days, and I exhibit them all; 13 emerged out of doors in from 3 to 5 weeks at an average temperature of about 57°, and I exhibit the seven most strongly coloured and marked of these. Others were exposed to a temperature of about 47° for from about 3 to 7 weeks, and I exhibit all of those which emerged, four in number; they are very different from the others, the general tendency being to greater darkness.

The general observations I have to make on the results of the *V. urticæ* experiments are as follows: The effect of exposing this species to cold for a moderate period seems to be generally, not universally, slightly to darken the colouring, to lower the colour of the yellow parts (in one individual this is almost gone), and to intensify the contrasts of light and shade; to spread the dark portions, and especially the dark outer margins, and, above all, the blue crescents contained in these. I have examined some long series of *V. urticæ* in other cabinets, selected to represent all ordinary variations, and have scarcely, if at all, seen among them such conspicuous blue crescents as several of mine exhibit. The effect of exposure to cold continued for a period of from 8 to 9 weeks (or for a shorter period if exposed when the pupa is freshly formed) is more marked, generally in the increase of darkness. Further experiments must be tried on this insect, on which I am inclined to think the treatment most likely to produce darkness would be exposure for a considerable time from a very early pupal period to a temperature of about 50°.

I may add that I am well aware that my exhibits of *V. urticæ* would have been more effective had they been limited to a few extreme examples, but I have been desirous of imparting further knowledge than an exhibit so limited could have conveyed. Some of the most extreme specimens make a near approach to the var. *polaris* of Northern Europe.

Bombyx quercus and var. *callunæ*.—I have not been able to complete my experiments on these, but have obtained some results from temperature, and they are in the same direction as those obtained as to other species. To begin with the true *quercus* form, "*Family A.*" Some recent pupæ and nearly full-fed larvæ, all stated to be from the same hedge at Windsor, supplied to me by Mr. Edmonds in 1890, were placed at 80°, generally at about a week after "spinning up," but some certainly at a somewhat later stage. I produce seven that emerged in from 29 to 40 days; they are fair samples of the seven, and are, as will be seen, very light coloured. "*Family B.*" A second lot of 18 were sent me during last summer, also from Windsor. They were a particularly fine and healthy lot; some of them could not have been very recently "spun up," judging from the time when they began to emerge at the low temperature of about 47°, at which they were placed. Fifteen males emerged in from 39 to 71 days. The first was slightly crippled, owing to the want of proper provision for its reception. I produce the second at 40 days, and the fifteenth at 71 days. Both are, I think, rather dark, but the latest to emerge is substantially darker than the other, especially in its light parts. The 12 intermediate ones emerged in periods ranging from 40 to 70 days. These vary slightly, not darkening regularly, but there is on the whole a tendency, more particularly in the light band, to grow darker as the length of the period of pupation, and consequently of exposure to the low temperature, increases.

Var. *callunæ.* "*Family A.*"—A few sent from Aberdeen were placed at 80°, and two emerged in from 27 to 46 days. I exhibit these, which are a good deal lighter than usual, especially the female, which can scarcely, if at all, be distinguished from the southern form. Another *family*, "*B*," from Perth, similarly forced, produced three males and two females. These are darker, but light for *callunæ.* I produce a fair sample of each sex; the males exhibited are perhaps slightly lighter than the average of the three. Another, *family* "*C*," from Perth, was divided; five males and five females were forced at 80°, appearing in from 29 to 42 days, and I exhibit two pairs of these—fair samples—one of the males slightly lighter than the average of the five. Six males and nine females were placed in the open air, and emerged in June and early in July; these varied but little. I produce two pairs which emerged between 28th June and 1st July, fair samples of the 11, except that one male is slightly darker than the average of the six males. It will be seen that the males especially are darker than those which had been forced.

To sum up as to *quercus* and *callunæ.* The same general result which has been noticed in other cases obtains here; that is, those at the higher temperature are lighter than those at the lower temperature. This particularly applies to the males, the females varying less; but in both males and females the forced ones have a reddish tint, which is wanting in the others. In some cases the effect of temperature is so considerable that I think some of the forced *callunæ* would, so far as regards colouring, be classed as *quercus*, while the individual *quercus* brought out in 71 days at the lower temperature is very dark for *quercus*.

I think these experiments tend to show that the southern form and its northern var. are respectively varieties of so fixed a kind when they reach the pupal stage that it is probably only in exceptional instances, if at all, that temperature could convert the one form, so far as its appearance is concerned, into the other. But further experiments should be made, especially in the application of a low temperature to the southern form while freshly pupated. I believe temperature applied early in the larval stage has effected a complete conversion as regards habits, but I do not know whether it has had this effect on the colouring.

C. caja.—Dr. Chapman kindly sent me, at the beginning of February last, a batch of eggs which had been laid by a female in captivity. These I forced, and had from them more than 100 pupæ between the 12th and 24th March. Some of these were forced at 80°, some placed in the refrigerator at about 47°, a few more at 33°, and others at a temperature varying from about 50° to 60°. Those at 33° died after a time, those at 47° either died or emerged in a very crippled condition, many of those at 50° to 60° died, but of those at 80°, about 30, nearly all emerged, with no cripples. Unfortunately all but one of these last-named were males, while most of the others which emerged were females; so that the means of comparison are not so exact as might have been desired. Still, they show unquestionable differences corresponding with their treatment. In the fore wings of those forced the brown ground colour is paler, the colouring of the hind wings is a yellower orange, and their dark spots are smaller, and show a less tendency to coalesce. But the most striking feature is in the black bars across the abdominal segments; these, with scarcely an exception, are much longer and broader in the moths from the pupæ kept at the lower temperature than in those from the higher temperature. I exhibit three average samples of the forced males and the one forced female, and two males and two females of those at the lower temperature—average examples.

These experiments having indicated that *caja* flourishes under a high temperature, I placed some more pupæ, afterwards kindly sent me by Dr. Chapman, at the temperature of 80°—90°; the effect was to increase sensibly the pallor of the brown part of the fore wings, especially towards the outer margin, where the colouring assumes a clouded and blotchy appearance. I had five of these, and exhibit two of them, typical specimens, or only slightly paler than the average of the five.

Size and shape as affected by temperature in the pupal stage.—This is a subject I approach with some hesitation, because accidental circumstances have interfered with the completion of the crucial tests I meant to have applied, and which are now in progress; but the evidence is so strong that I do not like to delay calling attention to the point, with a view of, if possible, enlisting other observers, until the question shall have been decided by exact measurements. I think it is generally assumed that, once the pupal state is entered upon, the size and shape of the imago are fixed once for all (except where the wings afterwards expand imperfectly), and no doubt that is true to the extent that, in an insect of variable size, the size the larva attains is the chief factor in the size of the imago, and under ordinary circumstances the only one. But there is very strong evidence that the size may be affected by the circumstances surrounding the pupa. The impression that this is so can hardly fail to be gathered by any one who sees the long series I possess of insects differently treated in the pupal stage, and I think I may say that this is the impression actually produced on all my friends who have seen these long series. It is an effect which by no means appears to operate in the same direction in all species.

In the three *Selenias*, of both the spring and the summer emergences, those at 80° appear smaller than those kept at and under 60°; it seems to be the same in *falcataria*, as well as in *B. quercus* and its var. *callunæ*. In *V. urticæ* there appears little difference, if any, in the size of butterflies from pupæ at 80° and from pupæ at about 60°; but those from the pupæ kept at 47° are generally smaller. I may add that on consulting the record of experiments on *P. pharos*, as recorded in 'Weissmann's Studies in the Theory of Descent,' by Meldola, I find it stated that the butterflies from three pupæ which had been iced were sensibly smaller than the rest.

As to *shape*, I can only say at present that I think this is affected by temperature. I think that in the *Selenias* of which the pupæ were kept at the lower temperature, the fore wings are longer and more angular; but on this subject I am making some exact observations, and in the meantime venture to ask the attention to it of those who have the opportunity of investigation.

The general differences in size, and possibly in shape, are, I think, exemplified by the specimens I exhibit, which were selected solely for colour and markings.

Species not found to be affected by temperature.—It may be useful to mention the names of some species on the colouring of which I have not hitherto found any effect produced by the pupal temperature. They are the spring emergence of *P. machaon* and *P. podalirius* (both from Southern Spain), *Thais polyxena, A. paphia, D. vinula, T. orbona* (*comes*), and *B. cynthia*. *P. brassicæ* and *P. rapæ* are affected, but as yet I have seen no great effect produced on them. I think the *spring* emergence of *A. levana* is affected, but, so far as my opportunities have enabled me to judge, very slightly so.

Effect of light.—It has been suggested to me by members of this Society that light, especially about the time of emergence, might influence colour. I have therefore tried some experiments on the point. The first were with some of the spring emergence of *illustraria*: 32 of a healthy brood were on the 1st February divided as nearly as might be between the two sexes, and placed in lots of two pairs each on the sill inside the window of a rather large bedroom facing E.S.E., in which there was always a small fire night and morning. They were at a temperature generally ranging from about 46° to 57°, rising sometimes to 63° during sunshine. The pupæ were protected from direct sunshine. Seven lots of four pupæ each were placed in white jam-pots, their tops covered respectively with glass—clear, purple, blue, green, yellow, orange, and red; while an eighth lot was covered so as to be quite dark. Afterwards another lot of four pupæ from the same parents was similarly exposed, with no light admitted but such as came through a solution of bichromate of potash. Nearly all emerged uncrippled between 8th March and 6th April. I can find no appreciable difference between them in appearance.

Afterwards I tried the following experiments with *B. cynthia*:—On the 13th April, I took seven pupæ out of their cocoons, and laid them on the bare surface of some cocoa-nut fibre at the bottom of a very large flower-pot placed in a balcony facing E.S.E., covered with a sheet of glass, and the pupæ protected from direct sunshine. Seven others were treated in another flower-pot, side by side, with the difference that the pupæ were left in their cocoons, which were covered with tinfoil, and were also provided with long caps of tinfoil, excluding light, but capable of being pushed off by the moths in emerging, which happened. All the 14 emerged between the 3rd and 25th July, only one being a cripple. I have failed to see any difference of appearance between the two lots. I may add that I could not find any difference in colouring produced in this species by the difference of temperature between pupæ kept at 80°, and emerging in 5 to 6 weeks, and pupæ kept in the open air and emerging in about 4 months.

General speculations as to temperature effects.—Some of the results seem attributable to the cause that a particular temperature is more conducive to health and vigour than any other, and therefore may be expected to produce larger size and greater intensity of coloration, which, in insects of the colouring of those operated on by me generally, but not always, means greater darkness. The connection between "varieties" and "cripples" is well known. A temperature of about 58° or 60° in *V. urticæ* seems to be the one most conducive to brightness and intensity of colouring and marking. And a temperature of 47°, especially if long continued, seems to stunt its size, as well as to deaden its brightness, and to produce a large proportion of cripples. In *B. quercus*, and still more in its var. *callunæ*, a temperature of 60° appears more conducive to vigour than a higher one.

But this is quite insufficient to account for all the effects produced by temperature in the cases of *V. urticæ*, *B. quercus* (and *callunæ*), *C. caja*, and *E. autumnaria*. Apart from the changes of colouring that may be supposed to be dependent on vigour, there seems in all these species what may provisionally be called a direct* tendency in the lower temperature to cause darkness, either by obscuring the general colour or increasing the size and intensity of the dark markings, or by some or all of these combined. And in the seasonally dimorphic species, such as the *Selenias* (and probably in *falcataria* also), the intensity and darkness of coloration caused by temperature appear to be quite independent of health and vigour, for those which have been forced, whether of the spring or summer emergence, appear in every way as healthy and well developed, and as thickly clothed with scales, as those kept at the lower temperature.

* In using this term I should have excluded from its application such effects in the way of darkness as can be explained by Weissmann's theory that the low temperature causes reversion to a darker ancestral form: a subject adverted to by me in earlier papers.

I have only to add that, with the permission of the authorities of the Natural History Museum at South Kensington, my exhibits will be left there for a time, for the more leisurely inspection of all interested in them, and if any desire to examine the long series I have at home, these will be much at their service.

Note.—To correct misapprehensions it may be as well to state that though, where the temperature conditions are extreme, whether high or low, there is, as might be expected, a tendency to crippling, there is no such tendency whatever under more moderate conditions. In those species in which the effects are most marked, the *extreme* effects in colouring are produced by small differences of temperature, without causing any crippling or any trace of disease or unhealthy appearance. Rather a large proportion of those subjected to extreme conditions was exhibited, as they showed much individual variation, but out of 172 specimens exhibited fully 150 are quite uncrippled.

V. *On Variation in the Colour of Cocoons of* Eriogaster lanestris *and* Saturnia carpini. By William Bateson, M.A., Fellow of St. John's College, Cambridge. Communicated by Dr. David Sharp, M.A., F.R.S.

[Read December 2nd, 1891.]

It is well known that the cocoons of certain moths are sometimes dark brown and sometimes of various lighter shades of colour, being occasionally quite white. This variation is well known in the case of the Small Egger (*Eriogaster lanestris*), and the Emperor Moth (*Saturnia carpini*).

It has been suggested by Poulton* and others that these colours are of value as a means of concealment from enemies, and it has been stated by them that the variation in colour of these cocoons accords with that of the substances to which the cocoons are attached. In the place referred to, Poulton says:—"I found that caterpillars of this species (*S. carpini*) spun very dark brown cocoons in a black calico bag, while white cocoons were spun in white surroundings in a strong light. In this case it seems almost impossible for the surrounding colours to influence directly the colour of the cocoon. It is necessary to assume the existence of a complex nervous circle as a medium through which the stimulus of colour can make itself felt. . . . . The Rev. W. J. H. Newman showed that the cocoons of *E. lanestris* are creamy white when spun on white paper, dark brown when constructed among leaves. . . . . The fact that light reflected from green leaves is here the stimulus for the production of a dark colour is readily intelligible when we remember that the moth does not emerge till the following February at the earliest, while the insect often remains in the pupal state for one or two years longer. The leaves in contact with the cocoon soon die

* E. B. Poulton, 'Colours of Animals,' 1890, pp. 142—146.

and turn brown, and after this change the dark colour is highly protective. It is also of especial importance for the cocoon to be well concealed during the winter months, when insect-eating animals are pressed for food, and are obliged to search for it with extreme care." An experiment with *Halias prasinana* is then described, in which a larva which had begun to spin a *brown* cocoon on an oak-leaf was transferred to a white box, where it subsequently spun a *white* cocoon.

If it were really established that there is an intimate relation of this kind between the colour of the cocoon and that of the substances to which it is attached, the fact would be very surprising, and perhaps unparalleled. We have here to deal with a case not of a graduated resemblance between the general tint of the skin of an animal and that of the ground on which it lies, such as is found in many forms which are provided with contractile or moveable chromatophores (the Sole, *Sepia*, &c.), but of a resemblance between the colour of external objects and that of a secreted substance poured out upon them. The existence of such a phenomenon, if proved, would introduce new possibilities into physiology.

It is, of course, believed that this power of adapting the colour of the cocoon is a protection from enemies, and it is suggested that as such it may have arisen and been perpetuated by Natural Selection. To this view there is an objection which may be widely applied in like cases, but which in this one has particular force. The belief that the resemblance between the cocoon and adjacent objects protects the insect is based on expectation and not on evidence. If we ask from *what* enemies the insect is thus protected, we are told from insectivorous enemies; and here the matter must rest. There is as yet no direct evidence that a definite bird or mammal, for instance, has ever been seen to open a cocoon of *S. carpini* or *E. lanestris;* still less that any such animal habitually searches for these cocoons. In the case of *S. carpini*, at least, it may be plausibly argued that, so far as *a priori* impression goes, it is unlikely that these cocoons are sought by birds, for the wall of the cocoon is so tough that it must be difficult for most birds to pierce it. No doubt rats and mice could gnaw through them, but it is likely that these animals, which are for the most part nocturnal, depend for their supply of food at least as much on the sense of smell as on that of sight.

It may be remarked in passing that there is abundant evidence that the larvæ of these insects are infested by *Tachina*, and by hymenopterous parasites, and, as in other cases, probably these are really their most formidable enemies.

As to their enemies in the pupal state, there is no evidence. In the absence of such evidence it may be contended that any disquisition on the modes by which they may be protected from hypothetical enemies is premature. This, however, is a line of argument of which Mr. Poulton and the apologists of Adaptation are well aware, and to which they expose themselves avowedly.

The fact, however, that the colour of these cocoons varies in accordance with that of adjacent substances did not seem, in my judgment, to be established beyond possibility of question, and it was in the belief that some simple sources of error were not excluded that the following experiments were undertaken.

Eriogaster lanestris.—I. A large colony of these caterpillars were brought home, they being then about three-quarters grown, and fed in a large plain glass vessel till Aug. 15th. On that date the whole was examined, and 11 cocoons were found spun on leaves. Of these 6 were of full colour—

4 were dark, but not quite so full in colour.
1 was a good deal lighter, but still brown.

The dark colour is about the tint of black coffee, and the lighter specimen may be described as having the colour of strong tea with some milk it. It will be convenient to refer to this specimen for comparison, and its tint may be spoken of as "half-colour."

II. From this colony a number were chosen which seemed to be ready to spin. These were shut up in a white muslin bag full of torn, crumpled strips of white paper. Of these larvæ several died, but five survived, and all spun cocoons attached to the muslin, or to the white paper, or to both. Of these five—

3 were quite white.
2 were very pale cream-colour.

The paper and bag were bespattered with a brown juicy substance, which will be described later.

III. A number of apparently full-fed larvæ were similarly chosen and shut up in *dark* substances, and of these six survived and spun as follows :—

a. In black gauze, 1 specimen. Cocoon lighter than "half-colour."
b. On brown paper in green muslin bag, 2 specimens. Both quite white.
c. On brown dried leaves in a green muslin bag, 2 specimens. One white; one very pale cream-colour.
d. In the same bag of leaves as *c*; spun on the green muslin, 1 specimen. Cocoon white.

All these six cocoons, attached to dark substances, were of light colour. There was a good deal of brown evacuation, as in II.

IV. Two larvæ, which had begun to spin in leaves, were taken out and shut up in white paper. Both spun cocoons of light colour.

One larva, which had similarly begun to spin in a leaf, was taken out, and it eventually spun a white cocoon between green gauze and a piece of clear glass.

One larva, beginning to spin on white paper, was disturbed, and afterwards spun a white cocoon.

Therefore, of 4 larvæ which were disturbed while spinning, all spun light cocoons, 1 being on a dark substance, 3 being on white substances.

These results leave little room for doubt that the absence of colour in the cocoons results from an unnatural condition, such as disturbance at the time of spinning, or removal from food-plant when the growth is nearly complete. Besides these the presence of parasites should be mentioned as sometimes associated with a similar effect. This was seen once in a specimen of *E. lanestris*, and once in *S. carpini*, which were inhabited by a *Tachina*. In both these cases the cocoons were quite white. On the other hand, several *Tachinæ* were found in one *Saturnia* cocoon of *dark* colour. It will be seen, therefore, that though these observations fully confirm the statement that the larvæ do spin dark cocoons on the leaves, and white cocoons when confined in white paper, yet they suggest that the operating cause is the confinement and not the whiteness of the paper. The nature of the distinction between brown and white cocoons is discussed below.

V. From these experiments it appeared that light-coloured cocoons were produced when the larvæ were confined in white substances, and also when they were confined in dark substances, but that when left with their food the cocoons were dark. This result suggested that perhaps the alteration of colour was brought about by some unhealthy condition associated with the removal of the larvæ from their food. The four larvæ which had been disturbed whilst spinning also produced white cocoons, though one of them was attached to a dark object. From this it seemed likely that disturbance at the time of spinning might also be sufficient to prevent the cocoon from being properly coloured. It became therefore necessary to see what coloured cocoons would be spun by larvæ which of their own free will spun upon white paper. With this object the vessel in which the remaining larvæ were feeding was carefully filled with crumpled white paper, so that each twig of food (hawthorn) was more or less surrounded with paper. All the larvæ in this vessel chose to spin in the paper, and 15 cocoons were thus obtained. Of these 15 cocoons on white paper—

4 were of full colour.
6 were lighter than this, but still substantially brown.
4 were light, 3 of them being white.

Of the 3 which were white, one was spun by one of four larvæ which remained at the last, and were not fed owing to a mistake.

To recapitulate:—Of 11 larvæ left with their food, all spun dark cocoons on leaves.

Of 14 larvæ left with their food and white paper, 10 spun dark cocoons on white paper, and 4 spun light cocoons on white paper.

Of 11 larvæ which were shut up, all spun light cocoons, 5 being on white substances, and 6 being on dark substances.

Saturnia carpini.—Eleven cocoons found spun in the hedges in a state of nature were all of full colour.

Experiments made with larvæ of this species agreed generally with the results from those made on *E. lanestris*, but I found it difficult to obtain any considerable number of dark cocoons from *carpini* larvæ in captivity, even when they were left with their food, and disturbed as little as possible.

Fifteen larvæ, which were shut up in various dark substances, such as brown paper, black muslin, green muslin, &c., spun cocoons which were all light in colour, though attached to dark substances, several being quite white. No dark cocoon was spun by any larva thus confined.

Fifteen larvæ were fed in a large vessel on food surrounded with crumpled white paper, treated as the *Eriogaster* larvæ were in experiment V. Of these 15, only 7 spun dark cocoons; but of these, 3 were more or less attached to white paper, the remaining 4 being among leaves.

4 were light brown in colour, being attached to both twigs and paper.
4 were white or nearly so, being attached to paper and leaves.

From this it seems to be difficult to get conditions which are sufficiently healthy to enable the larvæ to spin dark cocoons, but it does not appear that the colour of the cocoons depends upon that of foreign substances.

Most of the bags and vessels in which the larvæ were confined were found to be bespattered with brown fluid similar to that which was seen in the case of the *Eriogaster*.

The colouring substance of the cocoons.—It has been mentioned that many of the larvæ of *Eriogaster* and of *Saturnia* evacuated a quantity of brown fluid substance. The tint of this fluid so closely matches that of the brown cocoons that it seems possible that their colour may be given to them by an outpouring of the brown fluid upon them. In view of this possibility the nature of this fluid is a matter of interest, and the following facts relating to it have a bearing on the question of the coloration of cocoons.

The brown fluid was found only in vessels in which large and presumably full-fed larvæ were living. In cases in which a larva was removed and shut up, it was generally present on the second or third day after removal, but there were several large patches of it in the large vessel in which the *Saturnia* larvæ were kept without disturbance. The fluid itself is viscous, and of a dark coffee-brown colour, closely resembling that of the cocoons. It generally contained some fœcal matter and particles of semi-digested food. From this, therefore, it may be concluded that the fluid is voided from the intestines, but I never saw a larva in the act of evacuating it. If this should be found to be the origin of the fluid, it may probably be looked on as being of the nature of "meconium."

The presumption that it is with this fluid that the cocoons are coloured rests on the following observations: A considerable number of larvæ, which were known to have voided the brown fluid, spun white cocoons. On the other hand, many spun white cocoons which were not known to have voided any fluid, though nevertheless they may have done so. Next, it was observed that some of the dark *Saturnia* cocoons, after they were just finished, were wet, as though drenched with brown fluid. Several also of the pale *Saturnia* cocoons had a darker patch in one part, generally upon the neck of the cocoon, though in one case there was a dark patch on the side. The appearance of these patches was exactly as if a quantity of brown fluid had been ejected upon the inside of the cocoon. In one case a brown cocoon of *Saturnia*, which was spun against a piece of white paper, lay on a large stain of the brown fluid; and there could be little doubt that the fluid had soaked through the cocoon on to the paper.

There is, then, good evidence that a brown meconial fluid is voided by caterpillars which are removed and shut up before they spin, and if it were to be established that the colouring matter of the cocoons is due, or largely due, to this fluid, the phenomenon of the colour-variation of cocoons becomes much simpler; for the cocoons of secluded larvæ are, on this hypothesis, white by reason of the previous voiding of the brown fluid, and the consequent absence of a supply of colouring matter.

It should be mentioned, as making against this view, that in the case of three *Eriogaster* larvæ, which were disturbed whilst spinning, and which afterwards spun white cocoons, it was almost certain that no brown fluid was previously voided. It is, of course, possible that the

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shock of disturbance may have led to a retention of the brown fluid, though this cannot be proved.

After these experiments were performed I received information that Mr. Poulton* and Prof. Meldola have shown that the cocoon of *Eriogaster* is largely made up of oxalate of lime, which is deposited on the first thin web of silk. There was no direct evidence as to the manner in which this substance is deposited, but it was believed to be voided from the intestine. This observation would thus to some extent give support to the suggestion here made, that the colouring matter of the cocoons is produced chiefly, if not altogether, from the intestine.

* In a paper read before the Physiological Society, not yet published (February, 1892).

VI. *On the classification of the* Geometrina *of the European fauna.* By Edward Meyrick, B.A., F.Z.S.

[Read February 10th, 1892.]

Plate III.

The general principles on which this paper is based are the same which I have employed in my paper on the classification of the *Pyralidina* (Trans. Ent. Soc. Lond., 1890, 429), and the introductory remarks which I have made there must be taken to apply here also.

Those species marked with an asterisk (*) I have not been able to examine critically in respect of structure, though in some instances I have seen specimens of them. I have not thought it necessary to attempt to give a complete catalogue of European described species, but those which I have omitted are either probably of doubtful specific value, so far as can be judged from the descriptions, or are so unsatisfactorily characterised that there is no clue to their affinity; hence only confusion would have resulted if I had attempted to place them, and in no instance is the value of any generic name affected.

GEOMETRINA.

Ocelli usually obsolete, but sometimes present. Tongue usually well-developed. Maxillary palpi obsolete. Fore wings with vein 1 *b* usually furcate, but lower fork more or less slender or tending to be obsolete, 5 rising not nearer to 4 than to 6, 7 and 8 out of 9 (7 apparently but not really separate in *Cataclysme*), 10 and 11 usually variously anastomosing, 11 from beyond middle of cell. Hind wings with frenulum developed, 1 *c* obsolete, 5 widely remote from 4, sometimes obsolete (*Selidosemidæ*), 6 and 7 stalked or approximated at base, 8 connected with or closely approximated to cell near base, thence diverging or anastomosing with or closely approximated to cell to near or beyond middle, or rarely to beyond origin of 7, occasionally connected with cell beyond middle.

The group is closely related to the *Notodontidæ;* so closely that it may be assumed to have been derived from an early form of that family. It does not appear that there is any direct affinity with the *Noctuina*, as is commonly supposed. The reduction in the number of abdominal pro-legs in the larva of some *Noctuina* is the only ostensible ground for such a supposition, and is of little value, as there is no reason why such reduction should not have occurred quite independently. In other essential characters there is no approximation between the two groups; particular stress is to be laid on the difference in origin of vein 5 of the fore wings.

The definition of the group has been framed above so as to exclude the *Strophidiadæ* (*Microniadæ*), which I formerly included in it; I have recognised that the genera placed in that family (*Strophidia*, *Stesichora*, &c.) are in essential characters identical with the group of genera called by Guenée *Uranides*, as well as with *Erosia*, *Syngria*, *Molybdophora*, &c., and also with *Asthenia* and its allies; the whole forming a single natural family (scarcely represented in the European region, but sufficiently numerous within the tropics), which has marked affinity with the *Geometrina*, but cannot be advantageously included with them. For this family I think the term *Uraniadæ* should probably be retained. The larvæ have usually the full number of ten pro-legs, though one or two pairs are said to be rudimentary in some instances.

In the *Geometrina* the larvæ almost always have the pro-legs reduced to four only. In a few cases there are six well-developed pro-legs, and rudiments of the other two pairs are occasionally present. Too much stress should not be laid on this character; for, although the deficiency of pro-legs very early became a fixed attribute of the group, and it is practically impossible for them to reappear in any of the more highly developed genera, yet in the more ancestral forms it is by no means unlikely that, when the larvæ are fully known, some may be found which retain the full primitive number.

The presence of the ocelli in a few species does not appear to have any generic value in this group. The prominence of the forehead also seems to be of little practical importance. The maxillary palpi are invariably obsolete. The labial palpi present hardly any structural variation, except in relative size, and in the greater or less development of the projecting scales or hairs clothing the second joint; the terminal joint is more or less cylindrical and obtuse, usually very short. The differences in the structure of the antennæ are simple, but always of some importance, though not as a leading character. As a general rule, where there are nearly allied forms with pectinated and simple antennæ, those with the pectinated antennæ are the earlier. In the fore wings vein 1 *a* is usually very short, and in some instances tends to be obsolete. Vein 1 *b* has normally a well-marked basal furcation of moderate length, but the lower branch of this fork is commonly much more slender, and tends to be obsolete; when there appears to be no furcation, it is because this branch has become quite obsolete, and the result is never (as in the *Pyralidina*) effected by the gradual shortening of the fork. Vein 1 *c* is obsolete. In the hind wings 1 *c* is also obsolete; 1 *a* and 1 *b* are normally present, but in a few instances, where absorption of the inner marginal area has taken place, 1 *a* seems to be absent. Vein 8 has a short but strong basal furcation.

Although in external structure there are but few characters available for generic definition (in comparison with the *Pyralidina*, for instance), the neuration affords abundant material. The structure of veins 5 and 8 of the hind wings affords an easy means of separating the group into families which are at once highly natural and easy to recognise. In the fore wings the remarkable differences in the structure of veins 10 and 11 are of considerable though inferior value; here, however, care has to be taken to eliminate the element of variability. The tendency to anastomosis of these veins with one another and with 9 or 12 is far more pronounced in this group than in any other, though by no means confined to it. The term *anastomosis* is used when two veins meet, coincide for a short or long distance, and separate again; *connection* when two veins are united by a transverse bar; and I use the latter term also to include those very frequent cases when the bar is so short as to be reduced to a point, so that the veins appear to touch at a point only; this is of course, in fact, the intermediate stage between connection and anastomosis. Although in the following diagnoses I have kept these two terms distinct, yet there is little essential difference between them; in some species connection and anastomosis occur indiscriminately in different individuals.

It is curious that authors have generally failed to recognise that *Brephos* is a true member of this group. On the other hand, a few species of other groups are sometimes referred here. The following have been erroneously classed with the *Geometrina*, and will not be found amongst my genera:—

oranaria, Luc. Classed by Staudinger under *Sterrha*; it belongs to the *Arctiadæ*, near *Emydia*.

apicipunctata, Christ. Referred by its author to *Acidalia*. If I have correctly identified this species, it belongs to the *Uraniadæ*, and approaches *Erosia* and *Eversmannia*.

exornata, Ev. The genus *Eversmannia*, founded on this species, is closely allied to *Erosia*, and belongs to the *Uraniadæ*. The larvæ of *Erosia*, I may mention, are like those of ordinary *Noctuæ*, and have the 10 prolegs fully developed; I have bred them myself.

erasaria, Christ. This species, which I have not seen, is referred by its author to *Eversmannia*, and may be presumed to be rightly placed there.

guttata, Christ. The genus *Sericophara* is founded on this species; I have not seen it, but from the neural characters given by its author there cannot be the least doubt that it belongs to the *Noctuina*.

dentistrigatæ, Alph. The genus *Imitator* (a bad name) is founded on this species; figures of the neuration are given, which make it perfectly clear that this also belongs to the *Noctuina*.

oreophila, Stgr. (undescribed ?). This species, received as a Geometer under the generic name of *Fergana*, is, in fact, a species of *Stilbia*, usually referred to the *Noctuina*, though an anomalous form; at any rate, it has no relationship to the *Geometrina*.

Tabulation of Families.

1. Hind wings with 5 imperfect or obsolete ..	6. Selidosemidæ.
Hind wings with 5 fully developed	2.
2. Hind wings with 5 rising much nearer 6 than 4	5. Geometridæ.
Hind wings with 5 rising from about or below middle of transverse vein	3.
3. Hind wings with 8 connected with cell by an oblique bar towards base	3. Orthostixidæ.

Hind wings with 8 not connected with cell by bar near base	4.
4. Hind wings with 8 very shortly anastomosing with cell near base, thence rapidly diverging	4. STERRHIDÆ.
Hind wings with 8 approximated to or anastomosing with cell to middle or beyond	5.
5. Hind wings with 8 free or shortly anastomosing with cell near base only	2. MONOCTENIADÆ.
Hind wings with 8 anastomosing with cell to beyond middle, or connected with it by bar beyond middle	1. HYDRIOMENIDÆ.

It seems to me that at present clearness and intelligibility is best attained by treating all these six groups as equivalent families; they are in practice all easily separated by structure, and are also without doubt natural groups which are conveniently discussed as wholes. But the distinctions between families 2—5 are of a less marked character, less absolute, and tend more to be destroyed by intermediate gradations; and there would be much to be said for treating these four as subfamilies of one family (*Geometridæ*), to be accorded equal rank with the other two, the *Hydriomenidæ* and *Selidosemidæ*. I conceive it to be a question of convenience, and a matter of judgment rather than of fact, and probably the most careful students may be found to hold various opinions on the point.

1. HYDRIOMENIDÆ.

Fore wings with vein 10 rising separate, anastomosing with 11 and 9, or rising out of 11 and anastomosing with 9. Hind wings with vein 5 fully developed, 6 and 7 almost always stalked or from a point, 8 anastomosing with upper margin of cell from near base to beyond middle, or sometimes approximated only and connected by bar or shortly anastomosing beyond middle.

The peculiar anastomosis of vein 8 in the hind wings is highly characteristic of this family; it does not exist in the same form in any other family of the Lepidoptera, save in the case of one or two exceptional genera. It is occasionally so far modified as to be represented only by a connecting bar beyond middle of cell; this structure, occurring especially in the males of the *Lobophora* group, is clearly caused by a tendency to lateral expansion of the wing, which takes place usually in compensation for the absorption of a considerable portion of the inner marginal area in forming the characteristic lobes or pockets of that group. Even in this modified form it is almost equally peculiar, though of course a connecting bar nearer base is common. The constant and uniform anastomosis of veins 9, 10, 11 of fore wings also affords a very distinctive feature, equally absolute though less exclusive; it has the effect of producing a constant auxiliary cell, which in the generic descriptions of this family is termed the areole; when 10 and 11 rise separately, the resulting areole is double; when they are coincident towards base, it is simple. The combination of these well-marked characters with the ordinary structure of the *Geometrina* renders the family particularly easy of recognition. Also, as in all cases forms possessing the simple areole must necessarily have originated in the first instance from forms with the double areole (the reverse process is obviously impossible), and forms with the connecting bar in the hind wings from forms with complete anastomosis (in this case the retrograde change is certainly quite possible, but not very probable, and I have not detected any instance of it), considerable assistance is given towards determining the order of development of the genera.

The tongue is well-developed in all European genera, and is therefore not specially mentioned.

In one European genus (also in one or two exotics not closely related to it, and I have recorded an instance occurring abnormally in the case of one individual of an exotic species)* the posterior wall of the areole is wholly absent through obsolescence; this causes the neuration to appear very different, as it would seem that vein 7 is quite separate from 8 and 9, whilst 10 seems to rise out of 9, and 11 to anastomose with 9, or if the areole was simple, to rise also out of 9. If this structure had only occurred in a single instance, it would have been very puzzling; there is, however, no doubt that it has originated in the way described, and it is particularly necessary to have a right conception of the process, as it would otherwise be an unaccountable exception to an absolute character of the whole of the *Geometrina*. The sudden disappearance of a portion of a vein is still very curious and unusual, and probably depends on some physiological fact at present unappreciated.

* Proc. Linn. Soc. N.S. Wales, 1890, 825.

Structural variation within specific limits is in this family slight; the principal diversity is in the origin of vein 6 of the fore wings, which frequently rises either out of 9, or separate, in different individuals of the same species; this occurs more or less in nearly all the genera, and is therefore not specially mentioned in the diagnoses.

The family is a dominant one, and contains a very great number of species, spread all over the world. The uniformity of structure throughout these is remarkable, and their systematic classification is proportionately difficult. Probably *Lythria* is the oldest European form of the family, though the New Zealand genus *Notoreas* is still more ancestral, and in fact fulfils all the requirements of the primitive type. This must be derived from a genus closely approaching, or even perhaps identical with, the Australian *Oenone* in the *Monocteniadæ*, to which in Europe *Brephos* is the nearest approximation. From *Notoreas* springs immediately the *Xanthorhoe* group, and also through *Dasyuris* the *Hydriomena* group. From the latter the four groups typified respectively by *Tephroclystis*, *Lobophora*, *Eucestia*, and *Asthena*, are given off as so many diverging branches, which are themselves again variously branched. A linear arrangement of the genera of course cannot display this relationship effectually, but the main features are set forth above, and the natural affinities of the other genera constituting the various groups are explained under their respective heads.

Tabulation of Genera.

1. Posterior wall of areole absent	23. Cataclysme.
Posterior wall of areole present	2.
2. Posterior tibiæ without median spurs	3.
Posterior tibiæ with all spurs present	4.
3. Hind wings in ♂ with inner marginal lobe ..	2. Trichopteryx.
Hind wings in ♂ without lobe	11. Gymnoscelis.
4. Areole simple	5.
Areole double	17.
5. Fore wings with vein 11 running into 12 ..	6.
Fore wings with vein 11 free from 12	7.
6. Fore wings in ♂ with rough projecting hairs on costa	9. Phrissogonus.
Fore wings in ♂ without rough hairs on costa	10. Chloroclystis.

7.	Hind wings in ♂ with inner marginal lobe ..	3. Mysticoptera.
	Hind wings in ♂ without lobe	8.
8.	Antennæ in ♂ pectinated	9.
	Antennæ in ♂ simple	14.
9.	Thorax hairy beneath; palpi with long rough hairs	35. Lythria.
	Thorax glabrous; palpi rough-scaled	10.
10.	Hind wings in ♂ with inner marginal fold ..	8. Tyloptera.
	Hind wings in ♂ without inner marginal fold ..	11.
11.	Face forming an obtuse prominence	31. Rhodometra.
	Face not forming a prominence	12.
12.	Hind wings without frenulum (?)..	6. Leptostegna.
	Hind wings with frenulum present	13.
13.	Face with projecting scales	32. Asaphodes.
	Face without projecting scales	29. Venusia.
14.	Antennæ in ♂ ciliated with long fascicles; ♀ semiapterous	28. Operophtera.
	Antennæ in ♂ shortly and evenly ciliated; ♀ winged	15.
15.	Face flat, smooth	27. Euchœca.
	Face rounded, with more or less projecting scales	16.
16.	Abdomen with small segmental crests	12. Tephroclystis.
	Abdomen not crested	22. Plemyria.
17.	Antennæ in ♂ pectinated	18.
	Antennæ in ♂ not pectinated	21.
18.	Antennæ in ♂ bipectinated	19.
	Antennæ in ♂ unipectinated	14. Palæoctenis.
19.	Hind wings in ♂ with inner marginal lobe ..	1. Sparta.
	Hind wings in ♂ without lobe	20.
20.	Face flat, smooth	30. Ochodontia.
	Face rounded, with more or less projecting scales	33. Xanthorhoe.
21.	Hind wings in ♂ with inner marginal lobe ..	4. Lobophora.
	Hind wings in ♂ without lobe	22.
22.	Thorax with horny anterior prominence ..	25. Pelurga.
	Thorax without horny prominence	23.
23.	Hind wings in ♂ with basal inner marginal ridge and pocket	24.
	Hind wings in ♂ without basal ridge and pocket	26.
24.	Anterior tibiæ hooked	16. Eucestia.
	Anterior tibiæ not hooked	25.
25.	Hind wings with vein 8 separate, connected by bar	15. Schistostege.
	Hind wings with vein 8 anastomosing with cell	17. Carsia.
26.	Hind wings in ♂ with deep inner marginal furrow above	27.
	Hind wings in ♂ without inner marginal furrow	28.
27.	Inner marginal furrow with large lateral hair tuft	18. Calocalpe.

Inner marginal furrow without hair tuft ..	5. BESSOPHORA.
28. Thorax hairy beneath; palpi with long rough hairs	34. DASYURIS.
Thorax glabrous; palpi with projecting scales	29.
29. Fore wings in ♂ with hair-pencil beneath along vein 1 *b*	21. EUSTROMA.
Fore wings in ♂ without hair-pencil on vein 1 *b*	30.
30. Fore wings in ♂ with streak of spreading hairs clothing submedian fold beneath	20. LASIOGMA.
Fore wings in ♂ without submedian streak of hairs	31.
31. Abdomen in ♂ with anal claspers extremely large, exserted	19. PHILEREME.
Abdomen in ♂ with anal claspers normal ..	32.
32. Face flat, smooth	33.
Face rounded, with more or less projecting scales	34.
33. Hind wings in ♂ with vein 3 absent	7. LYGRANOA.
Hind wings in ♂ with all veins present ..	26. ASTHENA.
34. Abdomen with segmental crests throughout ..	13. EUCYMATOGE.
Abdomen not crested, or at most on one or two basal segments	24. HYDRIOMENA.

1. SPARTA, *Stgr.*

Face smooth. Palpi porrected. Antennæ in ♂ bipectinated to apex. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings in ♂ much reduced, with inner marginal lobe forming a pocket; 2 in ♂ absent, 8 connected to cell by bar, cell short.

A development of *Lobophora;* it appears to have distinct affinity with the South American *Dyspteris.* It contains only one South European species.

paradoxaria, Stgr.

2. TRICHOPTERYX, *Hb.*

Face smooth. Palpi short or long, porrected, rough-scaled. Antennæ in ♂ filiform, shortly ciliated. Thorax glabrous beneath. Abdomen sometimes crested. Posterior tibiæ in both sexes with median spurs absent, in ♂ sometimes with long hair-pencil. Fore wings with areole double. Hind wings in ♂ with folded lobe on inner margin, neuration more or less distorted; 6 and 7 sometimes separate, 8 in ♂ connected by bar with cell near apex, or rarely with 7, or as in ♀, in ♀ anastomosing with cell from near base to beyond middle, or rarely as in ♂.

A limited genus, immediately developed from *Lobophora;* it occurs throughout the temperate regions of the northern hemisphere. The modification of the structure of vein 8 of the hind wings in the ♀ of some species, so that it resembles that of the ♂, may be regarded as an instance of the transference through inheritance of secondary sexual characters. The converse in the ♂ may be simply retention of an original character, or reversion. The occasional separation of veins 6 and 7 (very rare in this family) is obviously due to the same tendency to lateral expansion which, as noted above, has modified the structure of vein 8, to compensate for the area absorbed by the folded lobe.

viretata, Hb.
appensata, Ev.
**ustata*, Christ.
carpinata, Bkh.
**expressata*, Christ.
sertata, Hb.
sabinata, H.-G.
polycommata, Hb.

3. Mysticoptera, n. g.

Face with short cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ filiform, minutely ciliated. Thorax glabrous beneath. Abdomen crested. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings in ♂ with doubly folded lobe on inner margin; 2 absent in ♂, 8 in ♂ connected with cell by bar beyond middle, in ♀ anastomosing with cell from near base to beyond middle.

Contains only the following species at present, inhabiting Central and Northern Europe; it is a development of *Lobophora*.

sexalisata, Hb.

4. Lobophora, *Curt.*

Face smooth or with short cone of scales. Palpi moderate or short, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Abdomen crested. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings in ♂ with more or less developed folded lobe on inner margin, neuration sometimes distorted; 6 and 7 sometimes separate, 8 anastomosing with cell from near base to beyond middle.

A small genus, occurring in Europe and North America; its identification in other regions is not yet certainly made out.

halterata, Hufn.
externata, H.-S.
**internata*, Püng.

5. Bessophora, n. g.

Face smooth. Palpi short, porrected, rough-scaled. Antennæ in ♂ filiform, minutely ciliated. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings in ♂ with deep hairy furrowed fold along inner margin on upper surface, absorbing dorsal half of wing; 8 connected with cell by bar about middle.

Includes only the following East Asiatic species. It is nearly related to *Lobophora*, and may probably be a modification of it. Christoph has described the genus under the name of *Ptychoptera*, which is, however, preoccupied in the Diptera.

Staudingeri, Christ.

6. Leptostegna, *Christ.*

Palpi very short. Antennæ in ♂ shortly bipectinated. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings without frenulum (?).

The above incomplete characters are taken from Christoph, as I have not been able to obtain a specimen. I judge that the genus is probably a good one, and referable to this neighbourhood, but I should expect that the ♂ would show some additional structure which has been overlooked in the hind wings, and think that the alleged absence of the frenulum requires confirmation. The single species is East Asiatic.

**tenerata*, Christ.

7. Lygranoa, *Butl.*

Face smooth. Palpi moderate, porrected, shortly rough-scaled. Antennæ in ♂ with two minute processes on each side of each joint, emitting long fascicles of cilia. Thorax glabrous beneath. Fore wings with areole double. Hind wings in ♂ with vein 3 absent, 6 and 7 separate, 8 connected with cell by bar beyond middle (in ♀ probably normal).

Certainly a development of the *Lobophora* group, but its exact affinity is at present doubtful. I have not seen the posterior legs, which are broken in my type, or the ♀. The ♂ shows neither lobe nor fold on the inner margin of the hind wings, but the differences in neuration from the normal type of the family probably indicate that it is descended from a form possessing some such structure, and that whilst having lost the structure itself, it has retained the abnormal neuration, which was in the first instance induced by the presence of the structure. The single species is from Eastern Asia and Japan.

fusca, Butl.

8. Tyloptera, *Christ.*

Face with hardly projecting scales. Palpi rather short, porrected, rough-scaled. Antennæ in both sexes bipectinated, apex simple. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings in ♂ with inner margin folded over above, veins 2 and 7 (?) absent (Christ.); 8 anastomosing with cell from near base to beyond middle in ♀.

I have only seen the ♀; the characters of the other sex are taken from Christoph. He alleges that the frenulum is absent, and possibly in the ♂ it may be so, but in the ♀ is certainly present. Probably the genus has some near affinity with *Bessophora*. If the Japanese *bella*, Butl., is identical, there is but one East Asiatic species.

eburneata, Christ.

9. Phrissogonus, *Butl.*

Face with short cone of scales or smooth. Palpi moderate or short, porrected, more or less rough-scaled. Antennæ in ♂ ciliated or naked. Thorax glabrous beneath. Abdomen slightly crested. Posterior tibiæ with all spurs present. Fore wings in ♂ with swelling or tuft or rough scales on costa, vein 5 sometimes distorted or absent; areole simple, 11 running into 12. Hind wings with vein 8 anastomosing with cell from near base to beyond middle.

A genus of half-a-dozen Australasian species, from which the above characters are drawn; the following little-known South European species, which I have not seen, must be nearly allied to these, and is probably congeneric. Rambur described it under the generic name *Thysanodes*, which is, however, preoccupied in the Coleoptera. It is an offshoot of *Chloroclystis*.

**phryganea*, Rbr.

10. Chloroclystis, *Hb.*

Face with short cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated shortly (in exotics sometimes fasciculate-ciliated or naked). Thorax glabrous beneath. Abdomen crested. Posterior tibiæ with all spurs present. Fore wings with areole simple, 11 running into or anastomosing with 12. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A development of *Tephroclystis*. It is a very natural genus, and is even recognisable superficially by the peculiar form of the posterior edge of the median band, and the strong tendency to a green coloration, which is not found in its near allies. It is especially characteristic of New Zealand, where there are at least 8 species, and there is another in Australia ; it has not yet been certainly identified elsewhere. I described it under the name of *Pasiphila*, being then unacquainted with Hübner's genus.

coronata, Hb.
rectangulata, L.
chloerata, Mab.
debiliata, Hb.
**agilata*, Christ.

11. Gymnoscelis, *Mab.*

Face with short cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Abdomen crested. Posterior tibiæ in both sexes without median spurs. Fore wings with areole simple, 11 sometimes anastomosing with or running into 12. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A small genus, probably overlooked, but containing several Malayan and Polynesian species. It is an offshoot of *Tephroclystis*, with near collateral relationship to *Chloroclystis*. The structure of vein 11 is variable within the limits of the same species ; in the European species it is sometimes free, sometimes anastomoses with 12.

pumilata. Hb.

12. Tephroclystis, *Hb.*

Face with short cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Abdomen more or less distinctly crested throughout. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle.

This large genus is especially characteristic of the European region; a few species occur in North America, but elsewhere it is hardly known to exist. It is certainly a development of *Eucymatoge*, which indicates the transition from the *Hydriomena* group. The structural variation in the genus is very small; the abdominal crests and frontal scale-cone are sometimes very slight. Only in one abnormal specimen of *T. isogrammaria* have I observed a very short anastomosis of vein 11 with 12; this was probably a mere sport, but in any case remains quite distinct from the structure of *Chloroclystis.*

venosata, F.
**silenicolata*, Mab.
expallidata, Gn.
distinctaria, H.-S.
extraversaria, H.-S.
campanulata, H.-S.
minutata, Gn.
absinthiata, Cl.
assimilata, Gn.
pimpinellata, Hb.
actæata, Wald.
alliaria, Stgr.
**zibellinata*, Christ.
valerianata, Hb.
albipunctata, Hw.
vulgata, Hw.
**gratiosata*, H.-S.
oblongata, Thnb.
subfulvata, Hw.
**subtiliata*, Christ.
satyrata, Hb.
**eynensata*, Grasl.
rivulosata, Dietz.
veratraria, H.-S.
**subpulchrata*, Alph.
pulchellata, Stph.
linariata, F.
digitaliaria, Dietz.
**luteostrigata*, Stgr.
**limbata*, Stgr.
laquæaria, H.-S.
abietaria, Göze.
breviculata, Donz.
**gueneata*, Mill.
succenturiata, L.
**biornata*, Christ.
castigata, Hb.
lariciata, Frr.
virgaureata, Dbld.
**undosata*, Dietz.
denticulata, Tr.
**subsequaria*, H.-S.
**tribunaria*, H.-S.
graphata, Tr.
scriptaria, H.-S.
**Mayeri*, Mn.
**riparia*, H.-S.
**italicata*, Gn.
ultimaria, B.
**minusculata*, Alph.
cerussaria, Ld.
fenestrata, Mill.
**pernotata*, Gn.
cauchyata, Dup.
immundata, Z.
plumbeolata, Hw.

isogrammaria, H.-S.
pygmæata, Hb.
tenuiata, Hb.
silenata, Stdfs.
trisignaria, H.-S.
selinata, H.-S.
conterminata, Z.
indigata, Hb.
**nigritaria*, Stgr.
massiliata, Mill.
**sextiata*, Mill.
constrictata, Gn.
altenaria, Stgr.
subciliata, Gn.
pusillata, F.
**cocciferata*, Mill.
abbreviata, Stph.
dodoneata, Gn.
exiguata, Hb.
**exactata*, Stgr.
**lentiscata*, Mab.
irriguata, Hb.
glaucomictata, Mn.
**extremata*, F.
**despectaria*, Ld.
insigniata, Hb.
designata, Stgr.
hyperboreata, Stgr.
**nobilitata*, Stgr.
fraxinata, Crewe.
innotata, Hufn.
tamarisciata, Frr.
euphrasiata, H.-S.
**gemellata*, H.-S.
lanceata, Hb.
insignata, Stgr.
mnemosynata, Mill.
phœniceata, Rbr.
oxycedrata, Rbr.
**rosmarinata*, Mill.
**unedonata*, Mill.
sobrinata, Hb.
**pauxillata*, Rbr.
**ericeata*, Rbr.
**Schmidii*, Dietz.
helveticaria, B.
scopariata, Rbr.
**littorata*, Const.
**santolinata*, Mab.
artemisiata, Const.
nanata, Hb.
**albofasciata*, Stgr.
**Sydyi*, Stgr.
extensaria, Frr.
**furcata*, Stgr.

13. Eucymatoge, *Hb.*

Face with short cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Abdomen more or less distinctly crested throughout. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

With the exception of two Australian species, I have not absolutely identified this genus outside the European region, but it probably occurs more widely. It is in its nature transitional, and passes into *Hydriomena* by slight gradations.

sinuosaria, Ev.
suboxydata, Stgr.
**lepsaria*, Stgr.
**saisanaria*, Stgr.
**unitaria*, H.-S.
impurata, Hb.
millefoliata, Rössl.
**spissilineata*, Metz.
subnotata, Hb.
**amplexata*, Christ.
scabiosata, Bkh.
nepetata, Mab.
togata, Hb.
sparsata, Tr.
aquata, Hb.
vitalbata, Hb.
tersata, Hb.
corticata, Tr.
**scotosiata*, Gn.
æmulata, Hb.
**lucillata*, Gn.
**calligrapharia*, H.-S.
**incurvaria*, Ersch.

14. Palæoctenis, n. g.

Face subprominent, with somewhat projecting scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ unipectinated to apex. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings in ♂ with a transparent basal spot near inner margin, bordered beneath by a membranous bladdery ridge, forming small pocket on lower surface; 8 connected with cell by bar near angle.

A development of *Eucestia*. The uniserial pectinations of the antennæ are unique in this family; in the *Monocteniadæ* they are very common, and possibly a tendency to reversion may be indicated here; there is certainly no direct relationship. The single species is North African. The genus was named *Heteropsis* by Guenée, but that name is preoccupied in the Lepidoptera by Westwood.

testaria, F.

15. Schistostege, *Hb.*

Face rather prominent, with somewhat projecting scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings in ♂ with a transparent basal spot near inner margin, bordered beneath by a membranous bladdery ridge, forming small pocket on lower surface; 8 connected with cell by bar near angle.

Also a development of *Eucestia*. It contains only the two following species, characteristic of South-east Europe.

decussata, Bkh.
nubilaria, Hb.

16. Eucestia, *Hb.*

Face forming a more or less strongly developed obtuse prominence. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Anterior tibiæ very short, with strong apical horny hook; posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings in ♂ with a transparent basal spot near inner margin, bordered beneath by a membranous bladdery ridge, forming small pocket on lower surface; 3 and 4 sometimes stalked in ♂, 8 anastomosing with cell from near base to beyond middle, or in ♂ sometimes connected with cell by bar beyond middle only.

The principal member of a well-defined group originating from *Hydriomena*. It is characteristic of the European region, but extends into India.

spartiata, Fuesl.
**linogrisearia*, Const.
rufata, F.
flavicornata, Z.
griseata, Schiff.
farinata, Hufn.
**luminosata*, Christ.
**distinctata*, Christ.
**amœnata*, Christ.
bosporaria, H.-S.
duplicata, Hb.
**castiliaria*, Stgr.
excelsata, Ersch.
Staudingeri, Ersch.
**senata*, Christ.
erubescens, Stgr.
columbata, Metz.
lithoxylata, Hb.
mundulata, Gn.
boisduvaliata, Dup.
plagiata, L.
numidaria, H.-S.
præformata, Hb.
**fraudulentata*, H.-S.
obsitaria, Ld.
**opificata*, Ld.
simpliciata, Tr.
**fraternata*, H.-S.
**perpetuata*, Ld.

17. Carsia, *Hb.*

Face prominent. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings in ♂ with a transparent basal spot near inner margin, bordered beneath by a membranous bladdery ridge, forming small pocket on lower surface; 8 anastomosing with cell shortly beyond middle.

The single species, ranging throughout the colder regions of Northern Europe, Asia, and America, only differs from *Eucestia* in the absence of the tibial hook.

paludata, Thnb.

18. Calocalpe, *Hb.*

Face with cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Posterior tibiæ in ♂ sometimes densely rough-scaled above, with all spurs present, but in ♂ very short. Fore wings with areole double. Hind wings in ♂ with deep fold along inner margin beneath, containing large lateral hair-tuft posteriorly; 8 anastomosing with cell from near base to beyond middle.

A development of *Hydriomena.* Although a small group, it ranges throughout Europe, Northern Asia, and North America.

flavipes, Mén.
**varia*, Hed.
**Christophi*, Hed.
**veternata*, Christ.
certata, Hb.
**exultata*, Christ.
montivagata, Dup.
undulata, L.

19. Philereme, *Hb.*

Face with cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Abdomen in ♂ with anal claspers extremely large, exserted. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A development of *Hydriomena;* at present restricted to the two following species, which extend through Central Europe to Eastern Asia.

vetulata, Schiff.
rhamnata, Schiff.

20. Lasiogma, n. g.

Face rather rounded-prominent. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings in ♂ beneath with a streak of long dense spreading hairs clothing submedian fold from base to near hind margin; areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A development of *Hydriomena*, with some collateral relationship to both the preceding and following genera. Besides the two following Asiatic species, the Japanese *lucicolans*, Butl., belongs to it. Staudinger has described the genus under the name of *Trichopleura*, which is, however, preoccupied in Pisces.

palæarctica, Stgr. (?=*undulosa*, Alph.).
**atrostrigata*, Brem.

21. Eustroma, *Hb.*

Face with cone of scales or almost smooth. Palpi moderate or rather long, porrected, rough-scaled. Antennæ in ♂ ciliated, sometimes serrate-dentate. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings in ♂ with strong hair-pencil lying near inner margin from base beneath, sometimes partially clothing 1 *b*; areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

Also an offshoot from *Hydriomena*, characteristic of the European region and North America.

tibialis, Esp.
reticulata, F.
prunata, L.
pyropata, Hb.
associata, Bkh.
populata, L.
testata, L.
Ledereri, Brem.
roessleraria, Stgr.
convergenata, Brem.
ludovicaria, Oberth. (=*tigrinata*, Christ.).

22. Plemyria, *Hb.*

Face with slight cone of scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A genus of some extent and very wide range, most numerous in South America, elsewhere subordinate to *Hydriomena*, of which it is a development. The connection is very close, and the terminal European species must be extremely near the ancestral form; hence the genus probably originated in Europe.

coloraria, H.-S.
Haberhaueri, Ld.
bicolorata, Hufn.
hastata, L. (=*thulearia*, H.-S.).
luctuata, Hb.
**funerata*, Hb.
**fulminata*, Alph.
tristata, L.
rivata, Hb.
sociata, Bkh.
galiata, Hb.

23. Cataclysme, *Hb.*

Face with more or less slightly projecting scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated, sometimes dentate. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double, but posterior wall absent between 7 and 8. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A close development of *Hydriomena*, not at present known to occur outside the European region.

virgata, Rott.
**intersecta*, Stgr.
uniformata, Bell.
riguata, Hb.
comparata, Stgr.

24. Hydriomena, *Hb.*

Face with more or less slightly projecting or loose scales, or with conical tuft. Palpi moderate, porrected or subascending, rough-scaled. Antennæ in ♂ ciliated, rarely dentate or naked. Thorax often crested, glabrous beneath. Abdomen not crested, or with crests on two basal segments only. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A very large genus, principally characteristic of temperate regions in both hemispheres. In so large a number of species there is naturally some slight structural variation in most details, but the gradations are so slight that I have not been able to subdivide the genus further; and, as here restricted, it is not, in fact, so large as to be unmanageable.

ocellata, L.
simulata, Hb.
variata, Schiff.
juniperata, L.
cupressata, H.-G.
sagittata, F.
fulvata, Forst.
dotata, L.
Fixseni, Brem.
agnes, Butl. (=*festinaria*, Christ.).
Danilovi, Ersch.
pauperaria, Ev.
depeculata, Ld.
picata, Hb.
**ludificata*, Stgr.
miata, L.
siterata, Hufn.
sordidata, F.
trifasciata, Bkh.
literata, Don.
truncata, Hufn.
immanata, Hw. (prob. =præc.).

destinata, Möschl.
capitata, H.-S.
silaceata, Hb.
**chlorovenosata*, Christ.
corylata, Thnb.
guriata, Emich.
suffumata, Hb.
fluidata, Ld.
**cuprearia*, H.-S.
frustata, Tr.
**obvallata*, Ld.
tophaceata, Hb.
achromaria, Lah.
alpicolaria, H.-S.
cæsiata, Lang.
infidaria, Lah.
flavicinctata, Hb.
cyanata, Hb.
nobiliaria, H.-S.
**intermediaria*, Alph.
**vallesiaria*, Lah.
**sandosaria*, H.-S.
**senectaria*, H.-S.
verberata, Sc.
**ibericata*, Stgr.
incultaria, H.-S.
**impunctata*, Stgr.
nebulata, Tr.
**approximata*, Stgr.
casearia, Const.
corollaria, H.-S.
incertata, Stgr.
pulchrata, Alph.
sabaudiata, Dup. (=*taochata*, Ld.).
**Oberthueri*, Hed.
dubitata, L.
pervagata, Christ.
rogata, Stgr.
badiata, Hb.
nigrofasciaria, Göze.
**alhambrata*, Stgr.
rubidata, F.
berberata, Schiff.
cuculata, Hufn.
permixtaria, H.-S.
hortulanaria, Stgr.
albicillata, L.
alaudaria, Frr.
mandschuricata, Brem.
adæquata, Bkh.
transversata, Thnb. (*lugubrata*, Stgr.).
molluginata, Hb.
unangulata. Hw.
minorata, Tr.
tæniata, Stph.
unifasciata, Hw.
alchemillata, L.
affinitata, Stph.
hydrata, Tr.
**lugdunaria*, H.-S.
decolorata, Hb.
albulata, Schiff.
niphonica, Butl. (=*suavata*, Christ.).
procellata, F.
**basochesiata*, Dup.
malvata, Rbr.
**putridaria*, H.-S.
**adumbraria*, H.-S.
**filaria*, Ev.
scripturata, Hb.
**kalischata*, Stgr.
bistrigata, Tr.
bilineata, L.
**confusaria*, Stgr.
albostrigaria, Brem.
plurilinearia, Moore. (=*unistirpis*, Butl.).
defectata, Christ.
fluviata, Hb.
cæspitaria, Christ.
polygrammata, Bkh.
lapidata, Hb.

25. Pelurga, *Hb.*

Face with hardly projecting scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ shortly ciliated. Thorax with horny rounded prominence anteriorly, crested posteriorly, beneath glabrous. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A special modification of *Hydriomena;* the single species ranges through Central Europe to Eastern Asia.

comitata, L.

26. Asthena, *Hb.*

Face smooth. Palpi short, porrected, slender, loosely scaled. Antennæ in ♂ shortly ciliated. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A genus of a few scattered species, most numerous in the Australian region ; it rises directly from *Hydriomena.*

dilutata, Bkh. (=*filigrammaria*, H.-S.).
murinata, Sc.
candidata, Schiff.
**nymphulata*, Gn.

27. Euchœca, *Hb.*

Face smooth. Palpi short, porrected, slender, loosely scaled. Antennæ in ♂ shortly ciliated. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A development of *Asthena*, containing, besides the following, a few American species and one Australian.

chionata, Ld.
luteata, Schiff.
obliterata, Hufn.
**semistrigata*, Christ.
sylvata, Hb.
Blomeri, Curt.

28. Operophtera, *Hb.*

Face smooth. Palpi short, porrected, loosely scaled. Antennæ in ♂ serrate, strongly ciliated with fascicles. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle. ♀ with aborted wings.

A development of *Euchœca;* the fasciculate antennal ciliations of the ♂, and aborted wings of the ♀, seem correlated with the appearance of the imago in winter, as is so often the case with winter species of all families. Besides the two following species, which occur throughout Northern and Central Europe, one at least ranging into North America, there is a third in Japan.

brumata, L.
boreata, Hb.

29. Venusia, *Curt.*

Face smooth. Palpi rather short, subascending, loosely scaled. Antennæ in ♂ bipectinated, apex simple. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle.

The single European species ranges into Japan and North America. Besides this I am only acquainted with three New Zealand species. The genus is nearly allied to *Euchœca*, and is probably a collateral branch from the same stock.

cambrica, Curt.

30. Ochodontia, *Ld.*

Face smooth. Palpi rather short, porrected, loosely scaled. Antennæ in ♂ bipectinated, apex simple. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

The genus is an offshoot of *Asthena.* The single species is a native of South-east Europe.

adustaria, F. d. W.

31. Rhodometra, n. g.

Face more or less strongly obtusely-prominent. Palpi rather short, porrected, loosely scaled. Antennæ in ♂ bipectinated, apex simple. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A small genus, apparently African in origin, which has extended itself into Europe. Its exact affinity is not clear; it is either related to the preceding group, or it may possibly be a modified offshoot from *Lythria;* other African forms may probably be found which will determine the point. This genus has long gone under the name of *Sterrha*, Hb.; as far as I can find out, this identification seems to have been founded in the first instance on a misreading, and never subsequently verified or corrected by others; the genus *Sterrha*, Hb., was formed to include the one species *sericeata*, Hb., only, and there can be no doubt therefore as to the right application of the name, which I have employed in its proper sense hereafter.

Staudinger in his Catalogue includes under this genus *oranaria*, Luc., an Algerian species; I find, however, according to specimens received from him, that it is not a Geometer at all, but a Bombycid of the family *Arctiadæ*, near *Emydia*.

anthophilaria, Hb.
sacraria, L.

32. Asaphodes, *Meyr.*

Face with tuft or hardly projecting scales. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated, apex simple. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A development of *Xanthorhoe*. Besides the following I am only acquainted with four species from New Zealand, but the genus is probably overlooked.

serraria, Z.
frigidaria, Gn.

33. Xanthorhoe, *Hb.*

Face with more or less slightly projecting scales or conical tuft. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated, apex usually simple. Thorax glabrous beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A large genus, but less numerous than *Hydriomena* in all regions except New Zealand, where it is dominant. The character of the antennal pectinations varies considerably; in some species they are very short, and then always terminate in long fascicles of cilia, but there can never be any doubt as to their presence.

vittata, Bkh.
Langi, Christ.
Alpherakii, Ersch.
cervinata, Schiff.
limitata, Sc.
coarctata, F.
plumbaria, F.
mœniata, Sc.
**cœlinaria*, Grasl.
**sartata*, Alph.
peribolata, Hw.
**proximaria*, Rbr.
undulata, Alph.
obvallaria, Mab.
integrata, Alph.
subproximaria, Stgr.
vicinaria, Dup.
junctata, Stgr.
**pinnaria*, Christ.
burgaria, Ev.
bipunctaria, Schiff.
**Staudingeri*, Alph. (*Kuldscha*).
flavolineata, Stgr.
**rectifasciaria*, Ld.
parallelaria, Vill.
multistrigaria, Hw.
didymata, L.
alexaria, Stgr.
tauaria, Christ.
fidoniata, Stgr.
turbata, Hb.
**muscicapata*, Christ.
ferrugata, Cl. (=*unidentaria*, Hw.).
pomœriaria, Ev.
designata, Rott.
**modestaria*, Ersch.
munitata, Hb.
conspectaria, Mn.
quadrifasciaria, Cl.
abrasaria, H.-S.
firmata, Hb.
montanata, Bkh.
**timozzaria*, Const.
deflorata, Ersch.
**lepidaria*, Christ.
abraxaria, Butl. (=*pudicata*, Christ.).
incursata, Hb.
fluctuata, L.
**alfacaria*, Stgr.
disjunctaria, Lah.
salicata, Hb.
schneideraria, Ld.
aqueata, Hb.
**tempestaria*, H.-S.
austriacaria, H.-S.
serpentinata, Ld.
aptata, Hb.
olivata, Bkh.
kollariaria, H.-S.
viridaria, F.

34. Dasyuris, *Gn.*

Face rough-haired or with projecting scales. Palpi moderate, porrected, with long dense rough hairs. Antennæ in ♂ shortly ciliated. Thorax and coxæ densely hairy beneath. Posterior tibiæ with all spurs present. Fore wings with areole double. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A development of the New Zealand genus *Notoreas.* I am acquainted with five New Zealand species of *Dasyuris,* and two Australian ; to these the one European species which I have seen is extremely closely allied not only in structure but in appearance, and doubtless the genus was once more generally distributed than it is now.

polata, Hb.
**ravaria,* Ld.

35. Lythria, *Hb.*

Face rough-haired or with loosely appressed scales. Palpi moderate, porrected, with long rough hairs. Antennæ in ♂ bipectinated, apex sometimes simple. Thorax roughly hairy beneath. Femora sometimes hairy; posterior tibiæ with all spurs present. Fore wings with areole simple. Hind wings with 8 anastomosing with cell from near base to beyond middle.

A development of *Notoreas.* Besides the following, there are two New Zealand species. It is probable that the generic name *Botys,* Latr., is applicable to this genus ; but, besides that the point is not quite certain (though it is certainly not to be used for any other), that name has been so largely used in a different sense in the *Pyralidina* that I conceive it to be unnecessary to make confusion by adopting it here, where there is already an old Hübnerian name in universal use. The course is exceptional, but it seems to me that there are exceptionally strong reasons for it.

plumularia, Frr.
purpuraria, L. (=*porphyraria,* H.-S.).
sanguinaria, Dup.
**venustata,* Stgr.

2. MONOCTENIADÆ.

Hind wings with vein 5 fully developed (only in *Phthorarcha* coincident), rising from near or below middle of transverse vein, 8 free or anastomosing shortly near base, or rarely anastomosing from near base to beyond middle, approximated to upper margin of cell to middle or beyond.

The few European genera unworthily represent this family, which is numerously developed in Australia, and to some extent in the Indo-Malayan region. Elsewhere, though probably once extensively prevalent, it has been driven out by higher forms, and only scattered fragments remain. Some of its more ancestral genera are amongst the most primitive forms of the *Geometrina*, and make a near approximation to the *Notodontidæ*, but the European genera are all amongst the later developed. The larvæ are little known, but some at least have a third pair of claspers, and sometimes show rudiments of the other two pairs.

In the normal and characteristic type of structure vein 5 of the hind wings is present, and 8 free and closely approximated to cell from near base to beyond middle ; this type occurs in no other family of the group. In two European genera (and also in one Australian, otherwise remote from them) 8 anastomoses with upper margin of cell quite as in the *Hydriomenidæ*, but the absence of the characteristic neuration of the fore wings of that family immediately distinguishes them, and there is not, in fact, any near relationship. In one of these same genera (*Phthorarcha*), a degenerate type, vein 5 of the hind wings is absent ; from a comparison of the closely allied *Erannis*, it appears that this vein is coincident with 4, and not obsolescent, as in the *Selidosemidæ*, where the vein is really present but reduced to a fold ; there is therefore no real confusion with that family, from the normal type of which *Phthorarcha* is further distinguished by the anastomosis of vein 8. In three or four genera there is a very short fusion or anastomosis of vein 8 with upper margin of cell near base ; these may be immediately distinguished from the *Sterrhidæ* by vein 8 remaining for some distance nearly approximated to upper margin of cell, instead of rapidly diverging, and by the absence of the characteristic neuration of the fore wings.

In this family the antennæ are very frequently unipectinated in the ♂ ; nearly three-fourths of the species, including the most dissimilar forms, show this structure, which is very rare in other *Geometrina*, and, indeed, amongst the Lepidoptera generally, but as it happens, none of the European genera are so characterised ; this is an indication of their less primitive nature.

Tabulation of Genera.

1.	Posterior tibiæ without median spurs	2.
	Posterior tibiæ with all spurs present	3.
.	Antennæ in ♂ bipectinated; ♀ winged.. ..	41. Heliothea.
	Antennæ in ♂ ciliated; ♀ apterous	37. Phthorarcha.
.	Fore wings with vein 10 absent	4.
	Fore wings with vein 10 present	5.
4.	Face with appressed scales	39. Eremia.
	Face with long rough hairs	40. Brephos.
5.	Tongue obsolete	38. Erannis.
	Tongue well-developed	6.
6.	Fore wings with vein 12 anastomosing with 10 ..	42. Myinodes.
	Fore wings with vein 12 free	36. Baptria.

36. Baptria, *Hb.*

Face with projecting scales. Tongue developed. Palpi moderate, porrected, with rough projecting hairs. Antennæ in ♂ evenly ciliated. Thorax hairy beneath. Femora glabrous; posterior tibiæ with all spurs present. Fore wings with 10 out of 11, anastomosing with 9. Hind wings with 6 and 7 stalked, 8 closely approximated to cell from near base to near angle of cell, rarely in ♀ shortly anastomosing near base.

The exact relationship of the genus is not clear, but it certainly belongs to the neighbourhood of those forms which mark the transition from this family to the preceding, though not exactly transitional itself. The single species occurs almost throughout Europe.

atrata, L.

37. Phthorarcha, n. g.

Face with appressed scales. Tongue obsolete. Palpi very short, porrected, rough-scaled. Antennæ in ♂ serrate, ciliated with very long fascicles of cilia. Thorax slightly hairy beneath. Femora glabrous; posterior tibiæ without median spurs. Fore wings with 10 anastomosing with 9, 11 anastomosing with 12 and 10. Hing wings with 5 wholly absent (probably coincident with 4), 6 and 7 stalked, 8 anastomosing with upper margin of cell from near base to beyond middle. ♀ apterous.

A development of *Erannis*. The single species is Central Asiatic.

primigena, Stgr.

38. Erannis, *Hb.*

Face with appressed scales. Tongue obsolete. Palpi very short, porrected, rough-scaled. Antennæ in ♂ serrate, ciliated with very long fascicles of cilia, or evenly. Thorax somewhat hairy beneath. Femora glabrous; posterior tibiæ with all spurs present. Fore wings with 11 sometimes anastomosing with 12 or 10. Hind wings with 6 and 7 stalked or from a point, 8 anastomosing with upper margin of cell from near base to beyond middle. ♀ apterous.

Nearly allied to *Eremia*, and probably derived with it from a common ancestor at no very remote distance. A small genus, confined to the European region and North America.

æscularia, Schiff.
aceraria, Schiff.
**bistriata*, Hed.
**membranaria*, Christ.

39. Eremia, *H.-S.*

Face with appressed scales. Tongue weak. Palpi short, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax slightly hairy beneath. Femora glabrous; posterior tibiæ with all spurs present. Fore wings with 10 absent. Hind wings with 6 and 7 stalked, 8 approximated to upper margin of cell to middle.

This genus is certainly nearly related to *Brephos*, with which, indeed, it practically agrees in all essential characters except the rough hairy clothing. Although the ♀ is winged, the wings are smaller than those of the ♂, and indicate an approach in character to *Erannis*. The two species are South European.

culminaria, Ev.
cacuminaria, Rbr.

Brephos, *O.*

Face with long rough hairs. Tongue developed. Palpi short, porrected, clothed with long rough hairs. Antennæ in ♂ serrate, evenly ciliated, or shortly bipectinated. Thorax hairy beneath. Femora hairy; posterior tibiæ with all spurs present. Fore wings with 10 absent. Hind wings with 6 and 7 stalked, 8 connected or shortly anastomosing with upper margin of cell towards base, closely approximated to it to middle.

Confined to the European region and Labrador. It would appear to be nearly related to the Australian *Oenone*, and may well have been developed from it.

parthenias, L.
notha, Hb.
puella, Esp.
**Middendorfii*, Mén.

41. Heliothea, *B.*

Face smooth, sometimes subprominent, forehead rough-haired. Tongue short. Palpi moderate, porrected, with long rough hairs. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora somewhat hairy; posterior tibiæ without median spurs. Fore wings with 10 connected or anastomosing with 12 and sometimes with 9 also, 11 out of 10 between connections. Hind wings with 6 and 7 from a point or stalked, 8 closely approximated to upper margin of cell from near base to middle.

Only known from South Europe and Central Asia. It is evidently allied to *Brephos*, but not very closely, and their common ancestor must be somewhat remote.

discoidaria, B.
iliensis, Alph.
Alpheraki, Stgr.
**Christophi*, Alph.

42. Myinodes, n. g.

Face smooth, prominent. Tongue developed. Palpi moderate, porrected, triangularly scaled. Antennæ in ♂ ciliated with fascicles. Thorax glabrous beneath. Femora glabrous; posterior tibiæ with all spurs present. Fore wings with 10 anastomosing with 12 and 9, 11 out of 10 between connections. Hind wings with 6 and 7 stalked, 8 approximated to upper margin of cell from near base to middle.

It has affinity with *Heliothea* more than with any other known genus. The single species is found in South-western Asia and Sicily.

interpunctaria, H.-S.

3. ORTHOSTIXIDÆ.

Hind wings with vein 5 fully developed, rising from about middle of transverse vein, 8 connected with upper margin of cell by an oblique bar towards base.

This small family is immediately derived from the *Monocteniadæ*, with which it is closely connected. It is convenient, however, to keep it separate, and the peculiar oblique bar connecting 8 with the cell towards base, combined with the development of 5, distinguish it from all other families. If there is any possibility of confusion with those forms of *Hydriomenidæ* in which 8 is also connected by a bar (though in them the bar is placed beyond and not before the middle of cell), the absence of the characteristic areole of the *Hydriomenidæ* will be a further test.

Only a few genera, and these of small size, are known to me, but they seem to be distributed impartially over the globe; perhaps rather more numerously in the Indo-Malayan region than elsewhere. The two European genera are not closely connected together, and have little resemblance to each other. The origin of the group must be sought in the neighbourhood of *Heliothea*, between which genus and *Orthostixis* there is, in fact, a close structural affinity, though little superficial similarity.

Tabulation of Genera.

Posterior tibiæ without median spurs	43. Orthostixis.
Posterior tibiæ with all spurs present	44. Epirranthis.

43. Orthostixis, *Hb.*

Face rounded, or in ♂ sometimes strongly prominent, with appressed scales. Tongue developed. Palpi moderate, porrected, loosely scaled. Antennæ in ♂ evenly ciliated. Thorax hairy beneath. Femora glabrous; posterior tibiæ without median spurs. Fore wings with 10 anastomosing or connected with 12 and 9, 11 out of 10 between connections. Hind wings with 6 and 7 stalked or separate.

A small genus, confined to Southern Europe and Central Asia; it is nearly allied on the one hand to the Indian *Naxa*, and on the other to *Zanclopteryx*, which is principally Indo-Malayan and African.

bremeraria, Stgr.
calcularia, Ld.
cribraria, Hb.
venitidata, Hb.

44. Epirranthis, *Hb.*

Face with appressed scales. Tongue developed. Palpi very short or moderate, porrected or subascending, rough-scaled. Antennæ in ♂ evenly ciliated. Thorax rather hairy beneath. Femora glabrous; posterior tibiæ with all spurs present. Fore wings with 10 anastomosing with 9, 11 anastomosing with 12 and 10 before 9. Hind wings with 6 and 7 separate.

Besides the following species, which ranges from Northern Europe to Eastern Asia, I am only acquainted with two from New Zealand. It is a rather isolated genus at present.

pulverata, Thnb.

4. STERRHIDÆ.

Fore wings with 10 rising out of 9, 11 anastomosing or connected with 9 or rarely (only in *Cleta*) free; or less usually 10 anastomosing with 11 and 9. Hind wings with vein 5 fully developed, rising from middle of transverse vein, 8 very shortly anastomosing with upper margin of cell near base, thence rapidly diverging.

In all European genera the tongue is well-developed, and is therefore not specially mentioned. The face is nearly always smooth. The posterior tibiæ in the ♂ are usually partially or entirely deprived of spurs, often much swollen and furnished with large tufts of hair, and the tarsi are then generally much abbreviated. The neuration of the fore wings results in the formation of an areole very similar to that of the *Hydriomenidæ*, but much more commonly simple; but although apparently similar, there is really an essential difference in formation, for in the *Hydriomenidæ*, whenever the areole is simple, 10 has coincided with 11 towards base, whereas in the *Sterrhidæ* it has coincided with 9. The characteristic structure of vein 8 in the hind wings will distinguish the family at once from all others, except a part of the *Geometridæ*, and from these the central position of vein 5 easily separates it. The family may be regarded as a development from the *Geometridæ*, and is of considerable extent.

The actual ancestral form of the family appears to be lost, but it must have been tolerably intermediate in character between *Calothysanis* and *Rhodostrophia*. The genera in which the areole is double are older than corresponding forms with the areole simple, and those with all spurs present are older than those in which they are partly absent. In particular the presence or absence of the median spurs in the ♀ affords a very reliable test.

Tabulation of Genera.

1.	Posterior tibiæ in ♀ with median spurs absent	2.
	Posterior tibiæ in ♀ with all spurs present ..	6.
2.	Fore wings with 11 connected with 9.. ..	45. Cleta.
	Fore wings with 11 free	3.
3.	Posterior tibiæ in ♂ with terminal spurs ..	4.
	Posterior tibiæ in ♂ wholly without spurs ..	5.
4.	Antennæ in ♂ bipectinated	46. Emmiltis.
	Antennæ in ♂ not bipectinated	49. Sterrha.
5.	Antennæ in ♂ bipectinated	47. Chrysoctenis.
	Antennæ in ♂ not bipectinated	48. Eois.
6.	Posterior tibiæ in ♂ wholly without spurs ..	7.
	Posterior tibiæ in ♂ with at least terminal spurs	9.
7.	Fore wings with areole double	53. Dithalama.
	Fore wings with areole simple	8.
8.	Antennæ in ♂ bipectinated or dentate-fasciculate; thorax hairy beneath	52. Problepsis.
	Antennæ in ♂ filiform or dentate; thorax glabrous	50. Leptomeris.
9.	Posterior tibiæ in ♂ without median spurs ..	10.
	Posterior tibiæ in ♂ with at least one median spur	11.
10.	Antennal pectinations short, emitting long fascicles of cilia	51. Cinglis.
	Antennal pectinations moderately long, normal	54. Leucophthalmia.
11.	Fore wings with areole double..	56. Rhodostrophia.
	Fore wings with areole simple	55. Calothysanis.

45. Cleta, *Dup.*

Face rough or with appressed scales. Palpi moderate, porrected, rough-scaled or with long rough projecting hairs. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath or almost glabrous. Femora glabrous or somewhat hairy beneath; posterior tibiæ in ♂ very short, more or less rough-haired, without spurs, in ♀ without median spurs; posterior tarsi in ♂ short. Fore wings wiih 10 out of 9, 11 separate. Hind wings with 6 and 7 stalked.

A development probably of *Eois*, characterised by the peculiar neuration; not yet recognised outside the European region.

vittaria, Hb.
perpusillaria, Ev.
**reaumuraria*, Mill.

46. Emmiltis, *Hb.*

Face with projecting tuft or smooth. Palpi moderate, porrected or ascending, rough-scaled or with long rough projecting hairs. Antennæ in ♂ bipectinated, extreme apex simple. Thorax sometimes hairy beneath. Femora glabrous; posterior tibiæ in ♂ moderate or rather short, not dilated, without median spurs, in ♀ without median spurs; posterior tarsi in ♂ normal or rather short. Fore wings with 10 out of 9, 11 connected with 9. Hind wings with 6 and 7 stalked.

Nearly related to *Sterrha*, of which it is perhaps a development. Characteristic of the Mediterranean countries, but extending into Central Asia.

plumularia, B.
**cirtanaria*, Luc.
pygmæaria, Hb.
megearia, Oberth.
kuldschaensis, Alph. (*Stigma*).

47. Chrysoctenis, n. g.

Face smooth. Palpi moderate, ascending, with long rough projecting hairs beneath. Antennæ in ♂ bipectinated, apex simple. Thorax rather hairy beneath. Femora somewhat hairy; posterior tibiæ in ♂ short, slender, loosely haired, without spurs, in ♀ without median spurs; posterior tarsi in ♂ short. Fore wings with 10 out of 9, 11 connected with 9. Hind wings with 6 and 7 stalked.

The single species is South European; it is probably an offshoot of *Eois*.

filaceeria, H.-S.

48. Eois, *Hb.*

Face smooth. Palpi rather short or moderate, porrected or subascending, loosely scaled. Antennæ in ♂ dentate or serrate, ciliated with fascicles or evenly, fascicles rarely (*perochraria*) rising from very short paired processes. Thorax glabrous beneath. Femora glabrous; posterior tibiæ in ♂ short or moderate, slender or moderately dilated, often furnished with tuft of hairs, without spurs, in ♀ with median spurs absent; posterior tarsi in ♂ moderate or abbreviated. Fore wings with 10 out of 9, 11 connected or anastomosing with 9. Hind wings with 6 and 7 stalked or rarely separate.

A large genus, principally characteristic of the European region, but extending also more or less into the adjoining regions, though much less generally present than *Leptomeris*. It is doubtless to be regarded as a development of *Leptomeris*.

muricata, Hufn.
plumboscriptata, Christ.
herbariata, F.
**subherbariata*, Rössl.
consolidata, Ld.
**subsaturata*, Gn. (? = *cervantaria*, Mill.; = *colonaria*, H.-S.).
**inustata*, H.-S.
contiguaria, Hb.
filicata, Hb.
rusticata, F.
textaria, Ld.
nexata, Hb.
virgularia, Hb.
camparia, H.-S.
sodaliaria, H.-S.
calunetaria, Stgr.
fathmaria, Oberth.
pecharia, Stgr.
**monadaria*, Gn.
subpurpurata, Stgr.
transmutata, Rbr.
**infirmaria*, Rbr. (? = *carnearia*, Mn.; = *aquitanaria*, Const.).
seeboldiata, Rössl.
incarnaria, H.-S.
obsoletaria, Rbr.
helianthemata, Mill.
fractilineata, Z.
ostrinaria, Hb.
**purpureomarginata*, Boh.
**graciliata*, Mn.
**longaria*, H.-S.
**mancipiata*, Stgr.
straminata, Tr.
asellaria, H.-S.
salutaria, Christ.
robiginata, Stgr.
flaveolaria, Hb.
**exilaria*, Gn.
perochraria, F. R.
numidaria, Luc.
diffluata, H.-S.
holosericata, Dup.
humiliata, Hufn.
dilutaria, Hb.
nitidata, H.-S.
**præustaria*, Mn.
circellata, Gn.
**squalidaria*, Stgr.
pallidata, Bkh.
subsericeata, Hw.
elongaria, Rbr.
inornata, Hw.
aversata, L.
degeneraria, Hb.
**agrostemmata*, Gn.
**Erschoffi*, Christ.
arenosaria, Stgr.
attenuaria, Rbr.
emarginata, L.
circuitaria, Hb.
**manicaria*, H.-S.
inclinata, Ld.

miserata, Stgr.
dimidiata, Hufn.
extarsaria, H.-S. (?= *eriopodata*, Grasl.; =*inesata*, Mill.).
**atromarginata*, Mab.
**disjunctaria*, Stgr.
lævigaria, Hb.
**æquifasciata*, Christ.
trigeminata, Hw.
bisetata, Hufn.
**roseofasciata*, Christ.
**belemiata*, Mill.
politata, Hb.
effusaria, Christ.
rufomixtata, Rbr.
cœnosaria, Ld.

49. Sterrha, *Hb.*

Face smooth or loosely haired. Palpi rather short, ascending or porrected, shortly rough-scaled beneath or with rough projecting hairs. Antennæ in ♂ filiform or dentate, evenly ciliated or with fascicles, rarely emitted from very short processes. Thorax glabrous or rarely hairy beneath. Femora glabrous or rarely hairy; posterior tibiæ in ♂ moderate, slender, without median spurs, rarely (*luridata*) with only one terminal spur, in ♀ without median spurs; posterior tarsi in ♂ moderate. Fore wings with 10 out of 9, 11 anastomosing or connected with 9. Hind wings with 6 and 7 stalked.

Not yet known to occur outside the European region. The genus is certainly closely related to *Eois*, but the nature of the relationship appears at present doubtful; it may be a collaterally developed branch, and there would be no difficulty in supposing this, but it seems to me also possible that the tibial characters of the ♂ might be derived by transference from the ♀, in which case these species, though possessing terminal spurs in the ♂, might be descended from others without terminal spurs, a result not otherwise attainable. If this could be proved, it would be a curious reversal of the undoubted fact that the absence of the median spurs in the ♀ is due to transference from the ♂. The point is certainly worthy of investigation, but difficult to decide.

The customary misuse of the generic name *Sterrha* (used by Hübner to include *sericeata* only, and therefore of unmistakable application) is noticed under *Rhodometra*.

subtilata, Christ.
luridata, Z.
intermedia, Stgr.
moniliata, F.
sericeata, Hb.
allardiata, Mab. (? = præc.).
merklaria, Oberth.

**determinata*, Stgr.
consanguinaria, Ld.
litigiosaria, B.
ossiculata, Ld.
**mutilata*, Stgr.
mediaria, Hb.
**nudaria*, Christ.
macilentaria, H.-S.
rufaria, Hb.
**rufociliaria*, Brem.
ochrata, Sc.
vitellinaria, Ev. (= *rufinaria*, Stgr.).
sentinaria, Hb.
luteolaria, Const.
trilineata, Sc.
**Falckii*, Hed.

50. Leptomeris, *Hb.*

Face smooth. Palpi moderate or rather short, subascending, loosely scaled beneath. Antennæ in ♂ serrate or dentate, ciliated with fascicles. Thorax glabrous beneath or rarely somewhat hairy. Femora glabrous; posterior tibiæ in ♂ large, dilated, containing tuft, without spurs, rarely with one very small terminal spur only (*umbellaria*), in ♀ with all spurs present; posterior tarsi in ♂ more or less strongly abbreviated. Fore wings with 10 out of 9, 11 connected or anastomosing with 9. Hind wings with 6 and 7 separate or stalked.

A large genus of nearly universal distribution; it may be regarded as a development of *Rhodostrophia*, or of a form nearly resembling it. The separation or stalking of veins 6 and 7 of the hind wings, though used as a sectional character by Lederer, is not constant; frequently both occur within the limits of the same species.

**ansulata*, Ld.
**characteristica*, Alph.
halimodendrata, Ersch.
annubiata, Stgr.
adulteraria, Ersch.
umbellaria, Hb.
remutaria, Hb.
punctata, Tr.
nemoraria, Hb.
immutata, L.
marginepunctata, Göze.
**cumulata*, Alph.
submutata, Tr.
concinnaria, Dup.
decorata, Bkh.
congruata, Z.
ornata, Sc.
imitaria, Hb.
emutaria, Hb.
flaccidaria, Z.
strigilaria, Hb.
incanata, L.
lambessata, Oberth.
strigaria, Hb.
fumata, Stph.
ochroleucata, H.-S.
corrivalaria, Kretsch.
caricaria, Reut.
beckeraria, Ld.
immistaria, H.-S.
**disclusaria*, Christ.
immorata, L.
tessellaria, B.
**sulphuraria*, Frr.

turbidaria, H.-S. **accurataria*, Christ.
rubiginata, Hufn. **subfalcaria*, Christ.

51. Cinglis, *Gn.*

Face smooth. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated, pectinations short, ending in fascicles of long cilia. Thorax glabrous beneath. Femora glabrous; posterior tibiæ in ♂ without median spurs, slender, in ♀ with all spurs present. Fore wings with 10 out of 9, 11 anastomosing with 9. Hind wings with 6 and 7 stalked.

The single species is of somewhat uncertain affinity, but is probably an offshoot of a small unnamed Australian group, which is itself nearly related collaterally to *Leptomeris*.

humifusaria, Ev.

52. Problepsis, *Ld.*

Face smooth. Palpi short or moderate, porrected or subascending, with appressed scales or somewhat rough. Antennæ in ♂ bipectinated or rarely dentate, pectinations or teeth ending in fascicles of cilia, towards apex simple. Thorax hairy or almost glabrous beneath. Femora rather hairy or glabrous; posterior tibiæ in ♂ flatly dilated, enclosing large tuft, without spurs, in ♀ with all spurs present; posterior tarsi in ♂ much abbreviated. Fore wings with 10 out of 9, 11 connected or anastomosing with 9. Hind wings with 6 and 7 separate.

A small genus, properly Indo-Malayan, but ranging into the neighbouring regions. It is a development of *Dithalama*. The species show considerable variation in structure, but are always separable from *Leptomeris* by either the antennal or thoracic structure, though both are variable.

ocellata, Friv.
phœbearia, Ersch.

53. Dithalama, *Meyr.*

Face smooth. Palpi moderate, subascending, loosely scaled. Antennæ in ♂ dentate, ciliated with fascicles. Thorax almost glabrous beneath. Femora glabrous; posterior tibiæ in ♂ dilated, containing tuft, without spurs, in ♀ with all spurs present; posterior tarsi in ♂ much abbreviated. Fore wings with 10 rising separate or out of 9, anastomosing with 11 and 9. Hind wings with 6 and 7 stalked or separate.

An Indo-Malayan genus of few species, straggling into Australia and Eastern Asia. Though doubtless more or less related to *Rhodostrophia*, its exact origin is not yet precisely determinable.

indicataria, Walk.

54. Leucophthalmia, *Hb.*

Face smooth. Palpi rather short, subascending, shortly rough-scaled. Antennæ in ♂ moderately bipectinated, apical $\frac{2}{5}$—$\frac{1}{3}$ simple. Thorax glabrous beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, without median spurs, in ♀ with all spurs present. Fore wings with 10 out of 9, 11 anastomosing with 9. Hind wings with 6 and 7 stalked.

A small characteristically European genus, only extending into North America. Probably it may be an offshoot of *Calothysanis*, to which it is certainly nearly allied.

orbicularia, Hb.
pendularia, Cl.
porata, F.
punctaria, L.
trilinearia, Bkh. (*linearia*, Hb.).
pupillaria, Hb.
albiocellaria, Hb.
annulata, Schlz.

55. Calothysanis, *Hb.*

Face smooth. Palpi moderate or rather short, porrected, shortly rough-scaled beneath. Antennæ in ♂ strongly bipectinated, towards apex simple. Thorax glabrous beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present in both sexes; sometimes with posterior femora tufted in ♂, or posterior tibiæ clothed with hairs. Fore wings with 10 out of 9, 11 anastomosing or connected with 9. Hind wings with 6 and 7 stalked.

A rather small genus, of Indo-Malayan origin, with stragglers in all adjacent regions. It is an early form of the family, collaterally related to *Rhodostrophia*, and also showing evident affinity with the *Geometridæ*.

amata, L.
**rectistrigaria*, Ev.
**sympathica*, Alph.
duplicaria, Walk. (*nigronotaria*, Brem.).

56. Rhodostrophia, *Hb.*

Face oblique, with appressed scales. Palpi moderate, subascending, shortly rough-scaled. Antennæ in ♂ bipectinated, apex simple. Thorax glabrous beneath. Femora glabrous; posterior tibiæ in ♂ slender, sometimes with long basal tuft, with all spurs present or with outer median spur obsolete, in ♀ with all spurs present. Fore wings with 6 sometimes out of 9, 10 anastomosing with 11 and 9. Hind wings with 6 and 7 stalked.

Not at present known outside the European region, where it is confined to the warmer districts. This genus must certainly closely approach the primitive type of the family. The species which are known to me as having one tibial spur obsolete are the first four and the last one, but they do not appear to form a single group separable from the rest.

vibicaria, Cl.
calabraria, Z.
auctata, Stgr.
adauctata, Stgr.
**perezaria*, Oberth.
sicanaria, Z.
dispar, Stgr.
terrestraria, Ld.
**cuprinaria*, Christ.
Ledereri, Alph.
jacularia, Hb.
**Staudingeri*, Alph.
badiaria, Frr.
**vastaria*, Christ.
acidaria, Stgr.
præcisaria, Stgr.

5. GEOMETRIDÆ.

Fore wings with 10 rising out of 9 or rarely absent (*Aplasta*). Hind wings with 5 fully developed, rising much above middle of transverse vein, 8 shortly anastomosing or connected with or appressed to upper margin of cell near base, thence rapidly diverging or sometimes approximated to upper margin of cell to near middle.

A moderately extensive family, most largely developed in the Indo-Malayan, African, and Australian regions. In all European genera the face is smooth, and the tongue well-developed. The neuration of the fore wings tends to vary markedly within the limits of the same species, and is therefore not always available for generic distinction; it nearly approaches that of the *Sterrhidæ*, but is less fixed. The peculiar position of vein 5 in the hind wings sufficiently characterises the family, which is otherwise closely allied to and intermediate between the *Sterrhidæ* and *Monocteniadæ*, with the former of which I at one time included it. The family is no doubt a development of some early form of the *Monocteniadæ.*

The genera in which vein 8 of the hind wings is approximated to the upper margin of cell to near middle are more ancestral than those in which it rapidly diverges.

In many of the species the terminal joint of the palpi is much longer in the ♀ than in the ♂.

Tabulation of Genera.

1. Posterior tibiæ in ♂ without median spurs ..	2.
Posterior tibiæ in ♂ with median spurs ..	4.
2. Antennæ in ♂ bipectinated; posterior tibiæ in ♀ without median spurs	3.
Antennæ in ♂ simple; tibiæ in ♀ with all spurs	57. Nemoria.
3. Antennæ in ♂ bipectinated to apex	58. Thalera.
Antennæ in ♂ with apex simple	59. Eucrostes.
4. Antennæ in ♂ bipectinated	5.
Antennæ in ♂ simple	8.
5. Antennæ in ♂ bipectinated to apex	62. Geometra.
Antennæ in ♂ with apex simple	6.
6. Hind wings with 6 and 7 stalked	60. Euchloris.
Hind wings with 6 and 7 separate	7.
7. Abdomen with dorsal crests	64. Pseudoterpna.
Abdomen not crested	61. Megalochlora.
8. Fore wings with 10 absent	65. Aplasta.
Fore wings with 10 present	63. Agathia.

57. Nemoria, *Hb.*

Face smooth. Palpi moderate or rather long, porrected, shortly rough-scaled. Antennæ in ♂ serrate or filiform, ciliated with fascicles or evenly. Thorax glabrous beneath. Femora glabrous; posterior tibiæ in ♂ sometimes dilated, without median spurs, in ♀ with all spurs present; posterior tarsi in ♂ sometimes abbreviated. Fore wings with 10 out of 9, 11 sometimes anastomosing with 12. Hind wings with 3 and 4 sometimes stalked, 6 and 7 stalked, 8 very shortly anastomosing with cell near base, thence rapidly diverging.

A genus of rather limited extent but wide distribution; probably a development of *Euchloris,* with perhaps collateral affinity to *Thalera.*

strigata, Müll.
ussuriaria, Brem.
**alboundulata*, Hed.
pulmentaria, Gn.
faustinata, Mill.
**melinaria*, H.-S.
**amphitritaria*, Oberth.
porrinata, Z.
viridata, L.
**pretiosaria*, Stgr.

58. Thalera, *Hb.*

Face smooth. Palpi rather short, ascending, loosely scaled. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora slightly hairy beneath; posterior tibiæ in ♂ not dilated, in both sexes without median spurs. Fore wings with 6 sometimes out of 9, 10 out of 9, 11 anastomosing with 12 and sometimes with 10. Hind wings with 6 and 7 stalked, 8 shortly anastomosing with cell near base, thence rapidly diverging.

A very small European and Asiatic genus, nearly related to *Eucrostes*, of which it may be a development.

fimbrialis, Sc.
laceratatia, Graes.
**rufolimbaria*, Hed.

59. Eucrostes, *Hb.*

Face smooth. Palpi rather short, porrected, loosely scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax glabrous or rather hairy beneath. Femora glabrous or loosely hairy; posterior tibiæ in ♂ not dilated, in both sexes without median spurs. Fore wings with 10 out of 9, 11 sometimes anastomosing with or running into 12, sometimes anastomosing with 10 also. Hind wings with 3 and 4 sometimes stalked, 6 and 7 from a point or stalked, 8 anastomosing very shortly with cell near base, thence rapidly diverging.

A genus of no great extent, but very general distribution. It is probably a development of *Euchloris*.

**impararia*, Gn.
herbaria, Hb.
olympiaria, H.-S.
**petitaria*, Christ.
indigenata, Vill.

60. Euchloris, *Hb.*

Face smooth. Palpi short or moderate, porrected, loosely or shortly rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax glabrous or hairy beneath. Femora glabrous or loosely hairy; posterior tibiæ in ♂ often dilated, sometimes with pencil of hairs in groove, with all spurs present; posterior tarsi in ♂ sometimes abbreviated. Fore wings with 10 out of 9, 11 sometimes anastomosing with 12, sometimes with 10 also, rarely running into 12. Hind wings with 3 and 4 sometimes stalked, 6 and 7 stalked, 8 very shortly anastomosing with cell near base, thence rapidly diverging.

Apparently a development of *Megalochlora.* The species are very numerous, and occur principally in the Indo-Malayan, Australian, and African regions; but a certain number are found in Europe and North America. I have elsewhere called this genus *Iodis*, Hb.

albocostaria, Brem.
**subtiliaria*, Brem.
**amœnaria*, Oberth.
**jankowskiaria*, Mill.
pustulata, Hufn.
neriaria, H.-S.
**tenuiaria*, Graes.
**crucigerata*, Christ.
fulminaria, Ld.
plusiaria, B.
smaragdaria, F.
chlorophyllaria, Hed.
vernaria, Hb.
Zimmermanni, Hed.
**alliata*, Höfn.
lactearia, L.
putata, L. (= *marina*, Butl.).
grandificaria, Graes.
gratiosaria, Brem.

61. Megalochlora, n. g.

Face smooth. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax densely hairy beneath. Femora hairy; posterior tibiæ in ♂ somewhat dilated, sometimes with large tuft in groove, with all spurs present. Fore wings with 10 out of 9. Hind wings with 6 and 7 separate, 8 nearly approximated to cell towards base, diverging from before middle.

An East Asiatic genus, which will probably be increased by future discoveries. It is a transitional form between *Euchloris* and *Pseudoterpna.*

sponsaria, Brem.
**glaucaria*, Mén. (? = præc.).
**herbacearia*, Mén.
**Dieckmanni*, Graes.
valida, Feld. (= *dioptasaria*, Christ.).
albovenaria, Brem.
iridicolor, Butl. (= *admirabilis*, Oberth.).

62. Geometra, *L.*

Face smooth. Palpi moderate or short, subascending, shortly rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora hairy or glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings with 10 out of 9, 11 sometimes anastomosing with 12 and 10. Hind wings with 6 and 7 separate, 8 approximated to cell towards base, diverging from before middle.

A development of *Pseudoterpna*, with near collateral relationship to the preceding. It is not ascertained to contain other species than those subjoined.

muscosa, Butl. (= *vestita*, Hed.).
papilionaria, L.

63. Agathia, *Gn.*

Face smooth. Palpi moderately long, porrected, shortly rough-scaled. Antennæ in ♂ filiform, minutely ciliated. Thorax densely hairy beneath. Femora glabrous; posterior tibiæ in ♂ sometimes dilated, with all spurs present. Fore wings with 10 out of 9. Hind wings with 6 and 7 separate, 8 anastomosing with or closely approximated to cell towards base, thence rapidly diverging.

A small Indo-Malayan genus, of which one or two species extend into the adjoining regions. It originates from *Pseudoterpna*, with some affinity to the preceding genus, but stands rather isolated.

carissima, Butl. (= *lacunaria*, Hed.).

64. Pseudoterpna, *Hb.*

Face smooth. Palpi moderate, porrected or subascending, rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax densely hairy beneath. Abdomen with dorsal crests. Femora glabrous or hairy beneath; posterior tibiæ in ♂ somewhat dilated, often containing hair-pencil, with all spurs present. Fore wings with 10 out of 9, 11 sometimes anastomosing with 12 and 10. Hind wings with 6 and 7 separate, 8 closely approximated to cell towards base, diverging from about middle.

A genus of some extent, which is principally Indo-Malayan and Australian; it includes Guenée's *Hypochroma*. It may be regarded as practically the ancestral type of the family, and certainly originates from some form of the *Monocteniadæ*, but the actual point of connection I cannot at present determine.

pruinata, Hufn.
coronillaria, Hb.
corsicaria, Rbr.
**Lahayei*, Oberth.

65. Aplasta, *Hb.*

Face smooth. Palpi moderate, porrected, with tolerably appressed scales. Antennæ in ♂ evenly ciliated. Thorax glabrous beneath. Femora slightly hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings with 10 absent, 11 anastomosing with 12. Hind wings with 6 and 7 stalked, 8 approximated to cell towards base, diverging from about middle.

This genus includes only the one species. Its position is doubtful; it is in some sense intermediate between this family and the *Monocteniadæ*, not fully agreeing with either, but capable of being classed with either according as the definition is framed. I have regarded it as to be placed here, though the characteristic structure of the hind wings is not very pronounced, and the absence of vein 10 in the fore wings is an exceptional though certainly not an inconsistent feature. This absence proves that it is not strictly a connecting link between the two families; but it is not improbable that it represents a small lateral offshoot from the real connecting link.

ononaria, Fuesl.

6. SELIDOSEMIDÆ.

Hind wings with 5 imperfect (not tubular), very weak or obsolete, 8 usually obsoletely connected with upper margin of cell near base, approximated to it to near middle, very rarely (only in *Axia*) to beyond origin of 7, or (only in *Narraga*) anastomosing.

The neuration of the fore wings in this family is frequently subject to very considerable variation even within the limits of the same species; and much caution is therefore required in using it as a generic character. It is, however, not equally variable in all species, and even where it appears most inconstant, it seems to remain fixed in certain details. In order to ascertain the limits of variation as far as possible, a considerable number of individual specimens have been examined in those cases where variability seemed to exist, and where the specimens were obtainable for the purpose ; and the detailed results of this examination are added hereafter in the form of an appendix. Typically 10 and 11 are free and separate, but there exists in this group a strong tendency to connection or anastomosis of these veins with one another or with 9 and 12. Vein 6 is almost always separate from 9. In the hind wings, in proportion as 5 becomes obsolete, 4 and 6 tend to approach more nearly together, so that no unduly broad interspace is left. Hence 6 and 7 are drawn apart, and are almost always separate. The posterior tibiæ are very frequently dilated in the ♂, and then usually contain a large hair-pencil concealed in a longitudinal groove, but the character is of little generic value. Occasionally the median spurs are absent ; in these cases the allied forms commonly have the spurs very small, and are in general so closely related in all other characters that it is evidently unadvisable to separate them generically. The tongue is sometimes rudimentary, and in some instances (as *Gonodontis*) it has been clear that the character does not involve generic separation ; in others it has proved possible to make use of it.

Owing to the variability and uncertainty of these characters, the family is one of the most difficult of all the Lepidoptera to classify. It is only after repeated examination and reclassification (most of my material has been recast six times) that I have been able to determine the most essential and reliable points of structure, and the mutual affinities of the genera ; and it is quite probable that in some respects my views may yet be materially altered by the discovery of new forms. There is a great variety of superficial appearance amongst the species, and often considerable difference even between rather nearly allied forms. The *Prosopolopha* group appears to be the most ancestral ; in its typical form (stout-bodied species, with triangular anterior thoracic crest) this is little represented now in Europe, and is principally characteristic of Australia. From this group originate three others : (1), the group of *Hybernia* and *Crocotá*, giving rise to *Pseudopanthera*, *Abraxas*, &c. ; (2), the *Ennomos* group, developing into *Metrocampa*, *Deilinia*, &c. ; and (3), the *Selidosema* group, of which

Nychiodes is apparently the lowest European representative, culminating in *Opisthograptis*; all genera in which the ♂ possesses the basal fovea of the fore wings are immediately and certainly referable to this group, but the character does not persist in all the genera of the group, having been lost in one or two of the higher genera, and probably not acquired in two or three of the most primitive, though highly characteristic of it as a whole, and not exactly reproduced in any other group of Lepidoptera known to me.

The structure mentioned above and hereafter as the fovea is a circular impression on the lower surface of the fore wings above the inner margin near the base, usually placed about the origin of the basal fork of vein 1*b*: it is specially characteristic of the ♂, but is occasionally transferred to the ♀ also. It varies in distinctness in different species; it is often more or less thinly scaled and transparent, and is sometimes surmounted by a small thickened gland. The purpose of the structure is unknown; it may possibly be a scent-producing organ. Somewhat similar structures are occasionally found in other Lepidoptera, but never to my knowledge in quite the same position. In *Anticypella* a quite analogous structure occurs in the hind wing beneath the costa. In *Deilinia* there is also a concavity in the hind wing, but it is rather differently constructed.

The family is very extensive, and universally distributed.

TABULATION OF GENERA.

1. Fore wings in ♂ with fovea	2.
Fore wings in ♂ without fovea	13.
2. Antennæ in ♂ bipectinated	3.
Antennæ in ♂ not pectinated	10.
3. Hind wings with 8 anastomosing with cell to middle	77. NARRAGA.
Hind wings with 8 not anastomosing with cell	4.
4. Anterior tibiæ with apical hook	69. ENCONISTA.
Anterior tibiæ without apical hook	5.
5. Hind wings with 6 and 7 stalked	78. TEPHRONIA.
Hind wings with 6 and 7 separate	6.
6. Tongue absent	75. EURRANTHIS.
Tongue developed	7.
7. Palpi and often face roughly hairy	76. BUPALUS.
Palpi and face at most rough-scaled ..	8.

8.	Fore wings with 11 rising separate, or if out of 10, from near base only, and then not anastomosing with 12		9.
	Fore wings with 11 absent or out of 10 high up, or if lower, anastomosing with 12 ..	68.	DIASTICTIS.
9.	Antennæ in ♂ bipectinated to apex ..	72.	CLEORA.
	Antennæ in ♂ with apex simple	73.	SELIDOSEMA.
10.	Antennæ in ♂ with two short acute projections on each side of each joint ..	70.	ECTROPIS.
	Antennæ in ♂ without paired projections..		11.
11.	Fore wings with 11 out of 10 or absent ..		12.
	Fore wings with 11 separate	74.	ASCOTIS.
12.	Thorax and femora densely hairy beneath	66.	ZETTIENIA.
	Thorax somewhat hairy, femora glabrous or nearly so	67.	OPISTHOGRAPTIS.
13.	Antennæ in ♂ simple		14.
	Antennæ in ♂ bipectinated or rarely with short paired processes only		19.
14.	Antennæ in ♂ ciliated with moderate fascicles	99.	ABRAXAS.
	Antennæ in ♂ shortly and evenly ciliated..		15.
15.	Abdomen in ♂ much exceeding hind wings	98.	CISTIDIA.
	Abdomen in ♂ not unusually long.. ..		16.
16.	Face with long rough hairs	107.	PSODOS.
	Face not rough-haired		17.
17.	Fore wings with 11 absent		18.
	Fore wings with 11 present	100.	PSEUDOPANTHERA.
18.	Face smooth	86.	EILICRINIA.
	Face subprominent, with short projecting scales	87.	OURAPTERYX.
19.	Hind wings with 8 approximated to whole of cell and basal ¼ of 7	117.	AXIA.
	Hind wings with 8 diverging from cell about middle		20.
20.	♀ apterous or semiapterous..		21.
	♀ with fully developed wings		26.
21.	♀ with anterior wings linear	112.	SPARTOPTERYX.
	♀ with anterior wings not linear		22.
22.	Face roughly hairy		23.
	Face not hairy		24.
23.	Thorax broad, very densely haired above ..	109.	APOCHEIMA.
	Thorax slender, loosely hairy on patagia ..	106.	LIGNYOPTERA.
24.	Thorax with small anterior crest; apex of antennæ in ♂ simple	108.	HYBERNIA.
	Thorax not crested; antennæ of ♂ pectinated to apex		25.
25.	Fore wings with 11 out of 9	105.	THERIA.
	Fore wings with 11 not out of 9	104.	CROCOTA (part).

26.	Hind wings in ♂ with subcostal fovea near base	27.
	Hind wings in ♂ without fovea	28.
27.	Fore wings with 11 out of 10	79. ANTICYPELLA.
	Fore wings with 11 not out of 10	83. DEILINIA.
28.	Abdomen with dorsal crest near base ..	85. SCARDAMIA.
	Abdomen not crested	29.
29.	Anterior tibiæ with strong apical hook ..	115. ONYCHORA.
	Anterior tibiæ without hook	30.
30.	Face with horny triangular projection ..	110. ZAMACRA.
	Face without horny projection	31.
31.	Antennæ in ♂ bipectinated to apex ..	32.
	Antennæ in ♂ with apical portion (sometimes only two or three joints) simple ..	45.
32.	Face with projecting scales (if very prominent, rarely with scales projecting shortly on sides only)	33.
	Face with tolerably appressed scales ..	41.
33.	Face with tuft of hairs from beneath antennæ across eye to middle	95. COLOTOIS.
	Face without lateral tuft	34.
34.	Fore wings with transparent scar along transverse vein	35.
	Fore wings without transparent scar ..	36.
35.	Fore wings with 6 out of 9	91. SELENIA.
	Fore wings with 6 separate	90. ARTEMIDORA.
36.	Femora glabrous	94. ARTIORA.
	Femora densely hairy	37.
37.	Fore wings with 11 connected with 12 ..	38.
	Fore wings with 11 free from 12	39.
38.	Posterior tibiæ with median spurs very short or absent	96. ENNOMOS.
	Posterior tibiæ with median spurs moderately long	116. PROSOPOLOPHA.
39.	Posterior tibiæ hairy, median spurs very short or absent	111. BISTON.
	Posterior tibiæ glabrous, median spurs moderately long	40.
40.	Face with scales forming a defined conical tuft	92. HYGROCHROA.
	Face without defined tuft	97. GONODONTIS.
41.	Tongue rudimentary	42.
	Tongue developed	43.
42.	Fore wings with 10 and 11 separate; median spurs absent	113. PHASELIA.
	Fore wings with 10 and 11 stalked; median spurs moderately long	81. NYCHIODES.
43.	Fore wings with 11 absent	103. HYPOPLECTIS.
	Fore wings with 11 present	44.

44.	Fore wings with 7 out of 9 above middle, 10 out of 9	93. CEPPHIS.
	Fore wings with 7 out of 9 below middle; 10 very rarely out of 9 close to base ..	104. CROCOTA (part).
45.	Fore wings with 10 absent	84. LOMOGRAPHA.
	Fore wings with 10 present	46.
46.	Face strongly prominent	101. HYPOSCOTIS.
	Face not strongly prominent	47.
47.	Crown of head with strong defined posterior tuft	114. CHEMERINA.
	Crown of head without defined tuft ..	48.
48.	Thorax with low double posterior crest ..	71. DEILEPTENIA.
	Thorax not crested	49.
49.	Fore wings with 11 (or 10) not connected with 12	50.
	Fore wings with 11 (or 10) connected with 12	51.
50.	Fore wings with 10 out of 9	82. EPHORIA.
	Fore wings with 10 not out of 9	102. THERAPIS.
51.	Fore wings with 10 nearly always out of 9, and anastomosing with 11	88. METROCAMPA.
	Fore wings with 10 not out of 9, rarely anastomosing with 11	52.
52.	Femora more or less hairy	80. SYNOPSIA.
	Femora glabrous	89. EUCHLÆNA.

66. ZETTIENIA, *Motsch.*

Face with cone of scales. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ ciliated with moderately long fascicles. Thorax densely hairy beneath. Femora hairy beneath; posterior tibiæ in ♂ dilated, with all spurs present. Fore wings in ♂ with fovea; 11 out of 10, either 10 or 11 anastomosing or connected with 12, 10 sometimes connected with 9. Hind wings with 8 approximated to cell to middle.

A development of *Diastictis*, but standing rather isolated. The two species are both East Asiatic.

albonotaria, Brem.
rufescentaria, Motsch. (= *consociaria*, Christ.).

67. OPISTHOGRAPTIS, *Hb.*

Face with appressed scales or short cone of scales. Tongue developed. Palpi moderate or rather short, porrected, rough-scaled. Antennæ in ♂ filiform or serrate-dentate, ciliated evenly or with short fascicles. Thorax somewhat hairy beneath. Femora glabrous or rarely slightly hairy; posterior tibiæ in ♂ more or less dilated, often bent, with all spurs present. Fore wings in ♂ with fovea; 10 often connected or anastomosing with 12 and 9, 11 out of 10 between connections or more usually absent. Hind wings with 8 approximated to cell to middle.

A genus of considerable extent and very general distribution. It is a development of *Diastictis*.

æstimaria, Hb.
proditaria, Brem.
luridulata, Stgr.
graphata, Hed.
notata, L.
alternaria, Hb.
liturata, Cl.
signaria, Hb.
clathrata. L.
**biparata*, Ld.
semilutata, Ld.
hopfferaria, Stgr.
luteolata, L.

68. Diastictis, *Hb.*

Face with appressed scales, or short ridge or tuft of projecting scales. Tongue developed. Palpi moderate, porrected or subascending, rough-scaled. Antennæ in ♂ bipectinated, apex simple (sometimes only 2 or 3 joints). Thorax sometimes crested posteriorly, more or less hairy beneath. Femora glabrous or rarely slightly hairy; posterior tibiæ in ♂ often dilated, with all spurs present. Fore wings in ♂ with fovea, sometimes surmounted by a small gland; 10 sometimes anastomosing with 12, often connected with 9, 11 out of 10 towards or above middle, or if lower anastomosing with 12, or often absent. Hind wings with 8 approximated to cell to middle.

A large genus, occurring more or less plentifully in all the principal regions. It is an intermediate development of *Selidosema*.

glarearia, Brahm.
brunneata, Thnb. (?= *fuscaria*, Hb.).
**saburraria*, Ev.
murinaria, F.
pumicaria, Ld.
dalmataria, Gn.
artesiaria, F.
loricaria, Ev.
**costimaculata*, Graes.
wauaria, L.
**halituaria*, Gn.
stevenaria, B.
assimilaria, Rbr.
vincularia. Hb.
semicanaria, Frr.
**legataria*, H.-S.
**perviaria*, Ld.
arenacearia, Hb.
catalaunaria, Gn.
**sparsaria*, Hb.
**griseolaria*, Ev.
**unicoloraria*, Rbr.
Viertlii, Boh.
roboraria, Schiff. (=*Menetriesi*, Stgr.).
consortaria, F. (=*conferenda*, Butl.).
senex, Butl. (=*Hedemanni*, Christ.).

saturniaria, Graes. (=*ocellata*, Leach).
flavomarginaria, Brem.
melanaria, L.

69. Enconista, *Ld.*

Face with tolerably appressed scales. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax rather hairy beneath. Femora glabrous; anterior tibiæ with strong apical hook; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ with fovea, surmounted by a small gland; 10 connected with 9, 11 out of 10, anastomosing with or running into 12. Hind wings with 8 approximated to cell to middle.

An offshoot of *Diastictis;* the single species is South European.

miniosaria, Dup.

70. Ectropis, *Hb.*

Face tolerably smooth or with hardly projecting scales. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ with two short acute projections on each side of each joint, emitting strong fascicles of cilia. Thorax rather hairy beneath. Femora glabrous; posterior tibiæ in ♂ sometimes dilated, with all spurs present. Fore wings in ♂ with fovea; 10 sometimes out of 9 or absent, sometimes connected with 9, 11 sometimes out of 9 or 10, sometimes anastomosing with 12. Hind wings with 8 approximated to cell to middle.

A small genus, but widely and perhaps universally distributed; probably a development of *Selidosema.* In some exotic species the antennal projections are more developed and form short tufted pectinations, but are always paired. The neuration of the fore wings is generally highly variable, and tends to assume a different type in each species, in exotics exceeding even the wide limits assigned above.

luridata, Bkh.
punctularia, Hb.
biundularia, Bkh. (=*crepuscularia*, Hb.; ?=**lutamentaria*, Graes.).
consonaria, Hb.
doerriesiaria, Christ. (?; ♂ not seen; probably new genus).

71. Deileptenia, *Hb.*

Face loosely haired or with appressed scales. Tongue developed. Palpi moderate, subascending, shortly rough-scaled. Antennæ in ♂ bipectinated, apex simple. Thorax with low double posterior crest, hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 11 out of 10 near base, sometimes anastomosing with 12. Hind wings with 8 approximated to cell to middle.

This small genus, to which I can only refer the following species, originates from *Selidosema*, from which it only differs essentially by the absence of the fovea, which has apparently become obsolete.

abietaria, Hb.
**nooraria*, Brem.
mandschuriaria, Brem.

72. Cleora, *Curt.*

Face with tolerably appressed scales. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora nearly glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ with fovea; 10 connected or anastomosing with 9. Hind wings with 8 approximated to cell to middle.

The single species constituting this genus is an offshoot of *Selidosema*, and is confined to Europe.

lichenaria, Hufn.

73. Selidosema, *Hb.*

Face with appressed or shortly projecting scales or small tuft. Tongue developed. Palpi moderate, porrected or subascending, rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax sometimes shortly crested posteriorly, hairy beneath. Femora glabrous or rarely somewhat hairy beneath; posterior tibiæ in ♂ dilated, with all spurs present. Fore wings in ♂ with fovea; 10 sometimes connected with 9, 11 sometimes out of 10 near base only, or if separate, sometimes anastomosing with 12. Hind wings with 8 approximated to cell to middle.

A genus of considerable extent, and universally distributed. It is probably derived from *Synopsia*.

castigataria, Brem.
(=*suifunaria*, Christ.).
gesticularia, Hb.
contaminaria, Hb.
ericetaria, Vill.
**granataria*, Rbr.

tæniolaria, Hb.
ambustaria, H.-G.
variolaria, Stgr.
repandata, L.
extinctaria, Ev.
**cocandaria*, Ersch.
glabraria, Hb.
angularia, Thnb.
umbraria, Hb.
gemmaria, Brahm.
secundaria, Esp.
ilicaria, H.-G.
cinctaria, Schiff.
perversaria, B.
**bituminaria*, Ld.
**bastelicaria*, Bell.
occitanaria, Dup.
**atlanticaria*, Stgr.
**solieraria*, Rbr.

74. Ascotis, *Hb.*

Face with short projecting scales. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ prominently ridged at apex of joints on inner half, emitting half-whorls of rather long cilia. Thorax densely hairy beneath. Femora somewhat hairy; posterior tibiæ in ♂ dilated, with all spurs present. Fore wings in ♂ with fovea; 10 connected with 9. Hind wings with 8 approximated to cell to middle.

The single species occurs through a large part of Europe and Central Asia to Japan. It is an offshoot of a well-marked group of *Selidosema* (perhaps separable as a distinct genus) which is freely represented in the Indo-Malayan, African, and Australian regions, but does not occur in Europe.

selenaria, Hb. (= *cretacea*, Butl.).

75. Eurranthis, *Hb.*

Face with long rough hairs. Tongue obsolete. Palpi moderate or rather long, porrected or ascending, with very long rough hairs. Antennæ in ♂ strongly bipectinated to apex, or with apex dentate only. Thorax hairy beneath. Femora glabrous or hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ with fovea; 10 sometimes connected with 9, 11 out of 10 or absent. Hind wings with 8 approximated to cell to near middle.

Contains only the following species, characteristic of Southern Europe. The genus is a development of *Bupalus*.

plumistaria, Vill.
chrysitaria, H.-G.
pennigeraria, Hb.

76. Bupalus, *Leach.*

Face with rough hairs or sometimes only loosely haired. Tongue developed. Palpi moderate or rather short, porrected, with rough projecting hairs. Antennæ in ♂ bipectinated, apex simple. Thorax hairy beneath. Femora hairy or glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ with fovea; 10 often connected or anastomosing with 9 (sometimes twice), 11 usually out of 10, always running into 12 or concealed by anastomosis of 10 with 12 and so apparently absent. Hind wings with 8 approximated to cell to middle.

A small genus, characteristic of Europe, originating from *Selidosema.*

piniarius, L.
atomarius, L.
carbonarius, Cl.
famulus, Esp.
limbarius, F.
rorarius, F.
fuscus, Thnb.

77. Narraga, *Walk.*

Face with appressed scales. Tongue weak. Palpi moderate, porrected, with long rough projecting hairs. Antennæ in ♂ bipectinated to apex. Thorax rather hairy beneath. Femora glabrous; posterior tibiæ in ♂ hardly dilated, with all spurs present. Fore wings in ♂ with fovea; 10 anastomosing or connected with 12 and 9, 11 absent. Hind wings with 6 and 7 stalked, 8 anastomosing with cell from near base to middle.

The single species, inhabiting South-east Europe, is a development of *Bupalus.* The structure of vein 8 of the hind wings is unique in this family, and is probably a direct effect of the narrowing of the hind wings, which has also caused the stalking of 6 and 7.

fasciolaria, Rott.

78. Tephronia, *Hb.*

Face with appressed scales. Tongue weak. Palpi very short, slender, porrected, second joint rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax somewhat hairy beneath. Femora glabrous; posterior tibiæ in ♂ somewhat dilated, median spurs in both sexes absent or present (*codetaria*). Fore wings in

♂ (and ♀ also) with fovea; 9 absent, 10 absent. Hind wings with 6 and 7 stalked, 8 approximated to cell to beyond middle.

The genus contains only the following species, attached to Central and Southern Europe. It is certainly a somewhat degenerate form of the *Selidosema* group, but it is so far modified that the actual point of connection is doubtful.

sepiaria, Hufn. (= *oppositaria*, Mn.).
cremiaria, Frr.
codetaria, Oberth.

79. Anticypella, n. g.

Face loosely scaled. Tongue developed. Palpi rather short, subascending, shortly rough-scaled. Antennæ in ♂ bipectinated, apex simple. Thorax densely hairy beneath. Femora slightly hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 connected with 12 and 9, 11 out of 10 between connections. Hind wings in ♂ with fovea beneath costa at base; 8 approximated to cell to middle.

The single species known to me is East Asiatic. It is doubtless an offshoot of *Synopsia*.

gigantaria, Stgr.

80. Synopsia, *Hb.*

Face loosely scaled. Tongue developed, sometimes short. Palpi moderate or rather short, subascending, shortly rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax densely hairy beneath. Femora more or less hairy beneath; posterior tibiæ in ♂ more or less dilated, with all spurs present. Fore wings n ♂ without fovea; 10 sometimes connected or anastomosing with 12, sometimes with 9 also, 11 out of 10 or sometimes separate, anastomosing with 12 and rarely with 10 also, or 11 out of 10 between connections. Hind wings with 8 approximated to cell to middle.

This genus, not at present identified outside the European region, seems to originate from a form approaching but not identical with *Nychiodes*.

**barcinonaria*, Bell.
nycthemeraria, H.-G. (?; ♂ not examined; perhaps a *Selidosema*).
fractaria, Stgr.
emaria, Brem.

**Lederi*, Christ.
crassestrigata, Christ.
abruptaria, Thnb.
sociaria, Hb.

81. Nychiodes, *Ld.*

Face with loosely appressed hairs. Tongue rudimentary. Palpi very short, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora thinly hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 connected or anastomosing with 9, 11 out of 10. Hind wings with 8 approximated to cell to middle.

Restricted to the following species. It is closely related to *Synopsia*, and is probably a collateral branch rising from an ancestor approaching the group of *Prosopolopha.*

lividaria, Hb.
amygdalaria, H.-S.
**phasidaria*, Rog.

82. Ephoria, n. g.

Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ shortly bipectinated, apex simple. Thorax hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 out of 9. Hind wings with 8 approximated to cell to middle.

This genus, to which I assign also the Japanese *formosa*, Butl., is apparently nearly related to *Deilinia*, and is probably a collateral offshoot from the same ancestral form. The following species is East Asiatic.

arenosa, Butl.

83. Deilinia, *Hb.*

Face smooth or with small tuft. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax rather hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 out of 9, rarely also 11 out of 9. Hind wings in ♂ with circular fovea at base of vein 8 beneath, fringed with hairs; 8 approximated to cell to near middle.

I now restrict this genus as above; hence, of the Australian species which I formerly placed in it, only *rectaria*, Walk., remains; the rest (differing in the absence of the fovea of hind wings, and in having 11 of the fore wings almost always anastomosing with 12), form a closely allied but distinct genus, for which I propose the name *Trochistis*. *Deilinia* proper occurs throughout the northern hemisphere, though only possessing a few species; it must originate from a form approaching *Euchlæna* and *Metrocampa*.

pusaria, L.
exanthemata, Sc.
straminea, Butl. (=*griscolimbata*, Oberth. = *ustulataria*, Christ.).
**cumulata*, Christ.

84. Lomographa, *Hb.*

Face nearly smooth or with slight tuft. Tongue developed. Palpi moderate or rather short, porrected or subascending, rough-scaled. Antennæ in ♂ bipectinated, towards apex simple. Thorax somewhat hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 absent, 11 sometimes out of 9, sometimes connected or anastomosing with 9 or 12. Hind wings with 8 approximated to cell to near middle.

Closely allied to *Deilinia*, and probably rising from *Euchlæna*. Besides the following there are a few Indo-Malayan and Australian species.

cararia, Hb. (♂ not seen).
dilectaria, Hb.
trimaculata, Vill.
laminaria, H.-S.

85. Scardamia, *Gn.*

Face more or less prominent, with appressed scales. Tongue developed. Palpi moderate, subascending, very shortly scaled. Antennæ in ♂ bipectinated, apex simple. Thorax slightly hairy beneath. Abdomen with dorsal well-defined crest near base. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 11 out of 10, anastomosing with 12. Hind wings with 8 approximated to cell to middle.

A development of *Euchlæna*. It is apparently an Indo-Malayan genus of few species, straggling into Africa, Eastern Asia, and Australia.

aurantiacaria, Brem.

86. Eilicrinia, *Hb.*

Face smooth. Tongue developed. Palpi short, porrected, shortly rough-scaled. Antennæ in ♂ shortly and evenly ciliated. Thorax hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 absent, 11 occasionally connected with 12 and 9. Hind wings with 8 approximated to cell to middle.

A development of *Metrocampa*, with affinity to *Ourapteryx*. It is apparently restricted to the European region.

trinotata, Metz.
subcordaria, H.-S.
cordiaria, Hb. (=*nuptaria*, Brem.).
cauteriata, Stgr.

87. Ourapteryx, *Leach.*

Face somewhat prominent, with short projecting hairs. Tongue developed. Palpi moderate or rather short, porrected or ascending, shortly rough-scaled. Antennæ in ♂ shortly and evenly ciliated. Thorax densely hairy beneath. Femora hairy beneath; posterior tibiæ in ♂ more or less dilated, with all spurs present. Fore wings in ♂ without fovea; 10 absent, 11 anastomosing or connected with 12 and sometimes with 9 also. Hind wings with 8 approximated to cell to near middle.

A small Indo-Malayan genus, containing one European species. It is a development of *Metrocampa*.

sambucaria, L.

88. Metrocampa, *Latr.*

Face smooth or with loosely appressed or projecting scales. Tongue developed. Palpi short or moderate, porrected or subascending, shortly rough-scaled. Antennæ in ♂ bipectinated, apex (often 2 to 4 joints only) simple. Thorax hairy beneath. Femora glabrous or rarely thinly hairy (*honoraria*); posterior tibiæ in ♂ sometimes dilated, with all spurs present. Fore wings in ♂ without fovea; 10 out of 9 or seldom separate, occasionally obsolete at base and then apparently out of 11, 11 anastomosing or connected with 12 and nearly always with 10 also. Hind wings with 8 approximated to cell to middle.

A genus of some extent, ranging throughout the northern hemisphere. It orignates from a form near

Ennomos, and has affinity to *Euchlæna*. I have satisfied myself that in those few individuals where 10 appears to rise out of 11, it really rises out of 9 as usual and anastomoses with 11, but the basal portion is obsolete and not traceable ; were it otherwise, intermediates would certainly occur.

prosapiaria, L. (?=*pinicolaria*, Bell.).
margaritaria, L.
honoraria, Schiff.
serrata, Brem.
**Stschurovskyi*, Ersch.
**pruinosaria*, Brem.
capreolaria, F.
pulveraria, L.
indictinaria, Brem. (=*Snelleni*, Hed.; ?=*emundata*, Christ.).
dolobraria, L.

89. Euchlæna, *Hb.*

Face with appressed scales. Tongue developed. Palpi moderate or short, porrected or ascending, shortly rough-scaled. Antennæ in ♂ bipectinated, apex simple. Thorax hairy beneath. Femora glabrous; posterior tibiæ in ♂ sometimes dilated, with all spurs present. Fore wings in ♂ without fovea ; 10 sometimes connected with 9, 11 out of 10, anastomosing or connected with or sometimes running into 12. Hind wings with 8 approximated to cell shortly or to near middle.

A small genus, inhabiting Europe and North America. It must be derived from a form approaching *Ennomos*.

prunaria, L.
parallelaria, Schiff.
apiciaria, Schiff.

90. Artemidora, n. g.

Face with projecting tuft of scales. Tongue developed. Palpi moderate, porrected or subascending, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax rather hairy beneath. Femora rather hairy beneath; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; a transparent scar on transverse vein ; 6 widely separate from 9, 10 sometimes connected with 9, 11 anastomosing with 12 and 10. Hind wings with 6 and 7 remote, 8 approximated to cell to middle.

Constituted for the following Central Asiatic species. It is probably an offshoot from *Hygrochroa* or an allied form, with collateral affinity to *Selenia*.

maracandaria, Ersch.

91. Selenia. *Hb.*

Face with projecting tuft of scales. Tongue developed. Palpi moderate, porrected or subascending, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax densely hairy beneath. Femora densely hairy beneath; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; a transparent scar on transverse vein; 6 out of 9, 11 rarely connected with 12 or 10. Hind wings with a transparent scar on transverse vein; 6 and 7 stalked, 8 approximated to cell to middle.

Contains the following and two or three North American species. It is an offshoot from *Hygrochroa*.

bilunaria, Esp.
lunaria, Schiff.
tetralunaria, Hufn.
**versicoloraria*, Christ.

92. Hygrochroa, *Hb.*

Face with projecting tuft of scales. Tongue developed. Palpi moderate, subascending, shortly rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax densely hairy beneath. Femora densely hairy beneath; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 sometimes out of 9, sometimes connected with 11. Hind wings with 8 approximated to cell to middle.

A development from the neighbourhood of *Ennomos*. The single species extends throughout the northern and central parts of the European region.

syringaria, L.

93. Cepphis, *Hb.*

Face with loosely appressed scales. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 7 and 8 unusually short, 7 rising above middle of 9, 10 out of 9. Hind wings with 8 approximated to cell to middle.

Allied to *Selenia* and *Hygrochroa*, from one or other of which it is probably an offshoot. The single species ranges throughout Central Europe and Asia to Japan.

advenaria, Hb.

94. Artiora, n. g.

Face with short projecting scales. Tongue short. Palpi short, porrected, shortly rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax rather hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 absent. Hind wings with 8 approximated to cell to middle.

Apparently a development of *Ennomos*. The single species is Central European. The name *Therapis*, used by Hübner to include this species and *flavicaria*, was wrongly applied here by Lederer, as Herrich-Schæffer had already limited it so as to make *flavicaria* the type.

evonymaria, Schiff.

95. Colotois, *Hb.*

Face with rough projecting hairs, with a tuft projecting from beneath antennæ across eye to middle. Tongue short. Palpi very short, porrected, rough-haired. Antennæ in ♂ very strongly bipectinated to apex. Thorax densely hairy above and beneath. Femora densely hairy beneath; posterior tibiæ in ♂ not dilated, with all spurs present, short. Fore wings in ♂ without fovea; 10 sometimes anastomosing or connected with 9, 11 anastomosing or connected with 12 and 10. Hind wings with 8 approximated to cell to middle.

The genus is a development of *Ennomos*, and contains only the one species, which occurs throughout most of the European region.

pennaria, L.

96. Ennomos, *Tr.*

Face with dense projecting scales, or rounded-prominent and with appressed scales, except at sides (*regina*). Tongue more or less developed or rudimentary. Palpi moderate, porrected or subascending, with rough projecting scales. Antennæ in ♂ bipectinated to apex. Thorax densely hairy above and beneath. Femora densely hairy beneath; posterior tibiæ in ♂ not dilated, median spurs very short or absent. Fore wings in ♂ without fovea; 6 sometimes out of 9, 10 rarely out of 9, sometimes anastomosing or connected with 9, 11 often out of 10, anastomosing or connected with or rarely running into 12, sometimes anastomosing or connected with 10 also, rarely absent. Hind wings with 6 and 7 rarely stalked, 8 approximated to cell to middle.

Probably a development of *Gonodontis*. It is a characteristically European genus, though straggling into North America. The position of 6 in both wings is not constant specifically. The median spurs are absent in the first five species, which are therefore more recent forms. The name *Eugonia*, Hb., is preoccupied by Hübner himself earlier in the same work, and cannot be employed here.

quercaria, Hb.
erosaria, Bkh.
**effractaria*, Frr.
fuscantaria, Hw.
alniaria, L.
quercinaria, Hufn.
autumnaria, Wernb.
regina, Stgr.

97. Gonodontis, *Hb.*

Face with dense projecting scales, or rounded-prominent and with tolerably appressed scales (*boisduvaliaria*). Tongue more or less developed or obsolete. Palpi moderate, porrected or subascending, with rough projecting scales. Antennæ in ♂ bipectinated to apex. Thorax densely hairy above and beneath, sometimes tending to form slight triangular anterior crest. Femora densely hairy beneath; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 often connected or anastomosing with 9, 11 occasionally connected or anastomosing with 10. Hind wings with 8 approximated to cell to middle.

The genus markedly approaches *Prosopolopha*, and probably originates with it from some earlier form. It is doubtful whether it occurs outside the European region.

bidentata, Cl.
dardoinaria, Donz.
tusciaria, Bkh.
elinguaria, L.
boisduvaliaria, Luc.

98. Cistidia, *Hb.*

Face roughly hairy or with loosely appressed scales. Tongue developed. Palpi moderate, subascending, rough-scaled or hairy. Antennæ in ♂ sometimes somewhat thickened towards apex, naked or very shortly ciliated. Thorax densely hairy beneath. Abdomen in ♂ very elongate. Femora hairy beneath; posterior tibiæ in ♂ much dilated, with all spurs present but short. Fore wings in ♂ without fovea; 10 sometimes out of 9, connected with 9. Hind wings with 8 approximated to cell to or beyond middle.

A curious genus, yet more peculiar in appearance than in actual structure. It seems to be an isolated development of *Pseudopanthera*, perhaps with some relationship to *Abraxas*. The two following species are East Asiatic and Japanese, and I have a third species from Japan, and a fourth from China.

stratonice, Cr.
couaggaria, Gn. (= *eurypyle*, Mén. = *eurymede*, Motsch.).

99. Abraxas, *Leach*.

Face smooth. Tongue developed. Palpi rather short, subascending, shortly rough-scaled. Antennæ in ♂ stout, ciliated with moderate fascicles. Thorax hairy beneath. Femora glabrous; posterior tibiæ in ♂ dilated, with all spurs present. Fore wings in ♂ without fovea; 10 sometimes connected with 9, 11 out of 10, anastomosing with or running into 12 or absent. Hind wings with 8 approximated to cell shortly or to middle.

A genus of rather limited extent, almost confined to India, China, and Japan, from which countries the few European species are all stragglers; they are all found native there, in company with others, and their present wide distribution is remarkable, and probably to some extent artificial. The genus is a development of *Pseudopanthera*.

grossulariata, L.
pantaria, L.
sylvata, Sc.
adustata, Schiff.
marginata, L.

100. Pseudopanthera, *Hb*.

Face usually more or less rounded or prominent, sometimes slightly tufted on lower edge. Tongue developed. Palpi rather short or moderate, porrected or ascending, rough-scaled. Antennæ in ♂ stout, more or less flatly subdentate, shortly and evenly ciliated. Thorax more or less hairy beneath. Femora glabrous or rarely slightly hairy; posterior tibiæ in ♂ sometimes dilated, with all spurs present. Fore wings in ♂ without fovea; 10 sometimes out of 9, usually connected or anastomosing with 9, 11 sometimes out of 10 or anastomosing with 10, sometimes anastomosing with 12. Hind wings with 8 approximated to cell to middle.

This genus appears to be principally European, though with occasional representatives in other regions. It is a development of *Crocota*.

unio, Oberth.
**ætheriata*, Graes.
clarissa, Butl.
punctata, F.
bimaculata, F.
pictaria, Curt.
macularia, L.
syriacata, Gn.
disparata, Stgr.
variegata, Dup.
**difficilis*, Alph.
glaucinaria, Hb.
sibiriata, Gn.
**creperaria*, Ersch.
obscuraria, Hb.
**onustaria*, H.-S.
ambiguata, Dup.
**stemmataria*, Ev.
obfuscaria, Hb.
**sericaria*, Alph.
**nimbata*, Alph.
furvata, F.
pullata, Tr.
sartata, Tr.
dumetata, Tr.
respersaria, Hb.
**colchidaria*, Ld.
dolosaria, H.-S.
poggearia, Ld.
**gruneraria*, Stgr.
exculta, Butl. (= *semiorbiculata*, Christ.).
**benesignata*, Bell.
hippocastanaria, Hb.
**tibiaria*, Rbr.
asperaria, Hb.
rippertaria, Dup.
scutularia, Dup.
partitaria, Hb.
petraria, Hb.
lineata, Sc.

101. Hyposcotis, *Hb.*

Face forming a rounded prominence, with appressed scales. Tongue developed. Palpi short, porrected, rough-scaled. Antennæ in ♂ shortly bipectinated, becoming simple toward apex. Thorax slightly hairy beneath. Femora glabrous; posterior tibiæ in ♂ dilated, with all spurs present. Fore wings in ♂ without fovea; 10 out of 9, anastomosing with 9, 11 anastomosing with 12 and 10. Hind wings with 8 approximated to cell to middle.

The single species is very closely related to *Pseudopanthera*, and may possibly be a development of it, but more probably a transitional form marking the passage from *Crocota* to *Pseudopanthera*.

mucidaria, Hb.

102. Therapis, *Hb.*

Face prominent beneath, with slightly projecting scales. Tongue developed. Palpi moderately long, porrected, rough-scaled. Antennæ in ♂ bipectinated, apex simple. Thorax slightly hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 and 11 free. Hind wings with 8 approximated to cell to middle.

Probably a development of either *Crocota* or *Pseudopanthera*. The single species inhabits South-east Europe.

flavicaria, Hb.

103. Hypoplectis, *Hb.*

Face with appressed scales. Tongue developed. Palpi short, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax somewhat hairy beneath. Femora glabrous; posterior tibiæ in ♂ slightly dilated, with all spurs present. Fore wings in ♂ without fovea; 10 anastomosing or connected with 12 and 9, 11 absent. Hind wings with 8 approximated to cell to middle.

The single species, which ranges through most of the European region, is an offshoot of *Crocota*.

adspersaria, Hb.

104. Crocota, *Hb.*

Face more or less rounded-prominent or nearly flat, with tolerably appressed scales. Tongue developed. Palpi moderate or rather short, porrected or ascending, rough-scaled or sometimes hairy. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora glabrous or sometimes hairy; posterior tibiæ in ♂ moderately or hardly dilated, with all spurs present. Fore wings in ♂ without fovea; 10 very rarely out of 9, usually connected or anastomosing with 9, 11 rarely out of 10 (*formosaria*), usually connected or anastomosing with 12, occasionally with 10 also. Hind wings with 6 and 7 rarely stalked (*ochrearia*, *curvaria*), 8 approximated to cell to middle. Female sometimes semi-apterous or apterous.

The genus is characteristic of the European region, though stragglers occur elsewhere. It is probably derived from *Biston*.

lutearia, F.
niveata, Sc.
peletieraria, Dup.
sordaria, Thnb.
dilucidaria, Hb (?=*canitiaria*, Gn.).

cœlibaria, H.-S.
serotinaria, Hb.
andereggaria, Lah.
operaria, Hb.
zelleraria, Frr.
tenebraria, Esp.
emucidaria, Dup.
belgaria, Hb.
**penulataria*, Hb.
**tekkearia*, Christ.
conspersaria, F. (?=*raunaria*, Frr.).
**lentiscaria*, Donz.
Iveni, Ersch.
acuminaria, Ev. (=*glossaria*, Christ.; =*opulentaria*, Stgr.).
mundataria, Cr.
**Sieversi*, Christ.
strigillaria, Hb. (?=*bæticaria*, Rbr.).
formosaria, Ev.
**rectaria*, Frr.
**violentaria*, Christ.
curvaria, Ev.
gilvaria, F.
ochrearia, Ross.
**insignis*, Alph.
**unifasciata*, Mén.
pravata, Hb.

105. Theria, *Hb.*

Face with appressed scales. Tongue weak. Palpi very short, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax slightly hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 out of 9, sometimes connected or anastomosing with 9, 11 out of 9, anastomosing or connected with 12 and 10. Hind wings with 8 approximated to cell to near middle. Female semi-apterous.

A development from *Crocota*, which it closely resembles. The single species is European.

rupicapraria, Hb.

106. Lignyoptera, *Ld.*

Face loosely rough-haired. Tongue weak. Palpi moderate, porrected, with long rough hairs. Antennæ in ♂ shortly bipectinated, apex simple. Thorax roughly hairy above and beneath. Femora hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 11 anastomosing with 12. Hind wings with 8 approximated to cell to middle. Female apterous (?).

An offshoot from *Crocota;* the only species inhabits South-east Europe.

fumidaria, Hb.

107. Psodos, *Tr.*

Face with long rough hairs. Tongue developed. Palpi moderate, porrected, with long projecting hairs. Antennæ in ♂ stout, shortly ciliated. Thorax roughly hairy beneath. Femora hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 sometimes absent, 11 anastomosing or connected with 12 and seldom with 9 also. Hind wings with 6 and 7 sometimes short-stalked, 8 approximated to cell to middle.

This small genus, confined to the European mountains, is derived from *Crocota*, with close collateral affinity to *Lignyoptera*.

alticolaria, Mn.
coracina, Esp.
trepidaria, Hb.
alpinata, Sc.
quadrifaria, Sulz.

108. Hybernia, *Latr.*

Face with appressed scales or shortly rough-scaled. Tongue developed or weak. Palpi short or rather short, porrected, shortly rough-scaled. Antennæ in ♂ either bipectinated, pectinations sometimes short and terminating in fascicles of cilia, apex simple; or with two very short processes on each side of each joint, emitting long fascicles of cilia. Thorax with small triangular anterior crest, hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 sometimes out of 9, sometimes anastomosing or connected with 9, 11 sometimes out of 10, usually anastomosing with or running into 12, rarely absent. Hind wings with 8 approximated to cell to middle. Female semiapterous or apterous.

The genus is closely allied to *Crocota*, and probably derived with it from *Biston*. It is characteristic of the European region, though stragglers occur elsewhere also.

leucophæaria, Schiff.
bajaria, Schiff.
marginaria, Bkh.
defoliaria, Cl.
aurantiaria, Esp.
ankeraria, Stgr.
declinans, Stgr.

109. Apocheima, *Hb.*

Face roughly hairy. Tongue very short or rudimentary. Palpi short or moderate, porrected, rough-haired. Antennæ in ♂ bipectinated to apex, or with apex simple. Thorax clothed with dense hairs above, with slight anterior triangular crest, beneath densely hairy. Femora densely hairy; posterior tibiæ in ♂ not dilated, without median spurs, or rarely with spurs present but short (*pedaria* and *tartarica*). Fore wings in ♂ without fovea; 6 rarely out of 9, 10 usually anastomosing or connected with 9, 11 sometimes out of 10 or absent, or running into 12, or concealed by anastomosis of 10 with 12. Hind wings with 6 and 7 sometimes stalked, 8 approximated to cell to middle. Female with wings rudimentary or absent.

Almost confined to the European region; it is developed from *Biston*. The variation in structure is rather considerable, but not available for generic subdivision.

lefuaria, Ersch. (=*olgaria*, Oberth.; (=*maturaria*, Christ.).
fiduciaria, Ank.
zonaria, Schiff.
alpina, Sulz.
græcaria, Stgr.
**liquidaria*, Ev.
lapponaria, B.
pomonaria, Hb.
**lanaria*, Ev.
hispidaria, F.
**arcanaria*, Mill.
cineraria, Ersch.
**declinata*, Stgr. (?)
**tartarica*, Stgr.
pedaria, F.

110. Zamacra, n. g.

Face rough-haired, with horny triangular projection. Tongue rudimentary. Palpi rather short, porrected, rough-haired. Antennæ in ♂ strongly bipectinated to apex. Thorax densely haired above, with slight traces of anterior crest, beneath densely hairy. Femora densely hairy; posterior tibiæ without median spurs, in ♂ not dilated. Fore wings in ♂ without fovea; 10 absent, 11 anastomosing with 12. Hind wings with 6 and 7 stalked, 8 approximated to cell nearly throughout.

The single species is a development of *Biston*, from which it does not greatly differ, and inhabits the shores of the Mediterranean.

flabellaria, Heeg.

111. Biston, *Leach.*

Face densely rough-haired or rough-scaled. Tongue developed or very short or obsolete. Palpi moderate or short, porrected, rough-haired or rough-scaled. Antennæ in ♂ strongly bipectinated to apex, or with apex simple. Thorax densely haired above, with slight loose anterior crest, beneath densely hairy. Femora densely hairy; posterior tibiæ hairy, with median spurs very short or absent, in ♂ not dilated. Fore wings in ♂ without fovea; 10 usually connected or anastomosing with 9, 11 usually out of 10, rarely free or absent. Hind wings with 8 approximated to cell to middle.

Probably this may be derived from a form approaching *Phaselia*. The species are not numerous; besides the following, there are a few in India and Africa.

hirtarius, Cl.
necessarius, Z.
stratarius, Hufn.
tendinosarius, Brem.
**hueberarius*, Ball.
betularius, L.

112. Spartopteryx, *Gn.*

Palpi short. Antennæ in ♂ bipectinated to apex. Posterior tibiæ with all spurs present. Female semiapterous, anterior wings linear.

I have not seen the single Siberian species which constitutes this genus, and can only give the above-mentioned fragmentary details from Guenée. I conjecture, however, that it is probably a good genus, and allied to the ancestral form of *Phaselia*.

**serrularia*, Ld. (=*kindermannaria*, Stgr.).

113. Phaselia, *Gn.*

Face with tolerably appressed scales. Tongue obsolete. Palpi very short, porrected, rough-scaled. Antennæ in both sexes bipectinated to apex. Thorax with loose lateral and posterior crests, beneath densely hairy. Femora glabrous; posterior tibiæ without median spurs, in ♂ not dilated. Fore wings in ♂ without fovea; 10 connected with 9. Hind wings with 8 approximated to cell to middle.

Doubtless a development from the *Prosopolopha* group, but the actual point of connection seems uncertain. The genus seems attached to South-east Europe and South-west Asia.

serrularia, Ev.
**deliciosaria*, Ld.
**strictaria*, Ld.

114. Chemerina, *B.*

Face with appressed scales, crown with defined posterior tuft. Tongue developed. Palpi moderate, porrected, rough-scaled. Antennæ in ♂ bipectinated, apex simple. Thorax hairy beneath. Femora glabrous; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 out of 9, anastomosing with 11 and 9. Hind wings with 8 approximated to cell to middle.

The single species is nearly allied to *Prosopolopha*, of which it may be a development; it frequents the Mediterranean coasts.

caliginearia, Rbr.

115. Onychora, n. g.

Face subprominent, with appressed hairs. Tongue developed. Palpi rather short, porrected, rough-haired. Antennæ in ♂ bipectinated to apex. Thorax hairy beneath. Femora slightly hairy; anterior tibiæ very short, with strong apical hook; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 out of 9, anastomosing with 9, 11 anastomosing with 12 and 10. Hind wings with 8 approximated to cell to middle.

The only species is doubtless derived from *Prosopolopha;* it inhabits South-west Europe.

agaritharia, Dard.

116. Prosopolopha, *Ld.*

Face rough-haired, forehead sometimes tufted. Tongue developed. Palpi rather short, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax densely haired, with slight loose triangular anterior crest, beneath densely hairy. Femora hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 anastomosing with 9, 11 anastomosing with 12 and 10. Hind wings with 8 approximated to cell to beyond middle.

This genus was named *Ligia* by Duponchel, but the name is preoccupied in the Crustacea. The limits of the genus and its geographical range are somewhat uncertain; the group to which it belongs is most numerously represented in Australia, but is everywhere fragmentary and now probably dying out.

modesta, Stgr.
**turanica*, Ersch.
**ciliaria*, Mén.
**argentaria*, H.-S.
jourdanaria, Vill.
opacaria, Hb.

117. Axia, *Hb.*

Face rough-haired. Tongue weak. Palpi short, porrected, rough-scaled. Antennæ in ♂ bipectinated to apex. Thorax with collar forming an erect crest, patagia loosely rough-scaled, beneath hairy. Femora slightly hairy; posterior tibiæ in ♂ not dilated, with all spurs present. Fore wings in ♂ without fovea; 10 connected with 9. Hind wings with 8 approximated to cell throughout and to basal fourth of 7, thence diverging.

The peculiar structure of vein 8 of the hind wings distinguishes this genus at once, but it is notwithstanding nearly allied to *Prosopolopha*, and is probably at the same time one of the most primitive types of the *Geometrina*, retaining indications of its affinity to other groups. Only one species is known, which inhabits South-west Europe, and appears always rare.

margarita, Hb.

APPENDIX OF STATISTICS OF NEURAL VARIATION IN THE *SELIDOSEMIDÆ*.

As in the *Selidosemidæ* the structure of veins 10 and 11 of the fore wings is in many instances liable to vary to an unusual extent within the limits of the same genera and species, I give here an analysis of the results obtained from the inspection of the specimens examined for the purpose of this paper. Before doing so I have to acknowledge my indebtedness to Miss M. Kimber, F.E.S., for much valuable assistance; Miss Kimber very kindly accumulated from correspondents, and subsequently examined the neuration of, a considerable number of specimens of the commoner British species, and thus enabled these observations to be established on a wider basis than could otherwise have been the case.

In the following results the species are arranged in the order of the preceding classification. All the species of the family are given, except where no variation was found within the limits of the genus; in such cases the generic diagnosis sufficiently expresses the result. The number enclosed in brackets following the name of the species gives the total number of specimens examined; that which follows each statement of neural characters gives the number of specimens found to display characters in accordance with such statement. As a rule, more pains have been taken to examine a number of specimens in those species where the examination of a few indicated liability to variation. In interpreting the statement of characters, it must of course be remembered that, as usual, veins 10 and 11 are understood to be free and separate so far as they are not expressly stated to be otherwise. I would mention also that the accurate ascertainment of the neuration in an individual of this family is commonly much more difficult than might be supposed; the veins in question are nearly always very close together throughout their course, and a tendency to connection is often shown where no actual connection exists; on the other hand, the connecting bar is frequently hard to observe, and really doubtful cases sometimes occur. Allowance must be made for these difficulties; but I think the results are not without value as a numerical record of structural variability. I might also point out to those who advocate the naming of mere varieties that these examples of structural variation are at least as worthy of the dignity of a name as any examples of colour variation; so that in the case of a species with perhaps six colour varieties and as many structural, the various combinations would require no less than 36 names.

Zettienia albonotaria, Brem. (1).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).
Z. rufescentaria, Motsch. (2).
10 connected with 12, 11 out of 10. (1).
11 out of 12, anastomosing with 10. (1).
Opisthograptis æstimaria, Hb. (4).
10 connected with 12, 11 absent. (2).
10 connected with 12 and 9, 11 absent. (2).
O. proditaria, Brem. (1).
10 connected with 12, 11 absent. (1).
O. luridulata, Stgr. (1).
10 connected with 9, 11 absent. (1).
O. graphata, Hed. (1).
11 absent. (1).
O. notata, L. (15).
10 connected or anastomosing with 9, 11 absent. (7).
10 connected with 12 and 9, 11 absent. (8).
O. alternaria, Hb. (4).
10 connected with 12, 11 absent. (2).
10 connected with 12 and 9, 11 absent. (2).
O. liturata, Cl. (16).
11 absent. (3).
10 connected with 9, 11 absent. (5).
10 connected with 12, 11 absent. (8).
O. signaria, Hb. (3).
10 connected with 9, 11 absent. (2).
10 anastomosing with 12 and connected with 9, 11 absent. (1).
O. clathrata, L. (34).
10 connected with 9, 11 absent. (3).
10 anastomosing with 12, 11 absent. (9).
10 anastomosing or connected with 12 and 9, 11 absent. (21).
10 anastomosing with 12 and 9, 11 out of 10 between connections. (1).
O. semilutata, Ld. (1).
11 out of 10. (1).
O. hopfferaria, Stgr. (2).
10 connected with 9, 11 absent. (2).
O. luteolata, L. (48).
11 out of 10. (13).
10 connected with 9, 11 out of 10. (12).
10 anastomosing with 12 and connected with 9, 11 out of 10 between connections. (2).
11 absent. (10).

10 connected with 9, 11 absent. (10).

10 anastomosing with 12 and connected with 9, 11 absent. (1).

Diastictis glarearia, Brahm. (3).

10 connected or anastomosing with 12 and 9, 11 absent. (3).

D. brunneata, Thnb. (3).

10 connected or anastomosing with 12 and 9, 11 absent. (3).

D. murinaria, F. (4).

11 absent. (1).

10 connected with 9, 11 absent. (2).

11 out of 10, connected with 12. (1).

D. pumicaria, Ld. (1).

10 anastomosing with 12 and 9, 11 out of 10 between connections. (1).

D. dalmataria, Gn. (1).

10 anastomosing with 12 and 9, 11 out of 10 between connections. (1).

D. artesiaria, F. (1).

10 anastomosing with 12 and connected with 9, 11 absent. (1).

D. loricaria, Ev. (5).

10 anastomosing or connected with 12 and 9, 11 absent. (5).

D. wauaria, L. (28).

11 absent. (1).

10 connected with 9, 11 absent. (4).

10 connected with 12, 11 absent. (5).

10 connected with 12 and 9, 11 absent. (18).

D. stevenaria, B. (1).

10 connected with 9, 11 out of 10, anastomosing with 12. (1).

D. assimilaria, Rbr. (1).

10 connected with 9, 11 out of 10, anastomosing with 12. (1).

D. vincularia, Hb. (1).

10 connected with 9, 11 absent. (1).

D. semicanaria, Frr. (1).

11 out of 10, anastomosing with 12. (1).

D. arenacearia, Hb. (4).

11 out of 10, anastomosing with 12. (1).

10 connected with 9, 11 absent. (1).

10 connected with 12 and 9, 11 absent. (2).

D. catalaunaria, Gn. (1).

10 connected with 12, 11 out of 10. (1).

D. Viertlii, Boh. (1).

10 connected with 9, 11 absent. (1).

D. roboraria, Schiff. (6).
10 connected with 12 and 9, 11 absent. (5).
10 connected with 12 and 9, 11 out of 10 between connections. (1).
D. consortaria, F. (7).
10 connected with 12, 11 out of 10. (1).
10 anastomosing or connected with 12 and 9, 11 out of 10 above connections. (5).
10 connected or anastomosing with 12 and 9, 11 absent. (1).
D. senex, Butl. (4).
11 out of 10, anastomosing with 12. (4).
D. saturniaria, Graes. (3).
10 connected with 9, 11 out of 10, anastomosing with 12. (3).
D. flavomarginaria, Brem. (1).
10 anastomosing with 9, 11 out of 10, anastomosing with 12. (1).
D. melanaria, L. (3).
11 out of 10, anastomosing with 12. (2).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).
Ectropis luridata, Bkh. (6).
10 and 11 separate. (6).
E. punctularia, Hb. (31).
10 anastomosing with 12, 11 out of 10. (1).
10 absent. (13).
10 absent, 11 anastomosing or connected with 12. (16).
10 absent, 11 out of 9, anastomosing with 12 and connected with 9. (1).
E. biundularia, Bkh. (61).
10 out of 9, 11 out of 9. (1).
10 out of 9, connected with 9, 11 out of 9. (1).
10 out of 9, 11 out of 10. (31).
10 out of 9, connected with 9, 11 out of 10. (3).
10 absent, 11 connected with 9. (1).
10 absent, 11 out of 9. (22).
10 absent, 11 out of 9, connected with 9. (2).
E. consonaria, Hb. (15).
11 out of 10, anastomosing with 12. (12).
10 connected with 9, 11 out of 10, anastomosing with 12. (2).
10 absent, 11 anastomosing with 12. (1).
E. doerriesiaria, Christ. (1).
10 out of 11, anastomosing with 9. (1).
Deileptenia abietaria, Hb. (8).
11 out of 10, anastomosing with 12. (8).

D. mandschuriaria, Brem. (1).
 10 out of 11 near base. (1).
Cleora lichenaria, Hufn. (19).
 10 connected or anastomosing with 9. (19).
Selidosema castigataria, Brem. (2).
 10 connected with 9. (2).
S. gesticularia, Hb. (1).
 10 and 11 separate. (1).
S. contaminaria, Hb. (1).
 10 and 11 separate. (1).
S. ericetaria, Vill. (24).
 10 and 11 separate. (6).
 10 connected or anastomosing with 9. (17).
 11 out of 10 near base. (1).
S. tæniolaria, Hb. (1).
 10 connected with 9. (1).
S. ambustaria, H.-G. (1).
 10 connected with 9. (1).
S. variolaria, Stgr. (1).
 10 out of 11 near base, connected with 9. (1).
S. repandata, L. (55).
 10 and 11 separate. (7).
 10 connected or anastomosing with 9. (37).
 11 anastomosing with 12. (5).
 10 connected or anastomosing with 9, 11 anastomosing with 12. (3).
 11 out of 10 near base. (3).
S. extinctaria, Ev. (1).
 10 and 11 separate. (1).
S. glabraria, Hb. (3).
 10 connected with 9. (2).
 10 connected with 9, 11 out of 10 near base. (1).
S. angularia, Thnb. (1).
 11 out of 10 near base. (1).
S. umbraria, Hb. (2).
 10 and 11 separate. (2).
S. gemmaria, Brahm. (65).
 10 and 11 separate. (19).
 10 connected with 9. (40).
 10 out of 9 near base. (1).
 10 connected with 9, 11 out of 10 near base. (5).
S. secundaria, Esp. (3).
 10 connected with 9. (3).

S. ilicaria, H.-G. (1).
10 connected with 9. (1).
S. cinctaria, Schiff. (33).
10 and 11 separate. (20).
10 connected with 9. (11).
10 connected with 9, 11 connected with 12. (2).
S. perversaria, B. (1).
10 and 11 separate. (1).
S. occitanaria, Dup. (1).
10 and 11 separate. (1).
Eurranthis plumistaria, Vill. (3).
11 absent. (1).
10 connected with 9, 11 absent. (2).
E. chrysitaria, H.-G. (2).
11 out of 10. (2).
E. pennigeraria, Hb. (2).
11 out of 10. (2).
Bupalus piniarius, L. (68).
10 anastomosing with 9, 11 running into 12. (6).
10 anastomosing twice with 9, 11 running into 12. (2).
10 anastomosing with 9, then with 12 and 9 again, 11 running into 12. (1).
10 anastomosing with 9, 11 out of 10, running into 12. (31).
10 anastomosing with 12 and 9, 11 absent. (28).
B. atomarius, L. (34).
10 anastomosing with 12, 11 absent. (12).
10 anastomosing or connected with 12 and 9, 11 absent. (22).
B. carbonarius, Cl. (4).
10 connected with 9, 11 out of 10, running into 12. (2).
10 anastomosing with 12, 11 absent. (2).
B. famulus, Esp. (3).
10 connected with 9, 11 out of 10, running into 12. (3).
B. limbarius, F. (5).
11 out of 10, running into 12. (1).
10 connected with 9, 11 out of 10, running into 12. (4).
B. rorarius, F. (2).
10 connected with 9, 11 out of 10, running into 12. (2).
B. fuscus, Thnb. (2).
10 anastomosing or connected with 12 and 9, 11 absent. (2).
Synopsia nycthemeraria, H.-G.
10 connected with 9. (1).
S. fractaria, Stgr. (1).
10 connected with 9, 11 anastomosing with 12. (1).

S. emaria, Brem. (1).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).

S. crassestrigata, Christ. (1).
10 anastomosing with 12 and 9, 11 out of 10 between connections. (1).

S. abruptaria, Thnb. (30).
10 connected with 9, 11 out of 10. (1).
10 connected with 12, 11 out of 10. (1).
10 connected or anastomosing with 12 and 9, 11 out of 10 between connections. (3).
11 out of 10, anastomosing with 12. (8).
10 connected or anastomosing with 9, 11 out of 10, anastomosing with 12. (16).
10 anastomosing with 9, 11 out of 10, anastomosing with 12 and 10. (1).

S. sociaria, Hb. (4).
10 anastomosing with 9, 11 out of 10, anastomosing with 12. (4).

Deilinia pusaria, L. (18).
10 out of 9. (18).

D. exanthemata, Sc. (49).
10 out of 9. (48).
10 and 11 out of 9. (1).

D. straminea, Butl. (1).
10 out of 9. (1).

Lomographa cararia, Hb. (1).
10 absent, 11 connected with 9. (1).

L. dilectaria, Hb. (1).
10 absent, 11 connected with 9. (1).

L. trimaculata, Vill. (3).
10 absent. (1).
10 absent, 11 connected with 9. (2).

L. laminaria, H.S. (2).
10 absent, 11 out of 9, anastomosing with 12. (2).

Ourapteryx sambucaria, L. (36).
10 absent, 11 anastomosing with 12. (8).
10 absent, 11 anastomosing or connected with 12 and 9. (28).

Metrocampa prosapiaria, L. (28).
10 out of 9, 11 anastomosing with 12. (2).
10 out of 9, 11 anastomosing with 12 and 10. (8).
10 out of 9, anastomosing with 9, 11 anastomosing with 12 and 10. (13).

10 out of 9, anastomosing with 12, 11 running into 12. (1).
11 out of 10, anastomosing with 12. (3).
10 connected with 9, 11 out of 10, connected with 12. (1).

M. margaritaria, L. (45).
11 anastomosing with 12 and 10. (3).
10 out of 9, 11 anastomosing or connected with 12. (3).
10 out of 9, anastomosing with 9, 11 anastomosing with 12. (1).
10 out of 9, 11 anastomosing or connected with 12 and 10. (7).
10 out of 9, anastomosing or connected with 9, 11 anastomosing or connected with 12 and 10. (31).

M. honoraria, Schiff. (3).
11 anastomosing or connected with 12 and 10. (1).
10 out of 9, anastomosing with 9, 11 anastomosing with 12 and 10. (2).

M. serrata, Brem. (2).
11 anastomosing with 12 and 10. (2).

M. capreolaria, F. (4).
10 out of 9, connected with 9, 11 anastomosing with 12 and 10. (3).
10 connected with 9, 11 out of 10, anastomosing with 12 and 10. (1).

M. pulveraria, L. (16).
10 out of 9, 11 anastomosing or connected with 12 and 10. (14).
11 out of 10, anastomosing or connected with 12 and 10. (2).

M. indictinaria, Brem. (1).
10 out of 9, 11 anastomosing with 12 and 10. (1).

M. dolobraria, L. (13).
11 connected or anastomosing with 12 and 10. (9).
10 out of 9, 11 connected or anastomosing with 12 and 10. (3).
11 out of 10, connected with 12 and 10. (1).

Euchlæna prunaria, L. (16).
11 out of 10, anastomosing with 12. (6).
11 out of 10, running into 12. (2).
10 connected with 9, 11 out of 10, anastomosing with 12. (8).

E. parallelaria, Schiff. (13).
10 connected with 9, 11 out of 10, anastomosing with 12. (11).
11 out of 10, anastomosing with 12. (2).

E. apiciaria, Schiff. (23).
11 out of 10, anastomosing with 12. (6).

10 connected with 9, 11 out of 10, anastomosing or connected with 12. (17).

Artemidora maracandaria, Ersch. (2).

11 anastomosing with 12 and 10. (1).

10 connected with 9, 11 anastomosing with 12 and 10. (1).

Selenia bilunaria, Esp. (51).

10 and 11 separate. (47).

11 anastomosing with 12. (4).

S. lunaria, Schiff. (9).

10 and 11 separate. (9).

S. tetralunaria, Hufn. (21).

10 and 11 separate. (20).

10 connected with 11. (1).

Hygrochroa syringaria, L. (10).

10 and 11 separate. (8).

10 connected with 11. (1).

10 out of 9. (1).

Colotois pennaria, L. (50).

11 anastomosing or connected with 12 and 10. (2).

10 anastomosing or connected with 9, 11 anastomosing or connected with 12 and 10. (48).

Ennomos quercaria, Hb. (1).

10 connected with 12 and 9, 11 out of 10 between connections. (1).

E. erosaria, Bkh. (17).

11 out of 10, connected or anastomosing with 12. (5).

10 connected or anastomosing with 9, 11 out of 10, connected or anastomosing with 12. (5).

11 out of 10, anastomosing with 12 and 10. (2).

10 anastomosing with 9, 11 out of 10, anastomosing with 12 and 10. (1).

10 anastomosing with 12 and 9, 11 out of 10 between connections. (3).

10 anastomosing with 12 and 9, 11 absent. (1).

E. fuscantaria, Hw. (3).

11 connected with 12. (3).

E. alniaria, L. (39).

11 anastomosing with 12. (1).

10 anastomosing with 12, 11 running into 12. (1).

10 anastomosing with 9, 11 running into 12. (1).

10 anastomosing or connected with 9, 11 anastomosing with 12 and 10. (23).

11 anastomosing or connected with 12 and 10. (13).

E. quercinaria, Hufn. (24).

11 out of 10, anastomosing with 12. (1).

10 anastomosing or connected with 9, 11 out of 10, anastomosing or connected with 12. (3).

11 out of 10, anastomosing with 12 and 10. (1).

10 connected with 9, 11 out of 10, anastomosing with 12 and 10. (16).

10 anastomosing with 9, 11 anastomosing or connected with 12 and 10. (1).

10 anastomosing with 12, 11 absent. (2).

E. autumnaria, Wernb. (24).

11 connected or anastomosing with 12 and 10. (11).

10 connected or anastomosing with 9, 11 connected or anastomosing with 12 and 10. (10).

10 anastomosing with 9, 11 out of 10, anastomosing with 12 and 10. (1).

11 out of 10, anastomosing with 12 and 10. (1).

10 anastomosing with 12, 11 running into 12. (1).

E. regina, Stgr. (1).

10 connected with 9, 11 anastomosing with 12 and 10. (1).

Gonodontis bidentata, Cl. (21).

10 and 11 separate. (11).

10 connected or anastomosing with 9. (3).

10 connected or anastomosing with 11 and 9. (7).

G. dardoinaria, Donz.

10 anastomosing with 9. (1).

G. tusciaria, Bkh. (3).

10 and 11 separate. (1).

10 connected or anastomosing with 9. (2).

G. elinguaria, L. (36).

10 and 11 separate. (1).

10 anastomosing or connected with 9. (34).

11 connected with 12. (1).

G. boisduvaliaria, Luc. (1).

10 and 11 separate. (1).

Cistidia stratonice, Cr. (2).

10 connected with 9. (2).

C. couaggaria, Gn. (4).

10 out of 9, connected with 9. (4).

Abraxas grossulariata, L. (31).

11 out of 10, running into 12. (21).

10 connected with 9, 11 out of 10, running into 12. (8).

11 absent. (2).

A. pantaria, L. (3).
 10 connected with 9, 11 out of 10, running into 12. (3).
A. sylvata, Sc. (27).
 11 out of 10, running into 12. (1).
 11 out of 10, anastomosing with 12. (1).
 10 connected with 9, 11 out of 10, running into 12. (25).
A. adustata, Schiff. (18).
 11 out of 10, running into 12. (2).
 10 connected with 9, 11 out of 10, running into 12. (14).
 11 absent. (2).
A. marginata, L. (30).
 11 out of 10, running into 12. (2).
 11 absent. (28).
Pseudopanthera unio, Oberth. (1).
 10 anastomosing with 9, 11 out of 10, anastomosing with 12. (1).
P. clarissa, Butl. (4).
 11 out of 10. (4).
P. punctata, F. (17).
 10 out of 9. (10).
 10 and 11 out of 9. (1).
 10 out of 9, 11 connected or anastomosing with 10. (3).
 10 out of 9, 11 out of 9, anastomosing with 10. (1).
 10 out of 9, 11 connected with 12 and 10. (2).
P. bimaculata, F. (6).
 10 out of 9. (2).
 10 out of 9, 11 anastomosing with 12. (3).
 10 out of 9, 11 connected or anastomosing with 12 and 10. (1).
P. pictaria, Curt. (4).
 10 out of 9, 11 anastomosing with 12 and 10. (2).
 10 out of 9, anastomosing with 9, 11 anastomosing with 12 and 10. (2).
P. macularia, L. (57).
 10 and 11 separate. (4).
 11 anastomosing or connected with 12. (45).
 10 connected with 9, 11 anastomosing with 12. (8).
P. syriacata, Gn. (2).
 11 anastomosing with 12. (2).
P. disparata, Stgr. (2).
 10 out of 11, connected with 9. (2).
P. variegata, Dup. (2).
 10 out of 9, anastomosing with 9, 11 anastomosing with 12 and 10. (2).

P. glaucinaria, Hb. (3).
10 out of 9, anastomosing with 11 and 9. (3).
P. sibiriata, Gn. (1).
10 out of 9, anastomosing with 11 and 9. (1).
P. obscuraria, Hb. (38).
10 out of 9, anastomosing with 11 and 9. (31).
10 out of 9, anastomosing with 9, 11 anastomosing with 12 and 10. (7).
P. ambiguata, Dup. (1).
10 out of 9, anastomosing with 11 and 9. (1).
P. obfuscaria, Hb. (13).
10 connected or anastomosing with 9. (5).
10 anastomosing with 11. (1).
10 anastomosing or connected with 11 and 9. (5).
10 out of 11, anastomosing with 9. (2).
P. furvata, F. (1).
10 connected with 9. (1).
P. pullata, Tr. (1).
10 and 11 separate. (1).
P. sartata, Tr. (1).
10 connected with 9. (1).
P. dumetata, Tr. (1).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).
P. respersaria, Hb. (1).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).
P. dolosaria, H.S. (1).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).
P. poggearia, Ld. (1).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).
P. exculta, Butl. (1).
10 connected with 9, 11 out of 10, anastomosing with 12. (1).
P. hippocastanaria, Hb. (6).
10 connected with 9. (1).
10 connected with 11. (2).
10 connected or anastomosing with 11 and 9. (3).
P. asperaria, Hb. (3).
11 anastomosing with 12. (1).
10 connected with 9, 11 out of 10, running into 12. (1).
10 connected with 9, 11 absent. (1).
P. rippertaria, Dup. (1).
10 and 11 separate. (1).
P. scutularia, Dup. (1).
10 and 11 separate. (1).

P. partitaria, Hb. (1).
10 and 11 separate. (1).
P. petraria, Hb. (42).
10 and 11 separate. (7).
10 connected or anastomosing with 9. (28).
10 anastomosing with 11. (1).
10 out of 9, connected with 9. (2).
10 connected or anastomosing with 11 and 9. (4).
P. lineata, Sc. (16).
10 and 11 separate. (11).
10 anastomosing with 9. (2).
10 anastomosing with 11 and 9. (1).
11 connected with 12. (1).
10 anastomosing with 9, 11 connected with 12. (1).
Crocota lutearia, F. (3).
10 connected or anastomosing with 9, 11 connected or anastomosing with 12. (3).
C. niveata, Sc. (1).
10 connected with 9, 11 connected with 12. (1).
C. peletieraria, Dup. (1).
10 connected with 9, 11 connected with 12. (1).
C. sordaria, Thnb. (1).
10 anastomosing with 9, 11 anastomosing with 12. (1).
C. dilucidaria, Hb. (2).
10 anastomosing or connected with 9, 11 anastomosing with 12. (2).
C. cœlibaria, H.-S. (1).
10 connected with 9, 11 connected with 12. (1).
C. serotinaria, Hb. (1).
10 connected with 9, 11 connected with 12. (1).
C. andereggaria, Lah. (1).
10 anastomosing with 9, 11 anastomosing with 12. (1).
C. operaria, Hb. (2).
10 connected or anastomosing with 9, 11 connected with 12. (2).
C. zelleraria, Frr. (2).
10 anastomosing or connected with 9. (2).
C. tenebraria, Esp. (1).
10 connected with 9. (1).
C. emucidaria, Dup. (1).
10 connected with 9, 11 connected with 12. (1).
C. belgaria, Hb. (5).
10 connected with 9, 11 connected with 12. (5).

C. conspersaria, F. (2).

11 connected with 12. (1).

10 connected with 9, 11 connected with 12. (1).

C. Iveni, Ersch. (1).

10 anastomosing with 9, 11 anastomosing with 12 and 10. (1).

C. acuminaria, Ev. (2).

10 anastomosing with 9, 11 anastomosing with 12 and 10. (2).

C. mundataria, Cr. (1).

10 and 11 separate. (1).

C. strigillaria, Hb. (19).

10 anastomosing with 9. (4).

10 connected or anastomosing with 9, 11 connected or anastomosing with 12. (13).

10 out of 9, connected with 9, 11 anastomosing with 12. (2).

C. formosaria, Ev. (2).

10 connected with 9, 11 out of 10, anastomosing with 12. (2).

C. curvaria, Ev. (2).

10 anastomosing or connected with 9, 11 anastomosing with 12. (2).

C. gilvaria, F. (9).

10 anastomosing with 9. (2).

10 anastomosing with 11 and 9. (1).

11 anastomosing with 12 and 10. (1).

10 anastomosing or connected with 9, 11 anastomosing with 12. (5).

C. ochrearia, Ross. (11).

10 anastomosing with 9. (5).

11 connected with 12. (1).

10 anastomosing with 9, 11 connected with 12. (5).

C. pravata, Hb. (1).

11 connected with 12. (1).

Theria rupicapraria, Hb. (18).

10 out of 9, 11 out of 9, anastomosing with 12 and 10. (4).

10 out of 9, anastomosing or connected with 9, 11 out of 9, anastomosing or connected with 12 and 10. (14).

Psodos alticolaria, Mn. (1).

10 absent, 11 anastomosing with 12. (1).

P. coracina, Esp. (1).

10 absent, 11 anastomosing with 12. (4).

P. trepidaria, Hb. (5).

10 absent, 11 anastomosing or connected with 12. (4).

10 absent, 11 connected with 12 and 9. (1).

P. alpinata, Sc. (3).
 11 connected or anastomosing with 12. (3).
P. quadrifaria, Sulz. (3).
 11 connected with 12. (3).
Hybernia leucophæaria, Schiff. (23).
 11 anastomosing with 12. (4).
 11 running into 12. (17).
 10 connected with 9, 11 anastomosing with 12. (1).
 10 connected with 9, 11 running into 12. (1).
H. bajaria, Schiff. (1).
 11 anastomosing with 12. (1).
H. marginaria, Bkh. (53).
 11 anastomosing with 12. (20).
 11 out of 10, anastomosing with 12. (30).
 10 anastomosing or connected with 9, 11 out of 10, anastomosing with 12. (3).
H. defoliaria, Cl. (49).
 10 and 11 separate. (1).
 10 out of 9. (1).
 11 out of 10. (27).
 10 anastomosing or connected with 9, 11 out of 10. (19).
 11 absent. (1).
H. aurantiaria, Esp. (40).
 11 anastomosing with 12. (2).
 11 out of 10, anastomosing with 12. (32).
 10 connected with 9, 11 out of 10, anastomosing with 12. (5).
 10 anastomosing with 9, 11 out of 10, running into 12. (1).
H. ankeraria, Stgr. (1).
 10 and 11 separate. (1).
H. declinans, Stgr. (1).
 10 out of 11, connected with 9. (1).
Apocheima lefuaria, Ersch. (1).
 10 out of 11, connected with 9. (1).
A. fiduciaria, Ank. (1).
 11 absent. (1).
A. zonaria, Schiff. (14).
 10 anastomosing with 9. (1).
 10 out of 11, anastomosing or connected with 9. (13).
A. alpina, Sulz. (1).
 10 out of 11, connected with 9. (1).
A. græcaria, Stgr. (1).
 10 out of 11, connected with 9. (1).
A. lapponaria, B. (2).

10 out of 11. (1).
10 out of 11, connected with 9. (1).
A. pomonaria, Hb. (1).
10 out of 11, connected with 9. (1).
A. hispidaria, F. (1).
10 anastomosing with 9. (1).
A. cineraria, Ersch. (1).
10 anastomosing with 9. (1).
A. pedaria, F. (43).
11 out of 10, running into 12. (28).
10 anastomosing with 12, 11 absent. (15).
Biston hirtarius, Cl. (17).
10 anastomosing with 9. (1).
11 out of 10. (5).
10 connected or anastomosing with 9, 11 out of 10. (9).
10 out of 11, running into 9. (1).
11 absent. (1).
B. necessarius, Z. (1).
10 connected with 9, 11 out of 10. (1).
B. stratarius, Hufn. (8).
11 out of 10. (3).
10 connected or anastomosing with 9, 11 out of 10. (5).
B. tendinosarius, Brem. (1).
11 out of 10. (1).
B. betularius, L. (26).
11 out of 10. (4).
10 connected with 9, 11 out of 10. (22).

Explanation of Plate III.

Fig. 1. Fore wing of *Hydriomena picata*, showing veins numbered.
2. ,, *Cataclysme virgata.*
3. ,, *Opisthograptis luteolata*, ♂.
4. ,, *Ectropis biundularia.*
5. ,, *Pseudopanthera macularia.*
6. Hind wing of *Hydriomena picata*, showing veins numbered.
7. ,, *Baptria atrata.*
8. ,, *Opisthograptis luteolata.*
9. ,, *Pseudoterpna pruinata.*
10. ,, *Leptomeris imitaria.*

VII. *On a little-known species of* Papilio *from the Island of Lifu, Loyalty Group.* By the Hon. WALTER ROTHSCHILD, F.Z.S., F.E.S.

[Read February 24th, 1892.]

PLATE IV.

Papilio Gelon, Boisd.

This *Papilio* is one of the *Sarpedon* group, and is in structure nearest to *P. mendana* of Malayta Island, Solomon Islands.

On the upper surface the male is deep black, with a velvety sheen. On the fore wings the type-specimen has three small green dots between the third and fifth median nervules. The hind wings have a green band composed of four longitudinal spots situated as in *Sarpedon*. On the under side the fore wings are dull black, powdered with yellow scales, and with a metallic-brown sheen near the outer margin; there are three white spots between the fourth and fifth median nervules, and the costal and median veins are for half their length of a bright green colour. Hind wings chestnut-brown, with darker shading, and crossed by a narrow greenish white band one-third of the length from the base; all veins being green at their basal origin. Shape similar to *P. Evemon*.

Female greyish brown on the upper surface. Fore wings with a border of small yellowish spots about an eighth of an inch from the margin. One green spot on the costa about two-thirds the length from the base, and one similar between the costal and median veins. Hind wings with three small oblong blotches of whitish green in the place of the band in the male, the under side exactly as in the male, only the band of spots on the upper surface of fore wings shows through, and there are two green spots in the place of the band on the hind wings.

In a second specimen of the male the green band on the hind wings is continued across the front wings, showing that this species varies in the same manner as *P. semifasciata* of China and Japan.

Expanse, ♂ $2\frac{1}{2}$ in., ♀ 3 in.

Hab. Lifu Island, Loyalty Group.

Explanation of Plate IV.

Fig. 1. *Papilio Gelon*, ♂.
2. Variety of *Papilio Gelon*, ♂.
3. *Papilio Gelon*, ♀.
4. Under side of *Papilio Gelon*, ♂.

VIII. *Additions to the Longicornia of Mexico and Central America, with remarks on some of the previously-recorded species.* By the late Henry Walter Bates, F.R.S., F.L.S., &c. *With an Introduction by* Frederick DuCane Godman, F.R.S.

[Read March 9th, 1892.]

Plates V., VI., & VII.

[The late Henry Walter Bates was engaged upon this paper when seized by the illness which terminated fatally on February 16th. It was intended that it should include an account of all the additions to the Longicornia that had come to hand since the volume of the 'Biologia Centrali-Americana' treating of this subject had been closed, and to do for this Tribe what had already been done for the Families *Cicindelidæ* (Trans. Ent. Soc. Lond., 1890, pp. 493, *et seq.*) and *Carabidæ* (*op. cit.*, 1891, pp. 223, *et seq.*).

Unfortunately, Mr. Bates had not quite finished his task, the *Lamiidæ* remaining untouched. But his MS. extends to the end of the *Cerambycidæ*, and, as might have been expected from so methodical a worker, was so left that it could easily be arranged for publication. This has been done by Mr. Champion, and the paper is now offered to the Society as the last contribution to Entomological Science of one of her most devoted students, and as an evidence that the author continued his work to the last available moment of his life.

Seventy-nine species, of which seventy-four are described as new, are added, which, with the number recorded in the 'Biologia Centrali-Americana,' 1273, brings the total up to 1352 species. Eleven additional genera are enumerated, five only of which (*Asemum*, *Aneflus*, *Charisia*, *Ceresium*, and *Athetesis*) were previously known, and six (*Proteinidium*, *Anatinomma*, *Pœcilo-*

mallus, *Pachymerola*, *Triacetelus*, and *Axestoleus*) are characterized as new.

Of the five known species not previously recorded from Mexico or Central America, two are North American, one is South American, one Cuban, and one of general distribution. The well-known boreal genus *Asemum* has now a recorded representative from as far south as the Mexican State of Guerrero.

The material for this paper has been accumulating since January, 1886, when vol. v. of the Coleoptera of the 'Biologia Centrali-Americana' was completed. It has been chiefly obtained by the following collectors:—(1), Herr Höge, during his Second Mexican Expedition; (2), Mr. H. H. Smith, in Mexico, chiefly in the States of Guerrero, Vera Cruz, and Tabasco; (3), Mr. Gaumer, in Northern Yucatan; (4), Mr. Baron, in the Mexican State of Guerrero, kindly communicated by Mr. Harford; (5), Mr. Becker, in the Mexican State of Durango; (6), Mr. Flohr, in Mexico; (7), Herr Conradt, in Guatemala; (8), Herr E. Trötsch, in Chiriqui.—F. D. G.]

Prionus californicus, Motsch., Bull. Mosc., 1845, i., p. 89.

Hab. Mexico, North Sonora (*Morrison*).

Two specimens received from Mr. Morrison, as found within the Mexican frontier. The species is an addition to the Mexican fauna.

Derobrachus smithi, n. sp.

D. longicorni (Bates) proxime affinis; sat anguste parallelogrammicus, elytris post ante medium haud dilatatis, piceo-niger, thorace nitido, elytris passim minute granulato-coriaceis, castaneo-fuscis. ♂ antennæ corpore longiores, robustæ, articulis 1, 2 et 3ii basi grosse et aspere punctatis, 4—11 et 3ii apice elevato-lineatis opacis rufescentibus; ♀ antennæ corporis dimidio vix longiores, nitidæ, glabræ, ad basin sparsim punctatæ, articulo 3io gracili supra sulcato. Long. 50 millim., ♂ ♀.

Hab. Mexico, Xautipa in Guerrero (*H. H. Smith*).

This distinct species can be compared only with *D. longicornis*. It has the same elongate, somewhat narrow and parallelogrammical form of the body, and very similar elongated antennæ. It differs, however, from all the numerous examples of *D. longicornis* which I have seen in the minutely granulate-coriaceous surface of the elytra (so unlike the smooth, subopaque, silky gloss of *D. longicornis*), and in the shining head, thorax, and base of antennæ, the thorax having only a few coarse punctured wrinkles. The eyes are not nearly so closely approximated above. As in *D. longicornis*, the thorax has three long and acute spines on each side, and the elytra are acutely spined at the sutural angle, but the spine is followed by a short sinuation of the apical margin, which is not the case in *D. longicornis.*

Derobrachus geminatus, Leconte, Proc. Ac. Phil. vi., p. 233 (1853); Col. of Kansas and E. New Mexico, p. 19, t. 2, figg. 12 and 12*a*; Bates, Biol. Centr.-Amer., Col., v., p. 231.

Additional specimens of this species have been received from Villa Lerdo in Durango, and Chihuahua City (*Höge*). The few examples of the ♂ from Villa Lerdo resemble *D. forreri* (Bates) in the antennal joints 3—5 being longer and narrower than in Texas and Arizona specimens of *D. geminatus*, but the eyes are wide apart above as in that species, and not approximated as in *D. forreri.* The single specimen from Chihuahua is, however, in many respects intermediate between the two species.

Strongylaspis lobulifer, n. sp.

S. scobinato affinis; major, rufo-testaceus opacus, dense breviter griseo-pubescens; thorace angulis anticis breviter lobato-productis, disco convexo minus inæquali. Long. 47 millim., ♂.

Hab. Mexico, Atoyac in Vera Cruz (*H. H. Smith*).

I have seen but one example of this distinct species, and the prominent outstanding anterior angles of the thorax may prove to be only an individual peculiarity; but they are exactly symmetrical, the sides are deeply sinuated immediately behind them, and then more rapidly and curvilinearly diverging to the lateral tooth near the hind angle, the acute apex of which is curved, and points towards the elytral humeri; the surface is granulated. The elytra are finely and densely granulate-punctulate, but posteriorly appear nearly smooth. The antennæ in the ♂ are nearly as long as the body, with the basal joints (1—3) much more strongly asperate-granulate than in *S. scobinatus.*

Tragosoma nigripenne, n. sp.

T. depsario (L.) angustius; nigro-piceus, elytris nitidis, capite, thorace et pectore fulvo-fusco lanuginosis, palpis, antennis et pedibus piceo-rufis. Caput aspere confluenter punctatum, medio sulcatum; oculis magnis, convexis. Thorax dense punctatus dorso inæquali, angulis anticis subrectis, dente laterali plus minusve valido, lateribus post dentum sinuatis anguloque postico obtuso, elevato. Elytra valde elongata, fere parallelogrammica, confertim punctata, substriata, interstitiis nonnullis anguste convexis, apice late obtuse rotundata, angulo suturali spinoso. Antennæ corporis dimidio parum longiores, articulis 1 et 2 totis et 3—5 intus politis sparsim punctatis, cæteris crebre porosulis subopacis, 3—11 extus unicarinatis. Long. 23—30 millim., ♂ ♀.

Hab. Mexico, Ciudad in Durango (*Höge*).

All the examples are females, except one, distinguished by the slightly longer antennæ, the apical joints of which are rather longer and more slender. The abdomen in all the examples is at least one-fourth shorter than the elytra, triangular and depressed, in the male much shorter, and at the apex broader than in the female.

Pyrodes maculicollis, Bates, Entom. Monthly Mag., 1891, p. 158.

This fine and very distinct species is an important addition to the Mexican Longicorn fauna. Numerous examples were captured at Canelas in Durango by Mr. Becker.

Asemum glabrellum, n. sp. (Pl. V., fig. 6, ♀).

A. nitido (Lec.) affine. Gracile elongatum depressum, castaneum nitidum, fere totum glabrum. Caput sat dense punctatum, erecte pilosum, media fronte depressa et longitudinaliter sulculata; tuberibus antenniferis minime elevatis. Thorax relative brevis, rotundatus nec cordatus, postice angustatus, subtiliter sat sparsim punctatus, disco anteriori bifoveolato, angulis posticis deflexis subrotundatis. Elytra relative valde elongata lateribus tenuiter incumbenti-pubescentibus, punctulata, utrinque tenuiter bicostulata. Antennæ, tibiæ et tarsi dense corpusque subtus minus dense rufescenti-pubescentia vestiti. Long. 14 millim., ♀.

Hab. Mexico, Omilteme in Guerrero, alt. 8000 ft.

(*H. H. Smith*). Two examples only, females. The genus is an addition to the Mexican fauna.

Tetropium guatemalanum, n. sp.

T. velutino (Lec.) affine, gracilius, totum nigrum, parum nitidum, elytris opacis; nigro-pilosum, elytris subtiliter incumbenti-pubescentibus. Caput punctatum, inter antennas canaliculatum, vertice medio depresso. Thorax relative parvus, in medio rotundato-dilatatus, postice magis quam antice angustatus, supra inæqualis, præcipue ad latera aspere punctulatus. Elytra anguste elongata, densissime et subtilissime punctulata, utrinque obsolete bicostulata. Subtus cum pedibus griseo-pubescens. Long. 14 millim, ♀?.

Hab. GUATEMALA, Tepan (*Conradt*). A single example.

Hammaticherus glabricollis, Bates, Trans. Ent. Soc. Lond., 1870, p. 251.

Hab. MEXICO, Temax in North Yucatan (*Gaumer*). Three examples, females.

The Yucatan examples resemble the unique specimen found by me on the Upper Amazons very closely, except that the 3rd and 4th antennal joints have dentiform processes at their inner apices, of which there is scarcely any trace in the type-specimen, and the spine at the sutural apex of the elytra is a little longer. They are, however, females, whilst the Amazons specimen is a male, and the spines may be a sexual character, though they are not so in the allied *H. plicatus* (Oliv.), from which *H. glabricollis* differs in being much smaller, nearly glabrous and shining above, having an extremely fine grey pile on the elytra only, in the much less prominent eyes and less deep and regular thoracic furrows, and in the eyes having the basal, apical, and sutural borders black.

Aneflus cylindricollis, n. sp. (Pl. V., fig. 1).

Maxime elongatus, subcylindricus; piceo-fuscus, breviter griseo-pubescens, supra nitidus, subtus cum pedibus densius pubescens. Palpi ad apicem parum dilatati, truncati. Caput grosse aspere punctatum, oculis minus convexis. Antennæ (♀?) corporis dimidio haud longiores, scapo scabroso-punctato, articulo 4to præcedenti dimidio breviori, 3—7 ad apicem intus sat longe spinosis, 4—9 supra distincte unicarinatis. Thorax elongatus cylindricus, fortiter sed paullo irregulariter undulato-rugosus. Elytra apice valide bispinosa, versus basin grossius subrugulose, versus apicem subtilius et sparsim, punctata, utrinque anguste bicostulata, costula exteriori longiori et acutiori. Tibiæ 4 posteriores extus unicarinatæ. Long. 30 millim.

Hab. Mexico, Jalapa (*Höge*). A single example, apparently female. This genus is an addition to the Mexican fauna.

Aneflus (?) *fulvipennis*, n. sp. (Pl. V., fig. 2, ♂).

Valde elongatus, postice angustatus, elytris subplanatis. Fusco-piceus, tenuiter griseo-pubescens, elytris fulvo-testaceis nitidis, sutura marginibusque anguste nigris, glabris, pilis erectis sparsim vestitis. Caput ruguloso-punctatum, genis ante oculos dentiformiter productis. Thorax subquadratus, ad medium rotundato-dilatatus, supra inæqualis, grosse sparsim punctatus, plaga discoidali lævi polita. Elytra parum dense punctulata, utrinque costulis duabus obsoletis. Antennæ (♂) corpore longiores, articulis 3io segmenti fere dimidio longiori, 4to segmento æquali, 11mo distincte appendiculato, 3—6 apice unispinosis, 3 et 4 supra sulcatis, cæteris planatæ et obtusissime carinatis. Tibiæ 4 posteriores extus carinatæ. Long. 30 millim., ♂.

Hab. Mexico, Rinconada in Vera Cruz (*Schaus*). A single example.

Eburia baroni, n. sp. (Pl. V., fig. 3, ♂).

E. brevispini (Bates) proxime affinis et similis, differt præcipue thoracis tuberculo laterali elongato et acuto. Gracilis, pallide rufo-testacea, cinereo breviter pubescens, opaca. Elytris utrinque maculis eburneis geminatis duabus, lineis nigris continuatis interdum in fasciam latam dilatatis; maculis 2 basalibus brevibus exteriori longiori, 2 medianis elongatis sublinearibusque exteriori duplo longiori antice et postice interiorem transgredienti. Thorax interdum vittis nigro-obscuris, et femoribus versus apicem infuscatis. Long. 21—26 millim.

Hab. Mexico, Guerrero (*Baron*), Chilpancingo (*Höge*), Amula in Guerrero, 6000 ft., and Atoyac in Vera Cruz (*H. H. Smith*).

A long slender species, very closely allied to *E. brevispinis* (Bates), but differing in the long and acute lateral tooth of the thorax, which in *E. brevispinis* forms only a short conical tubercle. The colour and the number and shape of the elytral spots are similar, but in most examples of *E. baroni* the black lines which proceed from the ends of the ivory spots are expanded into a broad discoidal vitta. The posterior femora and the apex of the elytra are bispinose, the exterior spine of the femora and the sutural spine very short. The thorax is feebly rugose-punctate, and has two rather prominent antero-discoidal black tubercles, and a similar one on each side near the anterior angle.

Eburia porulosa, n. sp. (Pl. V., fig. 5, ♂).

E. muticæ (Lec.) affinis, femoribus inermibus vel brevissime dentatis. Pallide rufescenti-fusca, cinereo-griseo dense pubescens et breviter erecte pilosa. Thorax mediocris, lateribus acute spinosis, dorso haud dense sat grosse punctato-ruguloso, tuberculis antero-discoidalibus duobus nigris et interdum macula plana mediana posteriori glabris nitidis. Elytra fere cylindrica, apice utrinque bispinosa, supra passim sparse setifero-porosa, poris glabris nitidis; maculis utrinque parvis quatuor perparibus approximatis sordide eburneis, duabus basalibus minutis exteriori oblique, duabusque medianis spatio glabro circumcinctis. Pedes sat breves et robusti. Antennæ (♂) corporis dimidio longiores. Long. 20—24 millim., ♂ ♀.

Hab. Mexico, Temax in North Yucatan (*Gaumer*).

Var. *porifera.*—Robustior; thorax sat late rotundato-dilatatus, lateribus tuberculo parvo; elytrorum spinis apicalibus approximatis, macula eburnea mediana unica.

Hab. British Honduras, Cayo (*Blancaneaux*).

Appears distinct by its structural characters, but the Temax examples show much variability in the various differential features.

Proteinidium, nov. gen.

Subfam. *Elaphidiinæ* affine. Corpus valde elongatum, subcylindricum. Oculi supra sat distantes, lobo inferiori magno ultra antennarum basin extenso. Palpi articulo apicali (♀) mediocriter dilatato, truncato. Antennæ (♀) corporis dimidio haud longiores, absque spinis, articulis 3—11 subæqualibus, 5—10 extus paullo dilatato-compressis apice extus productis dentiformibus, haud vero supra carinatis. Thorax relative parvus, subcylindricus, inermis. Elytra apice rotundata, interdum juxta suturam emarginata. Femora minime incrassata; tibiæ 4 posteriores extus carinatæ, carinis interdum obsoletis. Acetabula antica et intermedia clausa. Prosternum inter coxas angustum, mesosternum latius, planum.

The series of this species, which presents a combination of characters forbidding its collocation in any described genus, consists, unfortunately, of females only. The only genus it seems to resemble is *Axestinus* (Lec.), which, however, has 12-jointed antennæ and other points of difference.

Proteinidium brevicorne, n. sp. (Pl. V., fig 4, ♀).

Castaneo- vel piceo-rufum, supra tenuiter, subtus densius, cinereo-fulvo pubescens, supra nitidum. Caput dense rugoso-punctatum. Thorax elytris angustior, paullo post angulos anticos leviter rotundatus, juxta basin paullo angustatus, angulis posticis margine reflexo; disco anteriori foveis duabus plus minusve impresso, fere lævi lateribus dense punctato-rugosis. Elytra sparsim, postice sparsissime punctata, punctis nonnullis minutis intermixtis. Long. 28—35 millim., ♀.

Hab. Mexico, Chihuahua City (*Höge*).

Anatinomma, nov. gen.

"Group" *Piezocerides*, Lac., affinis. Corpus cylindricum, longe erecte pilosum, elytris politis. Oculi omnino laterales, angusti, antice-postice valde compressi, convexi, antice antennarum basin haud attingentes. Palpi articulo apicali securiformi; labiales breves. Thorax inermis, subrotundatus. Elytra apice prope suturam emarginato, angulo suturali spinoso. Antennæ (♂) dimidio corporis parum longiores, dense pubescentes; articulis 3—11 æqualibus, paullo compressis, 5—10 paullo compressis, nec carinatis, ad apicem intus leviter angulatim producto. Pedes mediocres, tibiæ paullulum compressæ nullo modo carinatæ. Tarsi breves, articulo 1mo 2 et 3 conjunctis subæquali. Acetabula antica clausa. Prosternum inter coxas angustissimum, mesosternum latius, planum.

The species for which the institution of this genus is necessary does not fit into any of the numerous "Groupes" instituted by Lacordaire for the *Cerambycidæ*. Its facies is very nearly that of *Hemilissa* of the "*Piezocerides*" group, but it is deficient in the essential structural characters of that form. The eyes are not very unlike those of *Asemum*, but they are still narrower and more convex, and they are reniform, though the lower lobe is not wider than the upper, and is situated far behind the base of the antennæ. Above they are separated by the whole width of the head, from the sides of which they project obliquely.

Anatinomma alveolatum, n. sp. (Pl. V., fig. 8, ♂).

Obscure piceo-fuscum, fulvo-pilosum, elytris politis, capite thoraceque eleganter reticulato-punctatis, elytris ad basin subgrosse versus apicem subtilius punctatis. Antennæ articulo 1mo 2 et 3 conjunctis longiori, curvatim clavato punctato-scabroso, cæteris articulis dense asperato-punctatis sensim versus apicem lævioribus. Femora grosse dense punctata. Sterna dense punctata, prosterno medio grosse et discrete punctato. Long. 14—19 millim., ♂ ♀.

Hab. Mexico: A single specimen, ♂ (14 millim.) from Teapa in Tabasco (*H. H. Smith*), and a ♀ (19 millim.), labelled Mexico, from the collection of Dr. Baden.

The male, besides being much shorter than the female, is much narrower, the thorax, and especially the head, having superficially a different appearance. The smallness of the head renders the very wide separation of the eyes above much less striking than in the female.

Pœcilomallus, nov. gen. Elaphidiinæ.

Gen. *Hypermallo* affine. Differt corpore cylindrico; thorace sat elongato, cylindrico, paullo ante medium paullulum rotundato-dilatato; palpis articulo apicali maxime dilatato, securiformi; femoribus valde clavatis ad apicem inermibus, acetabulisque anticis et intermediis omnino clausis, epimeris intermediis longe ante acetabulum desinentibus.

Pœcilomallus palpalis, n. sp. (Pl. V., fig. 6).

Cylindricus, ænescenti-niger politus, elytris antice plaga communi X-formi posticeque fascia (margine posteriori dilacerata) fulvo-cinereo tomentosis; antennis pedibusque castaneo-rufis, cinereo-fulvo pubescentibus; corpore supra toto pilis longis erectis sparsis vestito. Oculi magni, mediocriter convexi. Antennæ articulo 4to sequenti distincte breviori, 3—6 ad apicem unispinosis (absque carinis). Thorax sparsissime punctatus, pube tenuiori incumbenti vestitus, plagis discoidalibus tribus nudis politissimis. Elytra apice breviter a sutura sinuato-truncata, supra sparsim sublineatim punctata. Pedes breves, robusti. Long. 11 millim.

Hab. Mexico, Temax in N. Yucatan (*Gaumer*). One example only.

Stizocera (*Peribœum*) *poeyi*, Chevr., Rev. Zool , 1838, p. 284 (*Elaphidion*); id., Ann. Soc. Ent. Fr., 1862, p. 268; Jacquelin-Duval in Sagra's Hist. de Cuba, Ins., p. 267, tab. 11, fig. 1 (French edit.), (*Elaphidion*).

Hab. PANAMA, Chiriqui (*Trötsch*).

A large example (18 millim.) of this beautiful Cuban species of the genus, agreeing well with a specimen from Cuba, with which I have compared it.

Psyrassa sthenias, n. sp.

Cæteris speciebus hujus generis major robustiorque. Valde elongata, rufo-castanea nitida, pilis nonnullis erectis exceptis glabra; elytris postice subtilius, disco hic illic lineatim, conspicue punctatis. Caput politum, sparse punctatum; palpis articulo apicali valde dilatato, gula transversim strigosa. Thorax elongatus, subcylindricus, usque ad post medium leviter rotundatus, prope basin angustatus; supra discrete punctatus, disco callisque duobus anterioribus parum elevatis, lævibus. Elytra postice sensim at parum angustata, apice sinuatim truncata. Antennæ articulis 3—10 subæqualibus, apud marginem exteriorem tantum carinatis, 3io longe 4 et 5 breviter spinosis. Tibiæ 4 posticæ extus carinatæ. Scapus et femora grosse et dense punctati. Long. 18 millim.

Hab. MEXICO, Acapulco (*Höge*). Two examples.

Psyrassa punctulata, n. sp.

Angusta, rufo-testacea, supra breviter pilosa pilis longis intermixtis, sat dense et fortiter (versus apicem paullo subtilius) punctata, thorace plaga discoidali oblonga lævi. Caput sparsissime punctatum; palpi articulo apicali (♀) mediocriter dilatato, ad apicem valde oblique truncato. Antennæ articulis 3 et 4 sequentibus paullulum brevioribus, 3—5 versus latera unicarinatis, 3io spina valida 4to spina multo minori armatis. Thorax angustus, cylindricus, juxta basin angustatus. Elytra apice sinuato-truncata. Pedes sicut in *P. basicorni* sat breves, femora paullo incrassata; tibiæ 4 posticæ extus carinatæ. Long. 11 millim., ♀.

Hab. MEXICO, Acapulco (*Höge*). One example only.

Psyrassa cribellata, n. sp. (Pl. V., fig. 9).

Maxime elongata, linearis, obscurius rufo-castanea, subtus fusco-nigra, cinereo-pubescens, supra sparsius incumbenti-pubescens, dense et fortiter punctata. Caput et thorax foveolatus, hic illic subreticulatus. Palpi articulo apicali (♀?) mediocriter dilatato, apice obtuse truncato. Thorax antice elytris vix angustior, elongato-cylindricus, prope basin gradatim angustatus, disco posteriori minus dense foveolato. Elytra apice oblique subprofunde sinuato-truncata, angulis acutis. Antennæ articulo 3io sequentis dimidio longiori et hoc sequentibus distincte breviori, 3—6 apud marginem exteriorem carinulatis, 3io valide spinoso 4to spina paullo breviori 5to minutissima. Tibiæ 4 posticæ extus carinatæ; scapus femoraque grosse punctatus. Long. 15 millim., ♀?.

Hab. Mexico, Acapulco (*Höge*). One example.

Psyrassa pilosella, n. sp. (Pl. V., fig. 11).

Minor, angusta, rufo-testacea polita, supra pilis erectis valde elongatis vestita (punctis piliferis sparsis exceptis) lævis. Palpi articulis apicalibus dilatatis, in maxillaribus obliquissime truncatis in labialibus multo minus oblique, latius triangularibus. Thorax elongato-cylindricus, convexus, prope basin mediocriter angustatus. Elytra relative breviora et minus linearia, apice obtuse rotundata. Antennæ tenues, articulo 3io 4to æquali sequentibus breviori, 3io spina tenuissima elongata, cæteris inermibus. Long. 8 millim.

Hab. Mexico, Iguala in Guerrero (*Höge*). One example only.

Psyrassa nigricornis, n. sp. (Pl. V., fig. 10).

P. castaneæ (Bates) affinis et similis, sed differt elytris, antennis (scapo rufo excepto), tibiis et tarsis nigris vel nigro-piceis. Rufo-testacea, nitida, supra pilis brevibus sparsis pilisque valde elongatis intermixtis, vestita. Palpi (♂?) parum dilatati, ad apicem recte truncati. Caput fere læve, inter antennas transversim elevatum. Thorax angustus, antice paullo postice magis et longius, angustatus, sparsissime punctatus. Elytra apice profunde sinuato-truncata, angulis acutis, sat grosse sed haud dense, postice multo subtilius, punctatis. Antennæ articulo 3io 4to æquali sequentibus multo breviori, nullis carinatis; 3io spina valde elongata, 4—6 spinis brevioribus. Tibiæ 4 posticæ extus carinulatæ. Long. 15 millim., ♂?.

Hab. Mexico, Acapulco (*Höge*). One example.

Psyrassa nigroæneа, n. sp.

Elongata, gracilis, nigro-ænea, breviter erecte pilosa, supra capite, thorace sat sparsim, elytris (prope apicem excepto) dense punctatis, ad apicem recte breviter truncata; femoribus rufis, tibiis et tarsis paullo obscurioribus. Antennæ (♀) tenues, articulis 3—5 supra carinatis, 3io apice valide, 4to brevissime, spinosis, cæteris inermibus. Palpi ad apicem mediocriter dilatata, truncata. Long. 11 millim., ♀.

Hab. MEXICO, Iguala in Guerrero (*Höge*). One example only.

Ceresium simplex, Gyll., Syn. Ins., App., i., 3, p. 178 (*Stenochorus*); *philippense*, Newm., Ent., 1842, p. 247 (*Œmona*); *guttaticolle*, Fairm., Rev. Zool., 1850, p. 63 (*Hesperophanes*); id., Ann. Soc. Ent. Fr., 1881, p. 472 (*Ceresium*); *Nyctipeta luzonica*, Eschsch., Dej. Cat., 3rd ed., p. 354; *Cerambyx maculaticollis*, Blanch., Voy. Pole Sud., iv., t. 16, f. 9 (*Diatomocephala* in text, p. 267).

Hab. MEXICO, Acapulco and Chilpancingo in Guerrero (*Höge*). Several examples.

Lacordaire (Gen. Col., viii., p. 355) adds other names to the synonymy of this widely-distributed insect, and mentions Guayaquil, an American locality, as coming within its range. I have examined examples from the Philippines, Madagascar, New Caledonia, New Ireland, and the Sandwich Islands. The genus is an addition to the Mexican fauna.

Hexoplon smithi, n. sp. (Pl. V., fig. 12).

H. albipenni (Bates) proxime affine. Caput, thorax, elytrorum basis antennarumque articuli 1 et 2 castaneo-rufi politi; antennarum articuli 3—11 et pedes melleo-flavi; elytra (triente basali castaneo-rufa nigro-maculata excepta) albo-testacea et utrinque post medium signatura V-formi, maculaque majori versus apicem, nigra. Subtus piceo-nigrum, ventris lateribus griseo-tomentosis. Supra lævis, elytris versus basin sparsim lineatim punctulatis, sutura sulcoque discoidali anterioribus depressis, ad apicem utrinque bispinosis. Femora sublinearia, intermedia et postica ad apicem unispinosa. Long. 12½ millim.

Hab. MEXICO, Dos Arroyos in Guerrero, alt. 1000 ft. (*H. H. Smith*). A single example.

In markings resembles most *H. calligramma* (Bates), but the posterior spot of the elytra is not a narrow undulated fascia, but large, triangular, and black.

Hexoplon sylvarum, n. sp. (Pl. V., fig. 14).

Angustum, thorace angustissimo et relative elongato; melleo-flavum, politum, capite, thorace, antennis articulis 1 et 2 elytris utrinque maculis duabus—1ma subhumerali, 2nda magna subapicali—castaneo-rufis. Supra læve, elytris fere usque ad apicem sparsim lineatim punctatis, sutura et sulculis anterioribus depressis, apice utrinque spina unica valida exteriori. Femora intermedia et postica sublinearia, apice unispinosa. Subtus testaceo-rufum, prothorace sicut supra castaneo-rufo. Long. 8½ millim.

Hab. Mexico, Atoyac in Vera Cruz (*H. H. Smith*). One example only.

Gnomidolon denticorne, n. sp.

Angustum, nitidum, erecte sparse pilosum antennisque basin versus longe laxe ciliatis. Caput et thorax castaneo-rufi, læves, hic anguste cylindricus. Elytra apice truncata, angulo exteriori longe spinoso, sutura et sulculo discoidali anterioribus hoc sat grosse punctato-striato; flavo-testacea, vitta utrinque elongata subflexuosa, basali ad apicem cum macula mediana fere conjuncta, vittula marginali versus basin et fascia ante apicali antice apud suturam profunde indentata, nigris. Subtus piceo-nigrum. Antennæ et pedes melleo-flavæ, illis articulis 1 et 2 rufis, 1mo ad apicem extus valde dentiformiter producto. Pedes melleo-flavi, femoribus posticis sublinearibus (4 anterioribus ad medium paullo dilatatis) apice unispinosis. Long. 8½ millim.

Hab. Panama, Chiriqui (*coll. Bates*).

Ibidion ruatanum, n. sp. (Pl. V., fig. 15, ♂).

I. gaumeri (Bates) primo intuitu similis sed valde differt, antennarum articulis dilatatis 3—5 haud linearibus, ad basin angustatis, 4to elongato-subovato, vix perspicue carinatis. Castaneo-rufum nitidum, longe erecte setosum, elytris utrinque maculis duabus albo-testaceis nigro-cinctis, 1ma ante medium lineari, vittiformi, 2nda post-medium parva ovata. Caput punctatum. Thorax elongatus, fere cylindricus, in medio paullulum rotundato-dilatatus, absque tuberculis sparsim setifero-porosis. Elytra in medio planata sat dense punctulata, apice singulatim obtuse rotundato. Long. 9 millim., ♂.

Hab. Honduras, Ruatan Island (*Gaumer*). A single example.

Ibidion griseolum, n. sp. (Pl. V., fig. 13, ♂).

I. textili (Thoms.) individuis griseis subsimilis, sed valde differt, elytris apice singulatim obtuse rotundatis, aliter signatis, antennisque articulo 3io breviori (articulo 4to haud duplo longiori). Anguste elongatum, thorace relative breviori, pallide rufo-fuscum, griseo subtiliter pubescens subopacum parce setosum, elytris extus nitentibus, utrinque maculis duabus (una paullo ante, 2nda paullo post-medium) irregulariter oblongis albo-testaceis. Thorax cylindricus, angustus, linea dorsali lævi, disco utrinque poris nonnullis setiferis. Elytra dorso subplanata, bicostulata, sat dense sublineatim punctata, apicem versus lævioribus. Antennæ articulis 3—5 minus late depressis supra carinatis, 5to 4to paullo longiori, 4to 3io triente tantum breviori. Femora valde clavata, tibiis haud carinatis. Long. 12—14 millim.

Hab. Mexico, Chilpancingo in Guerrero (*Höge*). Two examples.

Ibidion gaumeri, n. sp. (Pl. V., fig. 16, ♂).

I. textili (Thoms.) affinis, castaneo-rufum nitidum, corpore subtus (et interdum thorace) obscurioribus, elytris longe erecte pilosis, in medio planato-depressis, antennis dimidio basali laxe et longe ciliatis. Caput et thorax subtiliter griseo-pubescentia, hic elongato-cylindricus, disco antico bituberculato. Elytra utrinque maculis duabus oblongis albo-testaceis—1ma longiori paullo ante, 2nda breviori et oblique longe, post-medium—passim (partibus supra maculas et prope apicem sublævibus exceptis) punctulata, apice utrinque oblique truncato, angulis acutis. Antennæ (♂) corpore dimidio longiores; articulis 3—5 depressis et latioribus, sat linearibus, valide carinatis, 4to 3io plus quam duplo breviori. Femora fortiter clavata, posticis extus carinata. Long. 10—15 millim.

Hab. Mexico, Temax in N. Yucatan (*Gaumer*).

Distenia lineatopora, Bates, Biol. Centr.-Amer., Col., v., p. 35, tab. xvii., fig. 12.

Mr. H. H. Smith obtained a few examples of this species at Omilteme in Guerrero, alt. 8000 ft., which differ from the unique Guatemalan type-specimen in the number of lines of large punctures or pores on the elytra; instead of four only, they have four longer lines, with a variable number of pores in the interspaces between the rows. The femora, too, are often black, with the base only tawny-testaceous. The size varies from 10 to

16 millim. The two oblique dark fasciæ of the elytra are often irregular, and crossed by a longitudinal line down the middle of each elytron.

Distenia hœgei, Bates, Biol. Centr.-Amer., Col., v., p. 271, tab xix., figg. 16, 17.

Two examples taken by Mr. H. H. Smith at Amula in Guerrero, alt. 6000 ft., show a further variation in colours in addition to that described: the apical fourth of the elytra is wholly fulvous (nearly as in the var., fig. 17), the median fascia, of the same colour, is broad and dentate, widening on the side and terminating before the suture, and there is a third similar fascia close to the base (which is black), including the humerus and reaching the suture, the tawny-red colour continuing along the suture to the apex. The femora are wholly black; the antennæ tawny-red. The apex of the elytra is exactly as in the type-form, briefly truncate, with the sutural angle alone produced.

Distenia trifasciata, n. sp. (Pl. VI., fig. 1, var.).

D. hœgei (Bates) affinis, sed differt, *inter alia*, elytris apice prope suturam acute bidentatis et breviter sinuatis. Ænescenti-nigra, erecte pilosa, elytris fasciis latis subrectis tribus suturam haud attingentibus griseo- vel fulvo-griseo tomentosis. Antennis fulvo-rufo-testaceis, griseo-pubescentibus, scapo curvato-clavato, fere nigro; pedibus piceo-rufis, femoribus clavatis, clava nigro-ænea. Caput discrete punctatum, vertice fere lævi. Thorax sicut in *D. undata* 5-callosus, lævis, partibus depressis punctatis punctisque minutis intermixtis, tuberculo laterali conico, acuto, subelevato. Elytra a basi usque ad medium grosse striato-punctata, spatio lato basali inter strias suturalem et 2dam crebre confuse punctato. Subtus fere lævis, polita. Long. 15—22 millim.

Var. Antennis toto fulvo-rufis.

Hab. Mexico, Jalapa, Acapulco (*Höge*), Temax in N. Yucatan (*Gaumer*).

The small example (15 millim.) from Acapulco differs from the others in the apex of the elytra being widely sinuate-truncate, with the angles acute and equal; it is a ♂. In the others (both sexes) the elytra, which are gradually narrowed, as usual in *Distenia*, from the base, are rapidly narrowed in a curve near the apex, and the sinuate-truncature is narrow, and its angles, prolonged and acute, are rather closely approximated. The grey fasciæ are about equal in width to the two resulting intermediate fasciæ of the brassy-black ground colour.

Vesperoctenus flohri, Bates, Entom. Monthly Mag., 1891, p. 160.

This singular form is a notable addition to the insect fauna of Mexico, for the discovery of which science is indebted to the zeal and industry of Mr. Richard Becker. Mr. Julius Flohr, with his usual liberality, has supplied us with specimens of both sexes. Mr. Becker's examples were obtained in the Sierra Madre of Durango.

Gaurotes multiguttatus, n. sp. (Pl. VI., fig. 2, ♀).

G. maculoso (Bates) affinissimus, differt corpore toto obscure viridescenti-æneo, antennis fusco-nigris, articulis 3—11 basi griseis vel fulvo-griseis. Supra sat dense setifero-punctulatus punctis minoribus intermixtis, vertice spatio late mediano thoraceque disco plus minusve lævibus, pube grisea maculatim vestitus, elytris præcipue maculis parvis passim ornatis, apice sinuato-truncatis, angulis (præcipue suturali) acutis dentiformibus. Subtus cum pedibus densius griseo-pubescens; mesosterno convexo, antice alto verticali. ♂. Pygidium elongatum, deflexum, politum. Long. 11—14 millim., ♂ ♀.

Hab. Mexico, Xucumanatlan in Guerrero, alt. 7000 ft. (*H. H. Smith*). Two females.

A male example received from Mr. Harford, also from the State of Guerrero.

Ophistomis xanthotelus, n. sp. (Pl. VI., fig. 4, ♂).

Angustissimus, postice attenuatus, niger nitidus, antennis articulis 3 terminalibus læte fulvis. Caput totum nitidum, discrete sat dense punctatum, rostro mediocriter elongato. Thorax medio vix perspicue dilatato, lateribus fere rectis, sparsius discrete punctatus, linea dorsali lævi. Elytra postice valde attenuata, passim æqualiter et discrete punctulata punctis tenuiter griseo-piliferis, dorso basali et disco nullo modo depressis, apice utrinque medio longo unispinoso. Subtus fere lævis, politus. ♂. Ventris segmentum apicale elongatum, profunde longitudinaliter concavum; ♀ postice paullo minus attenuata, ventris segmento apicali brevi apice triangulariter excisa. Long. 12—16 millim., ♂ ♀.

Hab. MEXICO, Acaguizotla, alt. 3000 ft., La Venta, alt. 300 ft., Rincon, alt. 2800 ft., all in Guerrero (*H. H. Smith*).

Euryptera unicolor, n. sp. (Pl. VI., fig. 3).

E. fulvellæ (Bates) affinis. Oblonga, convexa, postice vix perspicue ampliata, læte fulvo-sericea, antennis, tibiis apice, tarsorumque articulis apice, nigris. Capite antice rostro valde elongato, palpis fuscis. Thorax late campanuliformis, cum elytris fulvo-aureo recumbente-pubescens, ante medium leviter dilatatus, angulis posticis elongatis acutis. Elytra oblonga, æqualiter convexa, dense punctulata, apice late obtuse flexuoso-truncata; angulo suturali rotundato, exteriori breviter dentato. Long. 15 millim., ♀?.

Hab. MEXICO, Tepetlapa in Guerrero, alt. 3000 ft. (*H. H. Smith*). A single example.

Euryptera planicoxis, n. sp. (Pl. VI., fig. 5).

Fulva nitida, pube fulvo-sericea vestita, antennis pedibusque nigris, femoribus subtus tibiis tarsisque ad basin fulvis; thorace vitta centrali paullo abbreviata fusca. Caput antice mediocriter elongatum, partibus oris fuscis; oculi valde convexi, ad medium intus profunde emarginati. Thorax campanuliformis, medio ad basin lobato. Elytra postice mediocriter dilatata, apice late truncata, angulis suturali et exteriori æqualiter acute dentatis, disco posteriori 3—4 sulcato carinaque acuta subsuturali; margine laterali incrassato, longe et dense fulvo-fimbriato. Abdomen rufescens. Ab omnibus *Lepturionis* differt, coxis anticis nullo modo salientes, sed acetabulis extus acute angulatis, intermediisque apertis. Antennæ corporis dimidio haud longiores; articulis 3 et 4 paullulum abbreviatis, 5—11 æqualibus. Mesosternum gibbosum. Long. 12½ millim.

Hab. PANAMA, Chiriqui (*Trötsch*). One example only.

The flat anterior coxæ, which do not project higher than the prosternal process, are an anomaly in *Euryptera*, and in all other genera of typical *Lepturinæ*.

Odontocera yucateca, n. sp. (Pl. VI., fig. 7, ♂).

O. fuscicorni (Bates) affinis et simillima, at differt thorace creberrime ruguloso-punctato nec alveolato, elytrisque ad basin vittula obscura valde oblique suturam longe post scutellum spectanti. Gracilis, nigro-obscura opaca; elytris pallido-vitreis fusco-marginatis, abdominis medio haud longioribus, postice valde angustatis apicibusque recte truncatis, vittula utrinque valde obliqua basali nigro-fusca, interdum obsoleta (ibique aspere punctulatis). Antennæ mediocres, articulis 5—10 serratis, 3io duobus sequentibus conjunctis longiori, cylindrico, tenui; obscure rufis. Thorax subovatus, postice angustatus, pilis argenteis anguste marginatus. Pedes obscure rufi, femorum clava nigro-fusca. Abdomen gracile clavatum ad basin attenuatum, nigro-fuscum, vel obscure rufum, segmentis 1—3 postice flavo-marginatis; ♂ articulo apicali ventrali medio valde concavo, ♀ plano. Long. 9—15 millim.

Hab. Mexico, Temax in N. Yucatan (*Gaumer*).

Acyphoderes cribricollis, n. sp. (Pl. VI., fig 6, ♂).

A. acutipenni (Chevr.) affinis; differt *inter alia*, thoracis disco grosse punctato, limbo partibusque depressis aureo-tomentosis. Multo angustior, nigro-fuscus, aureo-fulvo pubescens, elytris fulvis, vitreis, antennis et pedibus fulvo-rufis, femoribus posticis versus basin tibiisque apice nigro-fusco annulatis. Caput antice fulvo-aureo tomentosum, vertice glabro grosse punctato. Thorax sat angustus, subovatus, disco inæquali subcalloso glabro grosse punctato, limbo fulvo-aureo tomentoso. Elytra usque ad basin segmenti penultimi extensa, vitrea, fulva, fusco-marginata, passim sparse punctulata, gradatim dehiscentia, apice obtuse rotundata. Abdomen subtus fulvo-bifasciatum, segmento apicali ventrali rotundato-dilatato concavo. Antennæ sat graciles, articulis 6—10 sensim paullulum latioribus et serratis. Femora omnia gracile clavata. Long. 15—18 millim., ♂.

Hab. Mexico, Ventanas in Durango (*Höge*). Three examples, males.

Notwithstanding its elongate slender form, the species, by the longitudinal elevations of the thoracic disk, belongs to the genus *Acyphoderes*.

Charisia nigerrima, n. sp. (Pl. VI., fig. 8, ♀).

C. barbicro (Kirby) brevior et latior, tota nigra, subtus polita. Caput sparsim griseo-pubescens, grosse punctatum. Thorax valde transversus, in medio transversim densissime nigro-pilosus, postice subnudus ibique callo mediano polito. Elytra brevia, triangularia, humeris et apice asperrime punctatis, intus densissime nigro-pilosa, lateribus versus apicem elevatis politis ibique disco concavo. Pectus, femora omnia tibiæque 2 posticæ dense nigro-pilosæ, hæ longius et densius extus versus apicem pilosæ. Long. 11 millim., ♀.

Hab. Mexico, Atoyac in Vera Cruz (*H. H. Smith*).

This genus (*Charis*, Newm.) is new to the Central-American fauna.*

Pachymerola, nov. gen.

Gen. *Coremiæ* (Serv.) proxime affine, corpore gracili, sed conspicue differt femoribus posticis corpore paullo longioribus, gradatim valde clavatis subtus (cum tibiis) minute denticulatis, tibiisque posticis nudis. Palpi breves, articulo apicali haud angustato, late truncato. Antennæ longitudini corpori æquales; scapo clavato, articulis 3io (scapo subæquali) 4to et 5to gradatim perparum longioribus, 6—11 gradatim brevioribus 6to 5to paullo breviori, 5—11 paullulum compressis apicibusque extus angulatis. Thorax gracilis, post medium brevissime tuberculatus, antice paullo angustatus. Elytra linearia, ad apicem singulatim acuminata. Pedes mediocriter elongati, tarsi articulo 1mo 2 et 3 conjunctis subæquali.

The mesothoracic epimera reach the middle haunch-sockets, as in *Coremia*, and the group to which that genus belongs. The surface of the body is nearly opaque.

Pachymerola vitticollis, n. sp. (Pl. VI., fig. 11).

Nigra, opaca, supra tenuiter, subtus densius, griseo-pubescens, elytris obscure ænescentibus, lateribus a humeris usque ultra medium subnitidis; thorace utrinque vitta recta flavo-grisea. Elytra subtiliter alutacea, et sparsim aspere punctulata. Long. 8½ millim., ♂?.

Hab. Mexico, Chilpancingo in Guerrero, 4600 ft. (*H. H. Smith*). A single example, apparently ♂.

Cyllene robiniæ, Forst., Nov. Sp. Ins., p. 43 (1771) (*Leptura*); *pictus*, Drury, Ill., ii., Index (1773) (*Leptura*); i., p. 91, t. 41, f. 2; *flexuosus*, Fabr., Syst. Ent., p. 191 (1775) (*Callidium*).

Hab. Mexico, Villa Lerdo in Durango (*Höge*).

A new species to the Mexican fauna. The specimens do not differ in the least from others with which I have compared them from the Southern States.

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* The name *Charis* is long preoccupied in Lepidoptera (Hübner, 1816), and I propose to change it to *Charisia*.—[G. C. Champion.]

Trichoxys cinereolus, n. sp.

T. pellito (White) quoad colores et signaturas similis. Niger, elytris exceptis, dense griseo-cinereo tomentosus, elytris ad basin margine exteriori (anguste) sutura tota (apud apicem dilatata) annulo basali utrinque ovato (suturæ adherenti), fascia recta tenui mediana altera latiori post-mediana (apud suturam dilatata marginemque exteriorem haud attingenti) flavescenti-cinereis. Thorax rotundatus, elytris anguste elongato-oblongis ad apicem oblique truncatis (angulo exteriori breviter dentato). Antennæ (♀) corporis dimidio paullo longiores, (♂) segmentum ventralem 3ium attingentes; femora postica (♀) segmenti 3ii apicem (♂) abdominis apicem, attingentia. Long. 15 millim., ♀; 11 millim., ♂.

Hab. Mexico, Jalapa (*Höge*), Guerrero (*Harford*). One example of each sex.

Ochresthes nigritus, n. sp. (Pl. VI., fig. 10).

Gracilis, niger, subtus griseo-cinereo dense pubescens, supra nigropubescens, antennis articulis 3—11 pedibusque (femoribus partim nigris exceptis) obscure rufis; elytris fasciis angustis tribus, 1ma paullo ante, 2nda paullo post-medium, 3ia ante apicem (in maculas quatuor divisa), maculaque suturali ante fasciam primam, cinereopubescentibus; ad apicem singulatim rotundatis, suturaque posteriori minus depressa et carina divergenti discoidali fere obsoleta. Thorax rotundatus, versus basin sat fortiter angustatus. Elytra apice interdum cinereo-maculata. Long. 7½—12 millim.

Hab. Mexico, Omilteme, alt. 8000 ft., Chilpancingo, alt. 4600 ft., both in Guerrero (*H. H. Smith*).

Closely allied to *O. viridiventris* (Chevr.), and scarcely distinguishable from it except in the very different colour of the pubescence which clothes the upper surface. It belongs, with *O. viridiventris*, to a section of the genus in which the posterior-divergent discoidal carinæ of the elytra are barely perceptible, and the apices without truncature. All the specimens I have seen from Guerrero are alike in the black upper surface and cinereous elytral belts. In *O. viridiventris* the colour is ochreous.

Ochresthes clerinus, n. sp. (Pl. VI., fig. 13).

O. viridiventri (Chevr.) affinis; capite thoraceque relative parvis, hoc perparum rotundato. Niger, subtus dense cinereo-pubescens, capite thoraceque obscure griseis, antennis (scapo fusco excepto) et pedibus fulvo-rufis; elytris ad apicem singulatim rotundatis, sutura parum depressa, flavo-griseo tomentosis, fasciis quatuor (marginem haud attingentibus) nigris, 2 anterioribus postice curvatis et prope suturam ascendentibus, 2 posterioribus subrectis media linea nigra tenui connexis. Long. 11 millim.

Hab. Mexico, Omilteme in Guerrero, alt. 8000 ft. (*H. H. Smith*). One example only.

Closely allied to *O. nigritus* and *O. viridiventris.*

Ochresthes obscuricornis, n. sp.

O. viridiventri (Chevr.) iterum affinis, et differt corpore supra griseo-tomentoso, antennis et femoribus obscure piceis, illis articulis 3—8, tibiis et tarsis obscure rufis. Thorax rotundatus. Elytra sutura posteriori depressa carinisque discoidalibus obtusis, apice rotundatis, grisea, fasciis 4 nigris, 2 anterioribus postice curvatis, 3ia post-medium latiori et antice valde curvatis, 4ta abbreviata obliqua. Long. 12½ millim.

Hab. Mexico, Guerrero (*Harford*).

One example, in my own collection.

Ochresthes tulensis, n. sp. (Pl. VI., fig. 12).

O. sommeri (Chevr.) affinis et similis sed elytris relative longioribus, ad apicem truncatis, angulo exteriori dentiformi. Ochraceo-tomentosus, antennis pedibusque rufis. Elytra signaturis fuscis:—(1) fascia transversa juxta basin (raro obsoleta), (2) fasciis duabus ante medium paullo obliquis et flexuosis, extus prope marginem conjunctis, (3) fasciisque duabus ante apicem valde angulatis (præcipue anteriori). Thorax disco sæpe infuscato. Long. 13—15 millim.

Hab. Mexico, Tula in Hidalgo (*Höge*).

Separable in all the very numerous examples from *O. sommeri* and *O. circuliferus* by the two ante-median elytral fasciæ not being subsemicircular, and enclosing a pale spot. It differs also in the relatively longer elytra, which, however, have not the narrow form, tapering near the apex, of *O. citrinus* and *O. pollinosus.*

Clytanthus hololeucus, n. sp.

C. clathrato (Chevr.) affinis, elongatus, elytris sutura depressa, costa obtusa utrinque elevata, apicibusque truncatis, angulo suturali minuto exteriori valido dentiformibus; differt colore toto griseo-cinereo pubescens, ventris lateribus densius et magis cinereis. Thorax gracile ovatus. Long. 10½—13 millim.

Hab. Mexico, Saltillo in Coahuila (*Höge*).

Distinguished among the Clytid group by its uniform hoary laid pubescence. It belongs to the section (which includes all the Mexican species referred to *Clytanthus*) in which the elytra are as in *Cyllene*, *Trichoxys*, and *Ochresthes*, truncated and dentate at the apex, with depressed suture (except at the base), and a dorsal carina. The carina is, however, very obtuse, and the facies of the species, the slender elongate form, and narrow forehead (between the antennæ) give them a close resemblance to the *Clytanthi*.

Neoclytus smithi, n. sp. (Pl. VI., fig. 9, ♂).

Mecometopo hœgei (Bates) affinis; sed fronte nullo modo elongato thoraceque crista dorsali distinctus. Brevis, fusco-niger, sericeo griseo subtiliter pubescens, elytris fascia lata paullo ante medium (versus suturam dilatata marginemque haud attingenti) alteraque subapicali (apud suturam antice dilatata) pallide flavis; antennis (♂ corporis dimidium attingentibus, apicem versus paullo incrassatis) pedibusque rufo-piceis. Caput antice infra oculos parum elongatum, transversum. Thorax elytris paullulum latior, usque prope basin paullo dilatatus, ad basin constrictus, dorso convexo juxta basin subito declivis, in medio longitudinaliter elevatus et grosse transversim rugosus. Femora postica elongata et valde clavata; tibiis gracilibus. Long. 10 millim., ♂.

Hab. Mexico, Rincon in Guerrero, 2800 ft. (*H. H. Smith*).

I have seen one example only of this elegant little species, which seems to me better placed in *Neoclytus* than in *Mecometopus*, notwithstanding its greater general resemblance to many species of the latter genus.

Tilloclytus conradti, n. sp.

T. clavipedi (Bates) proxime affinis. Minor, niger, antennis, femorum basi tarsisque obscure rufis. Thorax elongato-cordatus, valde convexus, punctatus, cinereo-pubescens, medio disco fascia curvata nigra ibique utrinque cristula parva transversa. Elytra minus elongata, postice valde convexa, humeris prominentibus, utrinque prope basin crista obliqua et pone hanc fascia obliqua depressa, nitida, punctata, apicibus singulatim rotundatis; nigra, fascia basali, lineis duabus obliquis mox pone cristam, et tertia parte apicali, cinereo-pubescentibus. Long. 7½ millim.

Hab. Guatemala, Coban in Vera Paz (*Conradt*).

One example only. The antennæ are quite free from spine, and the basal joint of the posterior tarsi is longer than all the remaining joints taken together. The middle part of the elytra is velvety black, and with the base shows no distinct punctuation; the convex posterior part, which has a coarser greyish pile, and is slightly shining, is finely punctured.

Euderces cribripennis, n. sp. (Pl. VI., fig. 14).

E. lævicaudæ (Bates) affinis. Niger, antennarum basi tarsisque obscure rufis, elytris totis dense, dimidio basali grossius, dimidio apicali subtilius, punctatis, punctis majoribus setiferis intermixtis. Thorax elongatus, convexus, usque ultra medium leviter dilatatus, deinde ad basin citius angustatus, totus (hic illic confluenter) punctulato-strigosus. Elytra mediocriter subæqualiter convexa, subnitida, macula utrinque nigra velutina prope suturam haud procul a basi ibique fascia tenui recta eburnea suturam haud attingenti. Femora valde clavata; tarsis posticis articulo basali 2 et 3 conjunctis subæquali. Long. 4½ millim.

Hab. Mexico, Chilpancingo in Guerrero, alt. 4600 ft. (*H. H. Smith*).

Apilocera breviformis, n. sp. (Pl. VI., fig. 15).

A. sculpticolli (Bates) affinis; relative brevior elytrisque postice valde convexis. Nigra, antennis pedibusque rufo-piceis, elytris tertia parte apicali cinereo-pubescentibus fasciaque tenui recta ante medium eburnea. Caput minute et dense punctulatum. Thorax elongato, subovatus, antice convexus, dense aspere punctulatus, erecte cinereo-pilosus, ante medium sulculo arcuato impressus. Elytra in medio coarctata ibique transversim depressa, postice valde convexa, tuberculo utrinque sub-basali alte elevato, triangulari compresso; ante fasciolam eburneam crebre punctulata et griseo-pubescentia, mox post fasciolam nigro-velutina deinde nigro-polita, sparsim punctulata, triente apicali dense cinereo-pubescentia. Long. 5½ millim.

Hab. Mexico, Teapa in Tabasco (*H. H. Smith*). One example only.

Apilocera yucateca, n. sp. (Pl. VI., fig. 16).

A. sculpticolli (Bates) affinis; elytris ante medium multo minus et parum constricto-depressis. Obscure fulvo-rufa opaca (abdomine obscuriori), erecte pilosa; elytris quarto apicali cinereo-pubescentibus, ante medium utrinque semifascia recta eburnea, tuberibus centro basalibus oblongis mediocriter elevatis, obtusis; superficie sat dense punctulata, fascia parum punctata excepta ante maculam cineream apicalem. Thorax elongatus, paullo convexus, usque post medium leviter dilatatus, basi sat fortiter contracta, dorso longitudinaliter hic illic confluenter striato. Antennæ articulis 8—11 fusco-nigræ.

Hab. Mexico, Temax in North Yucatan (*Gaumer*).

Rhopalophora eximia, n. sp. (Pl. VII., fig. 1).

Elongata, gracilis, æneo-cyanea nitida, vittis duabus aureo-fulvis a thoracis margine anteriori usque ad elytrorum apicem extensis apud elytra latioribus et suturam fere attingentibus; antennis pedibusque lætius cyaneis; corpore subtus (præcipue lateribus) fulvo-aureo tomentoso. Thorax elongatus, antice paullo angustatus, dorso sparsim transverse rugoso. Elytra lateribus nudis sat grosse subsparsim punctata, apice breviter oblique truncata. Long. 14½ millim.

Hab. Mexico, Chilpancingo in Guerrero, alt. 4600 ft. (*H. H. Smith*).

One example only of this beautiful and very distinct species has been received.

Cosmisoma nudicorne, n. sp. (Pl. VII., fig. 2, ♂).

C. martyra (Thoms.) simillimum, differt solum antennis articulo 5to haud penicillato. Long. 13 millim., ♂.

Hab. Panama, Chiriqui (*Trötsch*).

One example, differing in nothing from *C. martyra* except in the absence of hair-brush from the antennæ. The colour is the same metallic greenish blue, with a dark subvelutine sutural vitta, and the thorax has the same strong sculpture, *viz.*, a deep transverse sulcus near the anterior, and another equally deep near the posterior, margin, the latter angulated anteriorly, and the intermediate space with five large obtuse tubercles. The antennæ have the same proportions ciliated beneath joints 1 to 4, and with equally long and slender apical joints. It is possible it may be only a variety or aberration.

Cosmisoma reticulatum, Bates, Biol. Centr.-Amer., Col., v., p. 311.

This curious species, which was unique in the Sallé collection, has been taken in some numbers by Herr Höge at Acapulco. In all the examples the joints 3—5 of the antennæ, except the black apical brush on the 5th, the base of the femora, and tibiæ, are testaceous-red.

Chrysoprasis guerrerensis, n. sp. (Pl. VII., fig. 3).

C. æneiventri (Bates) affinis, sed minor et minus elongata; viridi-ænea vel ænea (abdomine concolori) nitida, antennis et pedibus nigris; toto corpore breviter setoso. Caput crebre punctatum, epistomate aurato. Thorax rotundatus, prope basin mediocriter, antice magis et longius, angustatus, alveolato-punctatus, linea dorsali brevi posteriori. Elytra apice obtusissime singulatim truncata, discrete æqualiter punctata, nitida, apice nitidiora. Metasternum sat dense sed discrete punctulatum. Pedes mediocriter elongati, aspere punctati; femoribus posticis elongatis tibiisque flexuosis. Antennæ corpore (♂) paullo longiores, (♀) paullo breviores, articulis 3—6 ad apicem intus brevissime spinosis. Long. 8½—11 millim.

Hab. Mexico, Acapulco (*H. H. Smith, Höge*).

A good series of examples. In form the species is like a small and slightly built *C. sthenias*, Bates, or *C. bouchardi*, Pascoe; but it differs from the group to which these belong by the æneous abdomen.

Chrysoprasis sthenias, Bates, Trans. Ent. Soc. Lond., 1870, p. 411; Biol. Centr.-Amer., Col., v., p. 64.

Var. *C. leptosthenias*.

A forma typica differt solum antennis et pedibus distincte longioribus, metasternoque minus grosse et in medio haud alveolatim punctato. Long. 11—13 millim., ♂ ♀.

Hab. Mexico, Mescala and Dos Arroyos in Guerrero, alt. 1000 ft. (*H. H. Smith*), Acapulco (*Höge*).

Three examples, one of which is a ♀. In the ♂ the antennæ are nearly half as long again as the body; in the typical *C. sthenias* they are only about one-fourth longer than the body. The species is found also, as a slight var., in Nicaragua.

Zenochloris barbicauda, n. sp. (Pl. VII., fig. 4).

Elongata, sublinearis, obscure viridi-opaca, subtus cum pedibus viridi-metallica abdomineque rufo; supra glabra, elytris apice excepta setosis. Caput rugoso-punctatum. Thorax relative angustus, paullo post-medium subangulatim leviter dilatatus, deinde usque ad basin paullo sinuato-angustatus, supra dense sed fere passim discrete punctulatus, vittula dorsali-posteriori lævi. Elytra apice breviter oblique truncata, margine laterali medio longe sinuato, epipleuris angustis prope basin latioribus, acute marginatis; dense, postice subconfluenter, punctulata, glabra, opaca, ænea, apice grosse setifero-punctata. Metasternum haud dense piloso-punctatum. Abdomen punctulatum. Pedes aspere punctati et breviter setosi, femoribus posticis valde elongatis tibiis subflexuosis. Antennæ breves, corporis dimidio (♀) subæquales, (♂) paullo longiores, nec spinosæ nec ciliatæ, articulo 3io scapo parum longiori, 5—10 subcompressis, ad apicem extus breviter productis. Long. 10½—14 millim.

Hab. Mexico, Mescala in Guerrero (*H. H. Smith*), Acapulco (*Höge*). Three examples.

In the form and proportions of the antennal joints, and other characters, this species agrees with *Z. paradoxa*, and I refer it to the same genus, notwithstanding the difference in the facies. Two Colombian species (undescribed?) have the same sharply defined and carinated epipleuræ, but they have a distinct thoracic lateral tubercle or spine.

Stenosphenus sublævicollis, n. sp.

S. cribripenni (Thoms.) affinissimus, forsan ejus varietas; paullo minus angustatus; thorace punctis multo minoribus et paucioribus, fere lævi, elytris densius magis æqualiter punctulatis apiceque spina exteriori minus elongata. Niger, pedibus rufo-testaceis. Long. 11½—13½ millim.

Hab. Mexico, Acapulco, Rincon, and Venta de Pelegrino, in Guerrero (*H. H. Smith*).

Mr. Smith found *S. cribripennis* also in Guerrero, chiefly at Chilpancingo; and Herr Höge took it in considerable numbers at various localities in the same State, including Acapulco.

Stenosphenus sexlineatus, n. sp. (Pl. VII., fig. 5, ♂).

S. ochraceo (Bates) simillimus; an varietas?; differt tantum thorace latiori, mox pone angulos anticos latius rotundato, lateribus utrinque punctis ochraceo-setiferis paucis. Rufo-testaceus, antennis articulis 3—11, elytris utrinque sutura et lineis lævibus elevatis tribus, nigro-fuscis, intervallis ochraceo incumbenti-pilosis; corpore subtus utrinque ochraceo-piloso. Thorax medio sparsissime punctulato. Long. 12—15 millim.

Hab. Mexico, Temax in N. Yucatan (*Gaumer*).

Differs from *S. ochraceus*, which is found from Chontales (Nicaragua) through Guatemala to Durango in North Mexico, in the constantly wider and more broadly rounded thorax, the sides of which, instead of being densely tomentose, have only a few greyish-yellow hairs.

Stenosphenus gaumeri, n. sp.

S. hirsutipenni (Bates) proxime affinis, sed distinctus statura minori, thorace angustiori cum lateribus perparum rotundatis, scapo et femoribus rufis etc. Parvus, angustus, testaceo-rufus politus, elytris castaneo-rufis utrinque vittis ochraceo-pilosis postice confluentibus tribus; antennis (scapo rufo excepto), tibiis et tarsis nigro-fuscis. Subtus castaneo-fuscus politus, lateribus subtiliter griseo-pilosis. Thorax angustus, oblongus, medio paullulum rotundato, dorso fere impunctato. Elytra recte attenuata, apice truncata, utrinque bispinosa; supra sat disperse punctata. Long. 9—11 millim.

Hab. Mexico, Temax in N. Yucatan (*Gaumer*). Three examples.

Stenosphenus comus, n. sp.

Elongata, capite antice breviori thoraceque breviori quadrato-ovato, elytris dense erecte pubescentibus; rufo-testaceus, antennis obscure fuscis. Caput confluenter punctatum. Thorax lateribus dense pubescens, dorso sublævi punctis majoribus piliferis. Elytra apice paullo oblique truncata, angulis acutis, brevibus; dense passim piloso-punctulata. Long. 9 millim.

Hab. Mexico, Villa Lerdo in Durango (*Höge*). Two examples.

Stenosphenus vitticollis, n. sp. (Pl. VII., fig. 6, ♀).

Pallide fulvo-testaceus nitidus, capite et thorace vitta mediana nigerrima, elytris sutura anguste et interdum lineis abbreviatis lateralibus et dorsalibus nigris, intervallis subsparsim incumbenti-ochraceo-pilosis, apice spinis duabus nigris exteriori elongata. Antennæ piceo-nigræ, articulis basi plus minusve obscure rufis. Caput parum punctatum, vitta nigra epistoma haud attingenti. Thorax gracile trapezoideus, lateribus paullulum rotundatis, dorso æquali fere impunctato. Pedes rufi, femoribus, tibiis tarsorumque apicibus nigris. Subtus rufus, lateribus fusco-nigris ochraceo-pubescentibus; prosterno utrinque vitta angusta nigra. Long. 13 millim.

Hab. Mexico, Teapa in Tabasco (*H. H. Smith*); Guatemala, Panzos in Vera Paz (*Conradt*).

Ancylocera rubella, n. sp. (Pl. VII., fig. 8, ♀).

A. cardinali (Dalm.) affinis et simillima; differt tantum elytris relative multo brevioribus, articulo 3io (♀) 4to haud longiori. Linearis, læte rufa, antennis, pedibus, prosterno medio, mesosterno toto metasternique lateribus nigris. Antennæ (♀) corporis medium vix attingentes, articulis 3—6 sicut in *A. cardinali* ♀ triangularibus, sed 7—10 magis oblongis. Thorax densissime grosse confluenter punctatus; elytra sublineatim dense prope apicem confuse punctatis. Long. 9 millim., ♀.

Hab. Mexico, Acapulco (*H. H. Smith*). One example only.

Championa badeni, n. sp.

Quoad formam *C. auratæ* (Bates) similis, sed thorace adhuc longiori elytrisque supra subplanatis apicibusque inermibus, rotundatis. Griseo-fusca, griseo brevissime pilosa, elytris ad medium fascia recta integra eburnea, secundaque ante apicem cinereo-pilosa. Oculi supra postice omnino divisi. Thorax cylindrico-elongatus, dense subrugose punctatus. Elytra dense confluenter punctata. Femora quam in *C. aurata* et *C. ctenostomoides*, magis abrupte sed vix crassius clavata. Antennæ (♀) corpore multo breviores, articulo 4to abbreviato 3ii dimidio breviori. Long. 14 millim., ♀.

Hab. Mexico.

A specimen of this species was sent to me with one of *C. ctenostomoides*, by Dr. Baden, without locality. The subsequent discovery of an indubitable Mexican example of the latter in the Sallé collection enabled me, in the Biologia Centr.-Amer. (Col., v., p. 315), to verify its locality, and I am now convinced that *C. badeni*, notwithstanding its different coloration and form of the elytral apices, is also Mexican. I have seen no other example.

C. ctenostomoides has been found in some numbers by Mr. H. H. Smith at Amula and Xucumanatlan in Guerrero.

Evander xanthomelas, Guér., Rev. Zool., 1844, p. 258 (*Amphidesmus*); Bates, Biol. Centr.-Amer., Col., v., pp. 72, 316.

Var. Elytris ochraceis, trienti apicali solum nigro; cæteris sicut in forma typica.

Hab. Mexico, Monterey in Nuevo Leon (*Höge*). One example; the typical form occurring also in the same locality.

Athetesis convergens, n. sp. (Pl. VII., fig. 10).

Valde elongata, fulvescenti-flava, incumbenti-pubescens, collo, antennis, thorace vittis duabus antice convergentibus, elytris fascia lata basali (nec marginem nec suturam attingenti) trienteque apicali, pedibusque (femorum basi excepta) nigris. Caput relative parvum, ante oculos transversim quadratum, verticale, tuberibus antenniferis paullo elevatis quadratis. Thorax trapezoideus, paullo post medium angulatim dentatus, ante dentem recte angustatus, post dentem sinuatus haud angustatus, angulis posticis prolongatis, dorso paullo inæquali, punctatus. Scutellum triangulare nigrum. Elytra valde elongata, quam in *A. prolixa* latiora et minus cylindrica, apicibus late singulatim rotundatis, utrinque disco usque paullo ultra medium tricostato, interstitiis apud fascias nigras minute et dense, apud fasciam medianam fulvam, grossius et minus dense punctatis, marginibus breviter fimbriatis. Antennæ (♀?) corporis dimidio perparum longiores, articulis 4—10 brevibus paullulum serratis. Subtus fulva nitida, metasterni lateribus abdominisque apice nigris. Mesosternum declive fere planum. Long. 19 millim., ♀?.

Hab. Mexico, Amula in Guerrero, 6000 ft. (*H. H. Smith*). One example.

The genus *Athetesis* is very closely allied to *Evander*, differing only in its long cylindrical form, and the nearly plane, very short antennæ. The present species is evidently congeneric with *A. prolixa*, although the anteriorly convergent thorax gives it a different facies. This genus is new to the Mexican fauna.

Elytroleptus scabricollis, n. sp. (Pl. VII., fig. 7).

E. pallido (Thoms.) brevior, elytris parum et gradatim dilatatis, apice acuminatim rotundato margineque sat longe fimbriato; subcyaneo-niger, dense erecte pilosus, partibus oris, vertice pedibusque anticis fulvo-rufis, elytris plus quam dimidio basali fulvo-flavis. Thorax ovatus, grossissime confluenter punctatus callisque tribus lævibus. Scutellum nigrum. Elytra utrinque tricostata, postice abbreviata, interstitiis dense punctatis. Antennæ corporis dimidium attingentes, articulis 5—11 valde serratis, 11 appendiculo parvo conico. Long. 10 millim.

Hab. Mexico, Iguala in Guerrero (*Höge*). Two examples.

Crioprosopus gaumeri, n. sp.

C. basileo (Bates) proxime affinis; differt (♂) thorace latiori, lateribusque rotundatis aut minime angulatis nec sublobato-productis, antennis corpore longioribus femoribusque apice nigris; ♀ thorace rufo, disco nigro bimaculato. ♂. Capite et thorax castaneo-fusci, hoc dense punctato, vitta dorsali antice tricuspidata lævi aut sublævi foveisque lateralibus; elytris splendidissime viridi-auratis, interdum partim fulvo-translucentibus, subtiliter et sparsissime punctulatis. Subtus cum pedibus rufus, femoribus ad apicem (plerumque cum tibiis et tarsis) nigris. Mesosternum antice planum declive, postice convexum. ♀. *C. basileo* simillima, differt tantum elytris brevioribus splendidioribusque, et thoracis (aurantiaco-rufi) margine anteriori maculisque duabus discoidalibus nigris. Long. 34—38 millim., ♂ ♀.

Hab. Mexico, Temax in North Yucatan (*Gaumer*).

This beautiful species is probably not more than an imperfectly segregated local form of *C basileus*, which is also found in Yucatan (at Merida); for the chief structural character, the rounded sides of the thorax, is not constant, some examples being slightly angulated, though not nearly approaching the distinctly lobed form of *C. basileus*. The antennæ in the ♂ are decidedly longer, passing the apex of the elytra to the length of the two terminal joints. The differences in colour and punctuation in both sexes, added to the characters just mentioned, will justify the separate naming of the two forms.

The following seems to be a colour variety of either *C. basileus* or *C. gaumeri*:—

C. nigricollis.—*C. basileo* (Bates) omnino congruit, thorace et sternis omnino nigris exceptis. — MEXICO, Jalapa (*Höge*). One example, ♀.

The punctuation is as in *C. basileus*; the elytra are brilliant golden-green, almost exactly as in *C. gaumeri*, the legs black except the red femora, of which the base and apex only are black.

Stenaspis pilosella, n. sp. (Pl. VII., fig. 11, ♂).

Parva, anguste oblonga, ænea vel viridi-ænea nitida, passim erecte griseo-pilosa, thorace et elytris sanguineo-marginatis, antennis, femoribus ad basin et tibiis obscure rufo-testaceis. Supra grosse et dense hic illic confluenter punctata. Thorax transversim quadratus, lateribus post medium late breviter dentatis, deinde usque ad basin angustatis. Scutellum angustum, subelongatum, triangulare. Elytra oblonga, parum convexa, apice rotundato (margine flexuosa). Pro- et mesosternum alte convexa, hoc antice verticale. Subtus subtiliter sparsim punctata, polita, prosterno grosse confluenter punctato, plaga laterali et pronoti limbo angustiori (ante basin abbreviato) sanguineis. Antennæ ♂ corpore duplo longiores, apice tenui hamato, articulis 3—8 subæqualibus; ♀ corpore multo breviores, crassiores. Long. 15—17 millim., ♂ ♀.

Hab. MEXICO, Omilteme in Guerrero, 8000 ft. (*H. H. Smith*).

The single ♂ is brassy green; the two females are brassy or æneo-cupreous. In the ♂ the bright red narrow elytral margin extends to the suture; in the females it terminates at the outer apex. The species is undoubtedly a *Stenaspis*. The mandibles are simple and acute at the apex.

Deltaspis rufostigma, n. sp.

D. cyanipedi (Klug = *auromarginata*, Serv. ?) proxime affinis et similis, sed conspicue differt thorace macula postero-discoidali 5-angulata aurantiaca nigro-viridi-limbata punctoque centrali nigro-viridi. Thorax quoque differt antice et postice subrecte angustatus tuberculoque laterali conico. Viridi-metallica, supra (et prothorax infra) passim dense confluenter punctata; subtus cum pedibus subtilius punctata, tenuiter griseo-pubescens. Prosternum apice prolongato, metasternumque (in ♂ tantum) tuberculo conico. Antennæ castaneo-fuscæ, apicem versus rufiores. Long. 21—24 millim., ♂ ♀.

Hab. Mexico, Guerrero. One pair sent me by Mr. Harford, together with a ♂ example of the following interesting variety :—

D. rufostigma, var. Thorax disco late nigro, tuberculo laterali adhuc longiori et acutiori ; elytrorum lateribus hic illic cupreo-aureo tinctis ; cæteris sicut in typo. ? = *D. auromarginata*, Serv. Long. 20 millim., ♂.

In the form and colour of the thorax this variety answers much better than *D. cyanipes* does to Serville's description of *D. auromarginata*. His phrases are "corselet presque cylindrique, unituberculé latéralement" . . . and "d'un vert sombre." In *D. cyanipes* the thorax could not possibly be described as approaching the cylindrical form, nor has it a distinct lateral tubercle ; the sides, in fact, are strongly and irregularly flexuous, the position of the lateral tubercle being occupied by a more projecting flexure. The thorax of *D. rufostigma*, however, is not at all cylindrical.

Deltaspis fulva, n. sp.

D. tuberculicolli affinis et similis ; differt præcipue antennarum articulo 1mo abdomine et pedibus rufo-testaceis. Rufo-fulva, dense erecte griseo-pubescens, antennis (scapo rufo excepto) nigris, capite, thorace limbo antico et postico elytrorumque sutura, fusco-nigris. Thorax dense punctatus, callo oblongo postero-discoidali lævi. Elytra densissime punctulata, apice flexuoso-truncato, angulo exteriori omnino rotundato. Long. 19—22 millim., ♂.

Hab. Mexico, Canelas in Durango (*Becker*). Two male examples.

Deltaspis disparilis, Bates, Ent. Monthly Mag., 1891, p. 160.

Hab. Mexico, Canelas in Durango (*Flohr, in coll. Bates*).

Deltaspis marginella, Bates, Ent. Monthly Mag., 1891, p. 160.

Hab. Mexico, Canelas in Durango (*Flohr, in coll. Bates*).

Deltaspis variabilis, Bates, Ent. Monthly Mag., 1891, p. 161.

Hab. Mexico, Guerrero (*Harford*).

Deltaspis rubens, Bates, Biol. Centr.-Amer., Col., v., p. 323.

The study of additional material obtained by Herr Höge has led me to conclude that two distinct though very similar and closely allied species were included in my description of *D. rubens*. They are distinguishable as follows :—

D. rubens.—Nigra, thorace supra et elytris coccineis, illo antice et postice nigro-marginato, his basi vittaque suturali nigris. Thorax grosse confluenter punctatus, disco paullo inæquali haud distincte calloso; elytris apice flexuoso-truncatis, angulis exteriori et suturali distinctis acutis. *Hab.* Mexico. I have before me one example only, a ♂.

D. tuberculicollis, n. sp.—Nigra vel piceo-nigra, pedibus sæpe fulvo-piceis, thorace supra coccineo antice et postice nigro-marginato, elytris fulvis vel rufescenti-fulvis—in ♂ unicoloribus, in ♀ vitta suturali fusco-nigra. Thorax grosse confluenter punctatus, disco tricalloso callo posteriori oblongo impunctato nitido. Elytra apice obtuso flexuoso-truncata, angulis obtusissimis. *Hab.* Mexico, Tupataro in Guanajuato (*Höge*), and Mexico City.

Metaleptus comis, n. sp. (Pl. VII., fig. 9, ♂).

Minor et gracilior, opacus, dense erecte sericeo-griseo- (capite pronotoque nigro-) pubescens; cærulescenti-niger, elytris fascia basali (versus scutellum angustata et supra epipleuras dilatata), abdomine dimidio apicali, pedibusque læte rufis, tarsis et interdum tibiis in medio fusco-nigris. Caput inæqualiter punctatum, ante oculos multo magis quam in *M. angulato* (Chevr.) elongatum. Thorax in medio angulato-dilatatus haud vero dentatus, sat grosse subalveolatim punctatus. Elytra subtilius sat dense punctata, ad apicem obtuse flexuoso-truncata, fere irregulariter rotundata sed angulis externis dentatis, disco lineis tenuibus sublævibus plus minusve distinctis. Subtus longius griseo-pubescentis, abdomine (basi et marginibus longe pubescentibus exceptis) polito vix sparsim punctulato. Antennæ et pedes gracillimæ, illæ ♂ corpore duplo longiores, 12 articulatæ, ♀ corpore brevioribus. Long. 10—14 millim., ♂ ♀.

Variat abdomine toto metasternoque medio læte rufis.

Hab. Mexico, Iguala in Guerrero (*Höge*).

Appears to be nearly allied to *M. batesi* (Horn), from Arizona. Dr. Horn has rightly corrected me as to the nature of the terminal segment of the antennæ in *Meta-*

leptus, which he says is a true 12th joint. I had given the antennæ as 11th joint appendiculated. In well-developed males of *M. comis* this joint is nearly as long as the 11th, and of great tenuity; in the female it forms a short conical appendage to the 11th.

The much longer and narrower anterior part of the head can alone scarcely warrant the generic separation of the present species from *Metaleptus*.

Triacetelus, nov. gen.

Metalepto (Bates) affinis sed thorace oblongo lateribus acute spinosis etc. certe distinctus. Corpus sat anguste elongatum, sericeo-pubescens, opacus. Caput ante oculos paullo magis quam in *M. angulato* elongatum. Antennæ tenues (♂), corpore magis quam duplo longiores, 12 articulatæ, scapo brevi fortiter clavato, articulis 3—10 et 12 longitudine fere æqualibus, 11 cæteris longiori, 3—6 apice paullo incrassatis. Elytra postice sensim paullo angustata, disco obtusissime costato, apice utrinque tridentato dente intermedia longiori et validiori. Pedes valde elongati; femora postica linearia ad apicem bidentata, tarsi postici articulo 1mo valde elongato. Mesosternum in medio tuberculatum. Metasterni episterna lata et valde elongata.

A distinct generic form, nearest allied to *Metaleptus*, of all genera known to me; but the mandibles are decidedly more obtuse and chisel-shaped at the apex than in that genus, though in *M. comis* they are by no means distinctly pointed.

Triacetelus sericatus, n. sp. (Pl. VII., fig. 12, ♂).

Fusco-niger, pectore ænescenti, elytris cinnamomeo-fulvis, antennis rufo-obscuris pedibusque læte rufis, thorace antennis corporeque subtus decumbenti-griseo-sericeo pilosis. Caput fronte declivi impunctata, vertice grosse sparsim occipite dense et subtilius, punctatis. Thorax sat elongato-oblongus, in medio paullo dilatatus et acute spinosus antice recte postice sinuatim et minus, angustatus, pubescentia utrinque transversim decumbenti, linea dorsali interdum lævi punctata. Elytra plerumque transversim decumbenti-pilosa. Ventris segmento apicali rufo. Long. 14—17 millim., ♂.

Hab. Mexico, Iguala in Guerrero (*Höge*). Four examples, all males.

Tylosis dimidiata, n. sp. (Pl. VII., fig. 13, ♂).

Fere cylindrica, nigra subtus polita, longe et minus dense erecte pilosa, elytris dimidio basali flavo-testaceo, dimidio apicali nigro antice apud suturam angulatim producto. Caput et thorax grosse subalveolatim punctati, hic oblongo-ovatus, callis discoidalibus duobus lineaque abbreviata mediana lævibus. Elytra passim densissime sat fortiter punctata, apice rotundato. Subtus cum pedibus punctata. Long. 7—11½ millim., ♂ ♀.

Hab. Mexico, Temax in North Yucatan (*Gaumer*).

A distinct species, agreeing in all structural characters with the typical *Tyloses*.

Tylosis angusticollis, Bates, Biol. Centr.-Amer., Col., v., p. 325.

Herr Höge has since obtained a large series of this supposed species, which shows all gradations in form of thorax between it and *T. puncticollis*. It must therefore sink into a synonym or variety of that species. The insect was met with at Matamoros Izucar in Puebla, Tacambaro in Michoacan, Durango City, and at Colima City, Tonila and Zapotlan, in the State of Colima.

Crossidius militaris, n. sp. (Pl. VII., fig. 14, ♂).

C. discoideo (Say) quoad colores similis sed multo major. Fere cylindricus, dense piloso-punctatus, opacus, coccineus; capite, thorace marginibus anticis et posticis, elytris ad basin anguste plagaque magna posteriori communi elongata in medio basin versus extensa, antennis, pedibus et sternis (prosterno ante coxas rufo excepto) cærulescenti-nigris. Thorax omnino rotundatus, inermis, absque callis, grosse confluenter punctatus; interdum maculis 2 vel 4 nigris. Elytra discrete apicem versus densius et subtilius punctata, sinuatim truncata, angulis plus minusve distinctis. Antennæ ♂ corpore multo longiores, distincte appendiculatæ; ♀ corporis dimidium vix attingentes. Long. 14—19 millim., ♂ ♀.

Hab. Mexico, Villa Lerdo in Durango (*Höge*).

This fine species appears to be much less variable in colour-pattern than other species of the genus.

Crossidius palmeri, Bates, Biol. Centr.-Amer., Col., v., p. 81.

Herr Höge has since met with this species in considerable numbers at Saltillo in Coahuila, and Monterey in Nuevo Leon. It varies remarkably in the form of the thorax, which is either rounded on the sides, or distinctly angulated and even acutely-tuberculated in the middle. This variability exists also in *Deltaspis*, from which *Crossidius* is hardly generically distinct.

Crossidius ægrotus, n. sp.

Elongatus, postice paullo angustatus, dense pilosus, parum nitidus; pallide fulvus, elytris flavo-testaceis (interdum sutura postice nigro-fusca marginata), thorace rufo-testaceo, capite, antennis pedibusque nigris. Thorax latus, in medio plus minusve angulatim rotundatus, confluenter punctatus, disco tricalloso. Elytra basi paullo sparsius postice densius punctata, apice flexuoso-truncato angulis rotundatis. Long. 15—17 millim., ♂ ♀.

Hab. Mexico, Chihuahua.

Taken by the late Mr. Montagu Kerr, the well-known African traveller, during a short visit to Central Chihuahua.

Ischnocnemis cærulescens, Bates, Biol. Centr.-Amer., Col., v., p. 328.

We are able now to supply the locality of this species. Mr. H. H. Smith met with it at various places in the State of Guerrero—Dos Arroyos (1000 ft.), R. Papagaio (1200 ft.), Acaguizotla (3500 ft.), Venta de Pelegrino, Tierra Colorada (2000 ft.), Hacienda de la Imagen (4000 ft.).

The following is a closely-allied but sufficiently distinct species:—

Ischnocnemis cyaneus, n. sp.

Latius cylindricus, cyaneus nitidus, antennis nigris; capite thoraceque dense sat grosse sed discrete punctatis, linea mediana postice dilatata lævi, elytris æqualiter discrete punctulatis, utrinque linea longitudinali nullo modo elevata lævi. Thorax gracile cylindrico, ovatus. Elytra ad apicem recte truncata, angulis distinctis. Subtus passim æqualiter minus sparsim punctulatus. Long. 13 millim., ♂.

Hab. Mexico, Yautepec in Morelos (*Höge*).

Distinctly broader in form than *I. cærulescens*, the punctuation of the thorax wider apart, the smooth line down the disk of each elytron not in the slightest degree elevated, and the elytral apex transversely truncated, with both sutural and exterior angles nearly rectangular and equal. In *I. cærulescens* the elytra are very obliquely truncated, with prolonged external angles.

Sphenothecus quadrivittatus, n. sp.

S. cyanicolli (Dup.) affinis et similis, sed differt elytris utrinque vittis costiformibus flavis duabus. Cyaneo-niger politus, subtus cum antennis pedibusque niger, elytris utrinque vittis convexis duabus flavis—1ma prope suturam basin versus paullo dilatata apicemque haud attingenti, 2nda submarginali angustiori postice multo abbreviata. Thorax sicut in *S. cyanicolli* in medio perparum rotundatus, antice paullo angustatus subsparsim punctulatus. Elytra costis lævibus, interspatiis pilifero-punctulatis, ad apicem valde flexuoso-truncata, angulis externis acute suturali brevissime dentatis. Long. 14—17 millim., ♂ ♀.

Hab. Mexico, Dos Arroyos, R. Papagaio (1200 ft.), Venta de Pelegrino, Rincon (2800 ft.), Acaguizotla (3500 ft.), Hacienda de la Imagen (4000 ft.), and Acapulco, all in Guerrero (*H. H. Smith*).

Sphenothecus cribricollis, n. sp.

S. quadrivittato similis, elytris utrinque flavo-bicostatis; differt thorace dense subrugose punctato, subopaco. Niger, elytris utrinque vittis duabus elevatis flavis. Caput antennarumque basis dense confluenter punctata. Thorax latior, et in medio latius rotundatus, disco posteriori foveatim depresso. Elytra vittis flavis utrinque ad apicem approximatis, interiorique basi haud dilatata, interspatiis densius punctatis, in medio inter vittas linea subelevata impunctata, ad apicem obtusius truncata, angulis externis haud producto-dentatis. Subtus sat dense punctulatus, punctulis griseo-piliferis. Long. 14—16 millim., ♂ ♀.

Hab. Mexico, Venta de Pelegrino, Dos Arroyos (1000 ft.), and Tierra Colorada (2000 ft.), all in Guerrero (*H. H. Smith*).

Sphenothecus cribellatus, n. sp.

Cyaneus, dense pilifero-punctatus pilis elongatis erectis intermixtis, subopacus; elytris utrinque vittis elevatis duabus flavis lævibus, interiori subrecta apicem fere attingenti et flavo-marginata, exteriori tenui postice abbreviata. Caput antennarumque basis dense confluenter punctata. Thorax dense subalveolatim punctatus, paullo ante basin rotundato-dilatatus, deinde usque ad apicem angustatus. Elytra lætius cærulescentia, interspatiis densissime sed discrete, sat grosse æqualiter punctatis; apice obtuse flexuoso-truncato, angulis externis rotundatis. Subtus cyanescenti-viridis, dense piloso-punctulatus. Mesosternum convexum, haud vero sicut in *Sphenothecis* genuinis, prominens. Antennæ ♀ corpore multo breviores. Long. 12 millim,, ♀.

Hab. MEXICO, Jalapa (*Flohr, in coll. Bates*). One female example.

The less prominent mesosternum seems to indicate a transition-form to *Ischnocnemis*, but the facies is that of *Sphenothecus*.

Entomosterna prolixa, n. sp.

E. miniatocolli (Chevr.) similis sed multo major elytrisque maxime elongatis. Nigra subnitida, prothorace (marginibus antico et postico anguste nigris exceptis) sanguineo, breviter incumbenti nigro-pilosa. Thorax sat elongatus, a basi ad apicem angustatus, leviter rotundatus, sparsim punctulatus, disco elongato-calloso lævi, margine basali valde elevato, angulis posticis longe exstantibus acutis. Elytra gradatim postice attenuata, disco utrinque bicostato, costa interiori mediocriter elevata ante apicem desinenti lævi, basi interdum flavescenti, costa exteriori vix elevata postice multo abbreviata, cum intervallis sat fortiter discrete punctata, apice flexuoso-truncato, angulis externis dentatis. Pedes valde elongati. Subtus griseo-pubescens, subtiliter punctulata. Antennæ (♂) corpore multo longiores, 11-articulatæ. Long. 14—15 millim., ♂.

Hab. MEXICO, Guerrero (*Harford*), Mescala in Guerrero (*H. H. Smith*).

AXESTOLEUS, nov. gen.

Gen. *Batyle* affinis, sat differt *inter alia* corpore supra opaco. Corpus subcylindricum. Mandibulæ acute falcatæ. Caput antice verticale quadratum, planum, infra oculos sat elongatum angulisque epistomatis lateralibus rectis. Antennæ 11-articulatæ, ♂ corpore vix longiores. Thorax subquadratus, inermis, nec antice nec postice profunde constricto-sulcatus. Pedes elongati, femoribus posticis linearibus corpore longioribus, tarsis posticis articulo 1mo valde elongato. Acetabula antica extus breviter angulata.

Allied to *Batyle* (Thoms., Lec.), and belonging to Leconte's group *Stenaspes*. In the sculpture and opacity of the upper surface it differs much from *Batyle*, and approaches *Purpuricenus;* but the slender form and unarmed thorax, and especially the somewhat elongated quadrangular muzzle, distinguish it from these and all the allied genera.

Entomosterna sanguiniventris (Chevr.), Biol. Centr.-Amer., Col., v., pp. 85, 330, comes near this genus, and does not agree with the typical *Entomosternæ* of the same author in the form of the thorax and the costate elytra. It differs from both genera in its 12-jointed antennæ.

Axestoleus meridionalis.

Batyle meridionalis, Bates, Biol. Centr.-Amer., Col., v., p. 87.

Hab. Mexico, Tehuantepec.

Axestoleus quinquepunctatus, n. sp. (Pl. VII., fig. 16).

Ab *A. meridionali* differt elytris relative brevioribus. Rufo-aurantiacus, antennis ad basin (cæteris rufo-piceis), thorace punctis 5, femoribus ad apicem tibiisque ad basin et elytris obscure nigris, his vittis utrinque abbreviatis postice attenuatis, una medio-basali altera marginali. Caput alutaceo-opacum. Thorax antice paullo angustatus, grosse punctatus, longe erecte pilosus, callis parvis nigris quinque minus punctatis nitidis. Elytra densissime punctulata, opaca, incumbenti-pilosa, apice obtuse truncato. Long. 13 millim.

Hab. Mexico, Acapulco (*Höge*). A single example, apparently female.

Batyle lævicollis, n. sp. (Pl. VII., fig. 15).

B. ignicolli (Say) affinis et similis; differt thorace glabro sparsim subtilissime punctato. Niger politus, thorace cum coxis anticis flavis. Frons canaliculata, grosse discrete punctata. Thorax rotundatus, convexus, margine basali sulcato angulisque posticis exstantibus acutis. Elytra sat fortiter sparsim punctata, punctis breviter pilosis, apice flexuoso-truncato, angulis exterioribus breviter dentiformibus. Mesosternum valde convexum. Femora (♂) corporis apicem attingentia, linearia, apice breviter spinoso. Long. 13 millim.

Hab. Mexico, Jalapa and Misantla in Vera Cruz (*Höge*).

Explanation of Plates V., VI. & VII.

PLATE V.

Fig. 1. *Aneflus cylindricollis.*
2. ,, (?) *fulvipennis*, ♂.
3. *Eburia baroni*, ♂.
4. *Proteinidium brevicorne*, ♀.
5. *Eburia porulosa*, ♂.
6. *Pœcilomallus palpalis.*
7. *Asemum glabrellum*, ♀.
8. *Anatinomma alveolatum*, ♂.
9. *Psyrassa cribellata.*
10. ,, *nigricornis.*
11. ,, *pilosella.*
12. *Hexoplon smithi.*
13. *Ibidion griseolum*, ♂.
14. *Hexoplon sylvarum.*
15. *Ibidion ruatanum*, ♂.
16. ,, *gaumeri*, ♂.

PLATE VI.

Fig. 1. *Distenia trifasciata*, var.
2. *Gaurotes multiguttatus*, ♀.
3. *Euryptera unicolor.*
4. *Ophistomis xanthotelus*, ♂.
5. *Euryptera planicoxis.*
6. *Acyphoderes cribricollis*, ♂.
7. *Odontocera yucateca*, ♂.
8. *Charisia nigerrima*, ♀.
9. *Neoclytus smithi*, ♂.
10. *Ochresthes nigritus.*
11. *Pachymerola vitticollis.*
12. *Ochresthes tulensis.*
13. ,, *clerinus.*
14. *Euderces cribripennis.*
15. *Apilocera breviformis.*
16. ,, *yucateca.*

PLATE VII.

Fig. 1. *Rhopalophora eximia.*
2. *Cosmisoma nudicorne*, ♂.
3. *Chrysoprasis guerrerensis.*
4. *Zenochloris barbicauda.*
5. *Stenosphenus sexlineatus*, ♂.
6. ,, *vitticollis*, ♀.
7. *Elytroleptus scabricollis.*
8. *Ancylocera rubella*, ♀.
9. *Metaleptus comis*, ♂.
10. *Athetesis convergens.*
11. *Stenaspis pilosella*, ♂.
12. *Triacetelus sericatus*, ♂.
13. *Tylosis dimidiata*, ♂.
14. *Crossidius militaris*, ♂.
15. *Batyle lævicollis*, ♂.
16. *Axestoleus quinquepunctatus.*

IX. *New species of* Ephemeridæ *from the Tenasserim Valley.* By the Rev. Alfred E. Eaton, M.A., F.E.S.

[Read March 9th, 1892.]

The rule that description and naming of new species of May-flies, represented incompletely by no matter how many specimens of one grade or sex only, ought never to be practised if the species lack definite character with regard to that grade or sex, does not apply to species of peculiar mark such as are distinguished in the following pages. Considerable interest attaches to them in respect of the geographical distribution of genera, and some of the flies are particularly ornamental. They were collected in the Tenasserim Valley by Mr. Doherty, and sent by him to Mr. R. McLachlan, F.R.S. The specimens, 21 in number, represent eight named genera, each (with one exception) by single species. A key to the genera and larger divisions of recent *Ephemeridæ* is given in Trans. Linn. Soc. Lond., 2nd ser., Zool., vol. 3, part 5, p. 309, &c., preceded by geographical notes.

1. *Ephemera pulcherrima*, sp. nov.

Subimago (dried), ♀.—A yellowish species with linear longitudinal abdominal markings, besides a round spot just above the pleura on each side of the 2nd segment; also with an angulated spot on the hind coxa; and with three round or oblong spots in the area immediately posterior to the submarginal area of the fore wing. Hind wing spotless. Wings very light yellow ochraceous, subopaque: fore wing sparsely marked with small violet-black spots, situated—one each at the bullæ of the subcosta and radius, one in line with these on the sector, a small one occupying the axil of the fork of the præbrachial nervure, and three others, one in the middle of each of the last three cross veinlets immediately posterior to the radius; hind wing spotless, unicolorous. Neuration in both wings concolorous with the membrane (but opaque), excepting a few cross veinlets in the submarginal area of the hind wing that are greyish towards the subcosta, and some in the fore wing, *viz.*, the cross veinlets anterior to the sector, many of those anterior to the pobrachial in the basal half of the wing, and a few of those nearest to the base in the areas intervening between that nervure and the 1st axillar nervure ; the great cross vein also is black between the subcosta and the radius. Body and legs yellowish ochre, with black markings ; those of the head and notum are of a pattern common in the genus, comprising the edge of the occiput on each side behind the eyes, and two longitudinal stripes extending from the pronotum (where they are parallel with each other) to the peak of the scutellum, angulated on the mesonotum and confluent just before their termination with a rounded pitch-brown spot on the succeeding part of the notum on each side. On each side of the thorax is a small spot in front of the roots of the costa, and a minute spot just above the coxa at the posterior angle of the metapleuron. The basal and the posterior margins of the hind coxa, and the anterior tibia, narrowly, at both extremities, are blackish. Dorsal abdominal markings—two subcontinuous and subparallel series of strongly marked linear stripes, rather near each other, extend from the 3rd to the 9th segment down the middle of the back, and are slightly coarctate at the bases of the 3rd to the 8th segments ; between these in each segment is a pair of divergent streaks from the base of the segment that are associated with the dorsal vessel, and are less distinctly defined than the linear stripes: in some of the segments the streaks are considerably abbreviated ; in the 2nd segment (which is marked with a round spot on each side just above the pleura) the stripes are represented by single dots ; at the joinings of the 1st to the 8th segments the stripes are crossed by single fine black lines that do not extend to the pleura. At the pleura, segments 2—9 have each a small triangular spot at the base, and segments 4—7 each have a fine curved longitudinal line from the margin near the posterior angle, which is reduced to a dot in segments 3 and 2. Venter bilineate longitudinally ; the lines subparallel, discontinuous, and some of them at their anterior extremities slightly inflected. Setæ fuscous, with opaque joinings, and some of them here and there blackish. Length of body about 12, wing about 13 mm.

2. *Potamanthus formosus*, sp. nov.

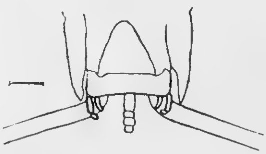
Imago (*dried*).—A species of elegant appearance, with transparent wings of a light flavescent tint : the fore wing strongly blotched with light reddish pitch-brown in the marginal area, and sparsely freckled faintly in the disk with light greyish or reddish grey. Upper parts of the anterior femur dull reddish purple-brown: a narrow stripe (of a like colour in the abdomen, but more of a piceous tint in the thorax, where it is narrowest) extends from the head along each side of the body to the 9th abdominal segment.

♂. Whitish ochre, more flavescent about the thorax, with reddish brown or reddish purple-brown markings, comprising—a fine median longitudinal line through the pronotum, continued along the median suture of the mesonotum; the orbits of the ocelli, and the greater part of the basal joints of the antennæ; and a longitudinal stripe of moderate width on each side of the body from the pronotum to the 9th abdominal segment, which, commencing opposite the back of the eyes, is arched on the pronotum, and prolonged posteriorly below the wings. Setæ flavescent for some distance from the roots, and then very light ochreous, with the joinings narrowly very light reddish purple; at the extreme tip, a few of the joints (2 or 3) are minutely pilose. Legs light yellowish amber-colour, except parts of the fore leg, *viz.*, the upper parts of the fore femur reddish purple-brown throughout; a small spot of the same colour underneath, just beyond the middle, and another rather larger underneath at the tip, produce annulations: tibia reddish purple-brown at the extreme base, but dark purple or violet-carmine at the tip; 1st tarsal joint, and the tips of the 2nd, 3rd, and 4th joints also of this colour. In the fore wing the cross-veinlets of the marginal area are rather broadly and conspicuously bordered with light reddish pitch-brown; the bordering sometimes is partly dark-edged, and the colouring, entirely permeating the costa and the terminal portion of the subcosta, spreads narrowly along both these nervures between the spots or blotches; it also invades the extreme apex of the submarginal area, and insinuates itself into the next area thereabouts in near proximity to the radius, and the fore parts of the last two or three cross-veinlets therein. The faintly coloured freckles in the disk of the fore wing are disposed approximately in two linear series—one of three freckles, posterior to the anal nervure, near the bends or primary forks of its branches; the other of four freckles, nearly parallel with the terminal margin, one of which is at the bend or inner extremity of the intercalary nervure contained within the fork of the præbrachial; there is also another freckle, out of rank, at the bend or inner extremity of the first long intercalary nervure after the pobrachial that represents a postical nervure. Hind wing spotless. Neuration for the most part light yellow amber-colour; but in the fore wing, the costa from the first cross-veinlet onwards, the greater part of the subcosta towards the tip, and the radius near its extremity, are rufo-piceous or warm amber-brown, as well as the cross-veinlets adjoining them, and from certain standpoints many of the other cross-veinlets become piceous. Cross-veinlets of the marginal area simple; in both sexes about 24 in number.

♀. Similar to the ♂, but with the cross-veinlets in the disk of the fore wing more generally piceous. Length of body, ♂ and ♀ 7; wing, ♂ 7, ♀ 9; setæ, ♂ 15 and 12—18 and 14, ♀ 11 mm.

3. *Rhoënanthus amabilis*, sp. nov.

Imago (*dried*), ♂.—Remarkable for the excessive smallness of the forceps, which in both of the specimens are quite rudimentary. Cross-veinlets of the fore wing pitch-brown, with narrow edging of the same colour, which in some parts is triangularly dilated at both ends of the veinlets, in other parts fills up meshes of the reticulation so as to form small spots, and along the terminal margin, where the neuration is closest, produces a cloudy marbled reticulation. Thorax light pitch-brown, approaching intense raw umber, modified on the mesonotum with a lighter tint. Abdomen rather darker than the thorax at the sides and hinder borders of the segments, but with dull whitish ochreous markings along the middle of the dorsum, comprising, in segments 7—9, a rounded median spot at the base, a dot on each side near the base, and two dots on each side before the dark apical border of the segment. Setæ white, with dark purple-madder annulations at the tips of the joints: in the first seven joints from the roots, the dark colouring largely predominates; after that, throughout the greater part of



Rhoënanthus amabilis (Tenasserim Valley).

the seta, the annulations are alternately narrow and broad, one joint being almost entirely white, and the next joint purple-madder in its apical half, and so on; the last three or four joints are pilose, as in *Potamanthus*. Forceps very minute; the limbs 2-jointed, much shorter than their distance apart, not exceeding in length one-third of the width of the basis, and being much smaller than the produced posterior lateral points of the 9th dorsal segment; their colour white, but purple-madder just at the base. Penis-lobes more minute than the forceps, filiform or subulate, with the tips incurved. Fore leg with the femur and the extreme base of the tibia light pitch-brown; the remainder whitish, with the 1st tarsal joint, and the tips of the other joints, as well as that of the tibia, rather broadly piceous. Hinder legs very light yellow-amber, with an annulation at the extremity of the tibia, the tips of the tarsal joints and the ungues piceous. Wings vitreous, with piceous markings; the longitudinal neuration for the most part whitish, the cross-veinlets in the fore wing and in part of the hind wing piceous; the remaining neuration in the hind wing whitish. In the fore wing the piceous markings (referred to more in detail in the prefatory diagnosis above) tend to be confluent transversely opposite the bulla of the subcosta, and again nearer the base in the middle of the disk; there is also a small blotch at the commencement of the pterostigmatic region: the marginal area contains about 7 cross-veinlets before and 17 beyond the bulla, nearly all simple. In the hind wing, besides some lesser markings posterior to the cubitus, is a blotch or several subconfluent spots on the cross-veinlets of the radial—sectorial regions a little before the apex, a spot at the junction of the sector and cubitus, and a large spot at the head of the intercalar nervure contained within the fork of the præbrachial. Length of wing, 8; setæ, 25 mm.

4. *Choroterpes exiguus*, sp. nov.

Imago (dried), ♂.—Body pitch-brown: venter in at least segments 5—8 paler, and in the 9th segment rusty or light burnt umber-brown. Legs in two specimens light pitch- or bistre-brown; femora banded just beyond the middle broadly, and at the knee narrowly, with a rather darker tint; in another specimen they are banded broadly in the middle and narrowly at the tip with pitch-black. Wings entirely vitreous, with light pitch-brown neuration: fore wing with no cross-veinlets before the bulla in the marginal area, but with 9—12 simple ones in the pterostigmatic region. Setæ, in the two specimens referred to above, sepia-brown; in the other specimen whitish, with the joinings narrowly black. Forceps-limbs suddenly and broadly dilated in the basal half of their basal joints. Penis-lobes narrow, lanceolate, and contiguous. Length of wing, 6—6·5; setæ about 10 mm.

5. *Hagenulus monstratus*, sp. nov.

Subimago (dried), ♂.—Wings light blackish grey (ivory-black), with most of the neuration of the same colour, but with the cross-veinlets of the marginal and next two areas of the fore wing bordered more or less broadly with pitch-black, broadest in the first half of the marginal area: in the same area, a blot of this colour embraces about four cross-veinlets in the middle of the pterostigmatic region; in the area next below the submarginal area, a spot at the bulla includes two cross-veinlets, and another at the apex about three cross-veinlets.

Imago (*dried*), ♀.—Body pitch-brown. Femora pitch-brown, with a narrow impure whitish annulation a little beyond the middle: tibiæ and tarsi brownish white, with the knee whitish; the fore tibia just below the knee and again at the tip narrowly and faintly annulated with light brown. Setæ whitish, rather broadly annulated with blackish at the bases of most of the joints. Ventral lobe of the 9th abdominal segment bifid: the 7th ventral segment unprovided with an egg-valve. Wings vitreous; the fore wings with pitch-black markings associated with the cross-veinlets. The most conspicuous of these markings are produced by the very broad bordering of the cross-veinlets in the marginal, submarginal, and the adjoining areas, which in places forms quadrangular or subquadrate spots; some of these in the basal halves of the areas in question, also in the middle of the pterostigmatic region, and again in the two areas which follow that, coalesce into large irregular blotches: posterior to the sector throughout the disk the edging of the cross-veinlets is very narrow, and in many instances only on the exterior side of the veinlet; and here the cross-veinlets are arranged in about ten broken subparallel curved transverse series at rather regular intervals. The marginal area of the fore wing contains about three cross-veinlets before the bulla and ten beyond it; those in the pterostigmatic region are distinct and fairly straight. Length of wing, 5 mm.

The remaining genera represented in this collection from Tenasserim are:—*Baëtis* by a single ♂ subim. of small dimensions; *Chirotonetes* by a fragmentary ♂ im- in no way remarkable; and *Heptagenia* by two species, —four ♂ im. and four subim. of one, and a subim. of the other species. Hitherto the genus *Potamanthus* has been known only as an European and N. American genus, *Rhoënanthus* from the Malay Archipelago, *Choroterpes* from Europe and America, *Hagenulus* from the Island of Cuba, and *Chirotonetes* from America, Japan, Europe, and Sumatra.

X. *On some eggs of Hemiptera.* By David Sharp, M.A., M.B., F.R.S., &c.

[Read May 11th, 1892.]

Plates VIII. & IX.

The remarkable examples of the eggs of insects I am about to describe were procured by the late Mr. Neville Goodman, of Cambridge, in the Valley of the Amazons. Mr. Goodman made a journey to that locality in the year 1879, being accompanied by his son Roger, and remained there from Sept. 26th to the end of December; during which time he formed, with the assistance of his son, an interesting collection of various orders of insects. After the decease of Mr. Goodman, his son, Mr. Roger Goodman, M.A., presented this collection to the University of Cambridge; and, on taking possession of the collection for preservation in the University Museum, my attention was attracted by a small object of a somewhat unusual nature.

The specimen had the appearance of a small wasp attached by the wings to a mass on a leaf, and on the wings of the wasp where it was attached were a number of small insects crowded together indiscriminately. On a closer examination it was seen that these small insects consisted of a number of two species of *Ichneumonidæ*, and some minute creatures that appeared to be made of legs and antennæ; these latter, on more careful comparison, were seen to be specimens of some species of Hemiptera-Heteroptera, just hatched from the egg, and with the abdomen quite shrivelled up.

The glimpse I could obtain of the central mass was very imperfect, but, as it seemed to be a cluster of insect eggs of a very unusual nature, I felt desirous of making further acquaintance with it; and, foreseeing that in so doing I should necessarily derange the natural position of the various parts of the specimen, I before doing so placed it in the hands of Mr. E. Wilson, who made of it the very good sketch from which fig. 1, Plate VIII., is taken.

On removing some of the superincumbent small insects, the central mass could be partly seen, and it could be noticed that it consisted of a densely packed mass of columnar bodies, probably about one hundred in number. A portion of this mass is seen in fig. 2, Plate VIII.

The fact that some of the small insects were newly-hatched Hemiptera suggested that this mass of columnar bodies might be the eggs from which the bugs had emerged, but if so, they were clearly eggs of a most peculiar nature, for they consisted of two tiers or stories, and moreover, attached to the mass, there were some peculiar bodies having more the appearance of the styles and stigma of a flower than of anything I was acquainted with in the insect world.

In order to get a better view of the object the wings of the wasp were displaced so that the upper surface was displayed, and a still more curious and problematic set of structures was revealed; for it was seen that the upper extremity of each egg of the two external series presented the appearance of a capsular body with an orifice in the middle, while the eggs in the centre had their free tops split up into ligulæ, and some of these latter were curled over, and were seen to embrace the peculiar floral-like structures I have already mentioned. Fig. 3 gives a view of a portion of the upper surface of the mass.

I then sent some of the small Hymenoptera to Mr. Peter Cameron, who was kind enough to inform me that they consisted of two species of the genus *Telenomus*, known to hymenopterologists as inquilines in the eggs of bugs. Mr. Cameron has since described them under the names of *T. melanogaster* and *T. amazonica* (Mem. Manchester Soc. 1891).

The probability that the columnar objects were the eggs of a bug was much increased by this fact, and became certainty on my observing that from the upper surfaces of several of the objects the young bugs were actually projecting, having, in fact, been killed, and arrested in the act of emerging from the egg. A few of the eggs were then detached from the mass, and submitted to examination to ascertain their structure; and on this being done, it appeared that each egg was an object similar to that of which a longitudinal section is shown in fig. 4, Plate IX.

Each egg is, in fact, a cylinder divided into two tiers, the lower of which is about two-thirds of the whole length, and is the egg proper; while the upper tier is a capsule containing the peculiar floral object. This capsule and its contents are of so remarkable a nature, and their functions are so problematical, that I think it advisable to describe their structure, so far as I have been able to observe it. The capsule is somewhat constricted in the middle, and the orifice at the top (fig. 4, *o*) forms the entrance to a dependent tube, which hangs down nearly as far as the middle of the length of the capsule.

The structure contained in the capsule I will call the cone; a section of it is shown in fig. 5, Plate IX. It is a quite hard structure of almost glassy consistency; it is not regularly conical in form, but is more like a truncated cone surmounted by a spike; from the sides of the part where the truncation occurs there extends a delicate lace-work structure, becoming divergent as it ascends, and coming into contact with the sides of the capsule, with which, indeed, the delicate lace-work is almost certainly continuous.

The chamber occupying the lower part of the cylinder is the egg proper, in which the embryo is developed. In fig. 6 is explained the way in which the insect emerges; the embryo, pushing upwards, lifts the cone contained in the superior capsule, whose point, as we have seen, projects into the dependent tube of the capsule, and the capsule is thus ruptured, as exhibited in *b*, fig. 6; the embryo, continuing to ascend, the cone is pushed out of the capsule (*c*, fig. 6), and falls away, and the insect then emerges, leaving the empty egg-shell, as shown in *d*, fig. 6.

The bunch of eggs, of which I am writing, had been killed by Mr. Goodman at exactly the right moment for allowing us to understand this process of emergence, the various stages of the act being displayed on different parts of this example.

The parasitic Hymenoptera had also just emerged; the holes they had made for this purpose are displayed at the lower part of fig. 2, and above them are seen some of the cones that have fallen out from the capsules, and have adhered to the sticky substance with which the whole of the outer surface of the egg-mass is smeared; the lower part of the mass being very thickly plastered with such substance.

The fact that the two outer series of eggs are intact as to their capsules is explained by the presence of the destroying Hymenoptera, the mothers of these having been able to place their eggs only in the two series of the hemipterous eggs next the outside, the others being protected by their more internal position in the closely-packed mass; the tops of the eggs are, of course, protected by the capsules and the cones contained therein, and the lower faces of the eggs by the leaf on which the mass is placed, so that only the outer two layers of the bugs' eggs have been within reach of the ovipositor of the female Hymenoptera.

We have seen that there are two species of these hymenopterous destroyers; perhaps one may have a longer ovipositor than the other, and so be able to reach the second row of eggs; or it may be that the two rows of eggs are pierced indiscriminately by each of the two destroying species.

We have thus accounted for the presence of the bugs and of the Hymenoptera in this curious entomological specimen, but we have not alluded to the large wasp depicted in fig. 1, and we cannot but feel some curiosity to know what part this has played in the drama. Of course this should be settled by actual observation. The presence of the wasp may be purely fortuitous; it may have become accidentally entangled in the sticky mass, and have been unable to disentangle itself. But this method of accounting for its presence does not appear at all probable, for, as will be observed on reference to fig. 1, the wasp is reposing on one side, and is attached by the tip of one wing to the lower part of the mass on which the adhesive matter I have alluded to is so abundantly placed; and, as its position does not look like one into which it could have got by means of accidental entanglement, I incline rather to the supposition that the wasp was stuck in its position by the parent bug as a meal for its future offspring when they should be hatched. This supposition is supported not only by the position of the wasp, but also by some other facts, *viz.*:

—1, that the bug is of a carnivorous nature (belonging, doubtless, to the *Reduviidæ*, though the species is not known); 2, that the newly-hatched bugs are mere skeletons, apparently almost all external organisation, with the abdomen destitute of any contents, so that they would be urgently in need of a supply of food; and 3, the fact that the wasp has a slit made on the back of its thorax, so that the young bugs could plunge their rostra without any difficulty into the interior of the wasp.

The Reduviid bugs have some of them the power of inflicting a wound that has a very numbing effect. It might well be, then, that the wasp was mastered by the parent bug, who split the wasp's thorax with its rostrum, benumbed it by the same process, and then attached it to the egg-mass as a store of food to start the newly-hatched young bugs on their journey through life. This, however, is purely supposition, though I hope it may be some day confirmed by the observation of a naturalist who shall be so happy as to have the opportunity of watching the habits of Reduviid bugs in the Amazon Valley.

But the chief interest in these bugs' eggs is connected with the peculiar capsule and its contained cone, and we cannot but ask what can be the function of this beautiful and complex structure. The answer that would be given by those who are acquainted with Leuckart's paper "On the Micropyle, and the minute structure of the Egg-shell in Insect's Eggs" (Müller's Arch. f. Anat. Phys., 1855), would be that it is a micropyle-apparatus of the most complex and perfect character; and on the whole I am inclined to believe that this solution, extraordinary as it may seem to be, is likely to prove, at any rate, partially correct; but it must be admitted that there is considerable doubt about it, and that some other purpose is also served by the structure.

A micropyle is a canal through an egg-shell, by which the entry of a spermatozoon to the egg is facilitated; nothing can be simpler than that arrangement, and one does not see any reason why it should be departed from to give place to an extraordinarily large and complex apparatus that the spermatozoon must traverse before arriving at its destination. The capsule and the cone contained in it are no doubt fabricated in the ovarian passages of the mother, and, on looking at our figures, it must appear a mystery how such a structure as is there represented can facilitate the entry of one or more spermatozoa to the egg, while the structure is passing through the maternal oviduct.

Leuckart, who is almost our sole source of information as to structures of this nature, has figured, in a rough manner, a number of eggs of bugs, *l. c.*, pl. viii., ff. 1—26. These exhibit a great variety of structures at the upper pole of the egg, but only one at all resembles our Amazonian egg in the mechanical arrangement of the apparatus; the resemblance, however, so far as one can judge, is but a distant one. The egg in question (f. 16, pl. viii.) is that of *Phytocoris viridis.*

Leuckart has not, however, given such an account of the intimate structure of the egg as would allow any valuable opinion to be formed as to the functions of the part he roughly figures, and he remained himself in doubt on this point, as will be seen by a passage on p. 149, *t. c.*, where he says:—"I do not know how to give any satisfactory conclusion as to the meaning of this wonderful apparatus: that its object should be to open (or unfold) the cover seems scarcely credible; one would, indeed, much rather suppose that it served as a support to the cover, especially as this latter is only very loosely inserted. Meanwhile, it remains doubtful whether the sole function of this structure consists in this."

A brief account of the structure of the capsule and its contents, in the case of the Amazonian Reduviid, is therefore desirable; but there is considerable difficulty attending the examination of these eggs after they have been long dried, and covered as they are externally by a gummy matter. The form of the capsule will be perceived by reference to the section shown in fig. 4; the wall of the capsule (fig. 4*c* and fig. 8*b*) is a piece of lacework, the meshes of which are completely filled up by some other substance, reminding one of what exists in dried leaves or husks of some seeds. The walls of this capsule are apparently impervious, and the only means of entrance to the interior of the capsule is by the dependent tubule at the summit.

The "cone" in the interior of the capsule is shown in section in fig. 5; it apparently consists of a series of closely-packed tubes, some of which extend from the sides of the spike at the summit to the base of the cone, while others open at the sides of the cone, but apparently also communicate with the shallow chamber at the base of the cone ; this chamber, *c* of fig. 5, is closed in below by a peculiar transparent plate, having the appearance of a piece of mica ; this plate, though itself quite impervious, is so transparent that it allows the meshwork of the surface above it to be seen, as shown in fig. 7. From the point at which the cone is narrowed or truncated there extends outwards a beautiful transparent lace-work of rather larger meshes ; this lace-work becomes more delicate as it diverges, and is perhaps, at its termination, actually continuous with the mesh-work of the inner wall of the capsule. The whole of the system of canals in the cone apparently converges to the chamber *c*, fig. 5 ; in the figure in question the section of this chamber is shown to be limited by a wall on each side, but I am very doubtful whether that wall (*d*) really exists ; I think it will ultimately prove that the transparent plate (*m*), forming the floor of the cone, is not really part of the cone, but is a peculiarly developed part of the inner membrane of the egg, and that the cone is merely loosely set on this, and that the two, though lifted up together by the emerging insect, have no actual continuity.

Supposing the cone to be a system of tubes giving entrance to air or other matter, then this substance will have to find its way into the interior of the egg proper by a gap or system of canals extending round the egg on the inside of the capsule at the spot marked *f* in fig. 4. Now it is at this spot, judging from what I have observed in the egg of another bug, *Piezosternum subulatum*, and from the figures of Leuckart, *t. c.*, pl. viii., ff. 6, 14, &c., that I should expect the true micropyle canals to exist ; it seems, therefore, quite possible that, though distinct from the true micropyles, the cone may be a means of communicating with them.

In the absence of any direct observation, it is useless to indulge in further speculation on what the function of these wonderful cones may be ; it seems in the highest degree improbable that they can be simple in their function, possessing as they do so great a development, and it is more probable that they serve two or even three purposes. That the peculiar capsule and its contents can be looked on as mere evolutions of the simple micropyle is almost impossible, unless some very peculiar or complex function is subserved by them.

Some time ago I exhibited the egg of another bug to this Society (*cf.* Proc. Ent. Soc., 1889, p. i). This egg is also of a very peculiar character; it possesses at one end a series of circumferential projections like small nails partially driven in; and also a peculiar flask-like structure in the middle, and quite isolated from the nail-like bodies; these latter are, I have no doubt, micropyles, as I have been able to see the canal extending through one or two of them to the interior of the egg. What the middle flask-like object may be I am unable to say, but I think it quite probable that its function may be partially the same as the capsule and cone of the Amazonian Reduviid; the wall of the flask representing the wall of the Reduviid capsule, and a substance that can be dimly perceived within the flask-wall seated at its base being, perhaps, similar in its function to the cone of the Reduviid bug. Fig. 9, Plate VIII., represents this egg of *Piezosternum subulatum*, *a* being the nail-like objects, and *b* the flask-like structure.

Explanation of Plates VIII. & IX.

Figs. 1 to 8 relate to the eggs of a Reduviid bug of unknown species, and fig. 9 to the egg of *Piezosternum subulatum* (*Pentatomidæ*).

Fig. 1, Plate VIII.—Sketch of the egg-mass of Reduviid hemipteron with wasp adherent to it by the wings, and with a crowd of parasitic *Proctotrupidæ* and newly-emerged Reduviids.

Fig. 2, Plate VIII.—Portion of the same egg-mass, showing the two outer circles of eggs, from which Hymenoptera have emerged at the holes marked *h*; *a*, egg situated near the centre, in which a bug is beginning the process of emergence by lifting a cone; *c*, cones that have fallen from eggs during the process of emergence, and become entangled in the sticky substance with which the eggs are covered.

Fig. 3, Plate VIII.—Portion of the same egg-mass, showing, *a*, eggs with capsules ruptured by the process of emergence of the young bugs; *b*, the capsules intact (the interior of the egg having been eaten by Hymenoptera).

Fig. 4, Plate IX.—Outline of one egg, seen in partial section (the capsule, *c*, being divided, and a portion of the lattice-work broken away); *a*, the cone surmounted by its spine projecting into the entrance-tube, *o*, of the capsule; *b*, lace or lattice-work (partially broken away), connecting the cone with the wall of the capsule; *d*, portion of the egg in which the embryo is developed.

Fig. 5, Plate IX.—Longitudinal section of a cone, showing its tubular structure and the small transverse space below it, with which all the tubes communicate; *a*, body of the cone; *b*, lattice-work that connected it with capsule; *c*, transverse inferior space or chamber; *d*, circumferential wall of this chamber.

Fig. 6, Plate IX.—Eggs, showing the mode of emergence; *a*, egg intact, with cone in the capsule above the embryo-chamber undisturbed; *b*, the young insect commencing to emerge, and rupturing the capsule by elevation of the cone; *c*, the young insect just emerging, with cone falling away; *d*, empty egg-shell.

Fig. 7, Plate IX.—The cone and its lattice-work removed from the capsule.

Fig. 8, Plate IX.—Portion of egg at the point of contact of the various parts; *a*, wall of the embryo chamber; *b*, wall of capsule; *c*, cone in the interior of capsule.

Fig. 9, Plate VIII.—Egg of *Piezosternum subulatum* (taken from interior of body), referred to in Proc. Ent. Soc., 1889, p. 1; *a*, nail-like objects, probably micropyles; *b*, vase-like structure of unknown function.

XI. *On a new and also on a little-known species of* Pseudacræa *in the collection of the Hon. Walter Rothschild.* By Arthur G. Butler, F.L.S., *and* The Hon. Walter Rothschild, F.Z.S.

[Read June 1st, 1892.]

Plate X.

Pseudacræa Clarkii, Butler; and *P. Poggei*, Daw.

Pseudacræa Clarkii.

♂. Prevailing colour of upper surface of wings reddish tawny (probably rosy carmine in freshly emerged examples); primaries with the apical two-fifths and a rather broad and regular outer border greyish olive-brown; an oblique quadrangular quadrifid patch of the ground colour half-way between the discoidal cell and the apex; veins and internervular folds black; a black streak in the cell just above the median vein; internervular streaks on the median interspaces very wide, that on the upper space tapering towards the cell, that on the lower space widening and obliquely truncated; the streak on the interno-median area confined to the basal half of the wing, very broad and obliquely truncated towards the base, its outer extremity curved round in a loop, which runs along the inner margin to the base; secondaries with greyish olivaceous costal border, interrupted near apex by an oblique whitey-brown streak; eight black spots on the basal half, one large within the cell near the base, followed by a small one just above the median vein; four large subconfluent black spots crossing the end of the cell from the first subcostal branch to the submedian vein, and two small spots beyond this series above the second subcostal and third median branches; abdominal border sordid white, interrupted by smoky-brown veins; a small white spot at base of interno-median area; external border rather broadly blackish, with dentate-sinuate inner edge, and enclosing about eight ill-defined whitish spots in pairs; body black; four white dots on the head, two pale ochreous spots on the collar, tegulæ and sides of thorax spotted with whitish; abdomen spotted laterally with ochreous, and with a longitudinal interrupted white stripe below the lateral series of spots; primaries below altogether paler than above; the ground colour rosy flesh-coloured; the darker area grey; veins and internervular streaks black as above, a submarginal black streak towards external angle, followed by four whitish dots; secondaries with the basi-abdominal area pale greenish sulphur; with black spots, and an interno-median streak arranged in four oblique series; discal area rosy flesh-coloured; external border less black than above, and enclosing twelve elongated greyish white spots, in pairs between the nervures; palpi black, with a broad lateral buff stripe; pectus blackish, spotted with pale buff; legs buff, the femora black above; venter buff, margined with blackish. Expanse of wings, 81 mm.

Hab. Lokolele, Congo R. Collected by Rev. James Clark.

Pseudacræa (*Panopea*) *Poggei.*

This wonderful species closely mimics *Danais* (*Limnas*) *chrysippus*, and also the mimic of the latter, *Diadema misippus.*

♂. Basal two-thirds of fore wings bright orange-tawny; apical third brownish black, striated as in *Pseudacræa* (*Panopea*) *Delagoæ* and allies, and crossed by a broad oblique white band, broken into three arrow-shaped and almost equal patches by the black nervures, and followed by four minute white dots, forming an interrupted submarginal series, followed in their turn by two indistinct whitish specks; apical end of discoidal cell enclosed by a black crescentic bar, the black of the apex running out into a thin marginal band, with chequered white fringe up to the inner angle. Hind wings paler tawny, more inclining to yellow; marginal band black; one round black spot at base of discoidal cell, and three similar spots at the base of the three branches of the median nervure; nervures of all four wings black, broadening at the margins. Under side similar, but all markings more distinct, and the colours much paler; nervures of hind wings white, and the four black spots and marginal band outlined white. Striations of apex of fore wings whitish grey. Antennæ, body, and head black, with two rows of white spots on head and thorax; abdomen spotted yellow. Expanse, 3 in.

Hab. Angola.

Explanation of Plate X.

Fig. 1. *Pseudacræa Clarkii.*
1*a*. Under side of ditto.
2. *Pseudacræa Poggei.*
2*a*. Under side of ditto.

XII. *On Variation in the Colour of Cocoons, Pupæ, and Larvæ: further experiments.* By WILLIAM BATESON, M.A., Fellow of St. John's College, Cambridge. Communicated by Dr. DAVID SHARP, M.A., F.R.S.

[Read October 5th, 1892.]

I. *The colour of the cocoons of* Saturnia carpini.

In the Trans. Ent. Soc. Lond., 1892, Part I., p. 45, I gave an account of some experiments touching the variation of the colour of the cocoons of the Small Egger (*Eriogaster lanestris*), and of the Emperor Moth (*Saturnia carpini*). It has been stated by Poulton* and others that the familiar variation of these cocoons, from coffee-brown to a cream-white colour, takes place in accordance with the substances to which the cocoons are attached, and the inference was suggested that this variation in colour was a protective adaptation to render the cocoons inconspicuous. The evidence which I brought forward went to show that the statement that there is any relation between the colour of these cocoons and that of the substances, to which they are attached, was founded on a mistake. In the case of *Eriogaster*, experiment showed

(1) That caterpillars left to spin in the leaves of the food-plant (hawthorn) spin *dark* cocoons.

(2) That caterpillars taken away from their food and shut up spin *light* cocoons, whether the surroundings in which they are confined are black or white.

(3) That caterpillars which of their own choice crawl into and spin in white paper placed amongst their leaves spin *dark* cocoons.

From these results it was to be concluded that the cause determining the production of light cocoons was removal from the food, or the state of annoyance incident to such removal, and that in fact the light-

* E. B. Poulton, 'Colours of Animals,' pp. 142—146.

coloured cocoon was an abnormal product resulting from unhealthy conditions.

As regards *S. carpini*, of the three points given above the second was fully established. No caterpillar which was removed and shut up spun a dark cocoon. The other two points were not fully established, for, while all the cocoons which I could find wild in the hedges were dark, few comparatively of those fed in captivity spun cocoons of full colour. Several of these, however, were attached to white paper, as in (3).

Lastly, in the case both of *Eriogaster* and *S. carpini*, there was evidence to show a strong probability that the colouring matter was derived from the contents of the alimentary canal, and that in the case of the light cocoons this substance was either evacuated, or not produced, or possibly absorbed. Two points, therefore, remained for further investigation; first, whether *S. carpini*, if in healthy circumstances, will spin dark cocoons independently of the colour of its surroundings; and secondly, the far more important question of the nature and origin of the colouring substance. To the solutions of both of these questions the evidence to be given contributes.

(1). From two batches of eggs I reared about 140 larvæ of *S. carpini*. Supposing that my larvæ had not been under good conditions last year, I resolved this year to sleeve them on a bush in the open air. On the 2nd of July, therefore, when they had made their last moult, I divided them into two lots, A and B.

A. Sixty-six larvæ were placed on a large branch of hawthorn in the Botanic Garden, and were covered with a large sleeve of white muslin. Into this sleeve I put a considerable quantity of crumpled white paper, arranging it so that the paper lay thickly amongst the leaves. In the autumn, when all had spun, I opened the sleeve, and counted the cocoons, numbering 53, the remainder having presumably escaped. Of these—

7 were spun on the white sleeve.
18 were spun in the white paper, or between it and the sleeve.
19 were spun partially attached to the white paper and partly to twigs, &c.
9 were spun on leaves or twigs, not attached to the white paper or sleeve.

With one exception all these cocoons are of the full dark colour. The exception is also a brown cocoon, but it is very thin and deficient in substance, and consequently of rather a lighter colour. It is one of the 19 named above.

B. Forty-four larvæ were enclosed in a sleeve of black muslin, and placed on another branch of the same bush. Into this sleeve I put a quantity of crumpled brown paper, of the darkest colour I could get. On opening this sleeve in September, I found 48 cocoons, namely—

2 in brown paper.
1 between paper and leaves.
4 on the black sleeve.
31 in the leaves, or massed against each other.

All these were of the full dark colour. I should say that the brown paper had become so much bleached by exposure to weather that it could scarcely be called brown.

This experiment must, I think, be considered to show conclusively that there is no relation between the colour of the cocoons of *S. carpini* and that of the substances to which they are attached. We need not therefore, in this case, consider the difficult problem whether, if such a relation did exist, it might or might not be properly considered a protective device.

(2). As to the origin of the colouring substance, I have satisfied myself that it is obtained from the contents of the alimentary canal. This conclusion is made for the following reasons:—

(*a*). The white cocoons are thin and papery, while the dark cocoons are stiff and very shiny, on the inside especially, looking as if they had been stiffened with brown size.

(*b*). In the case of some brown cocoons spun against white paper, there was a brown stain on the paper, as though a brown fluid had oozed through.

(*c*). In the case of a majority of larvæ, which, in 1891, spun white cocoons, there was evidence to show that an evacuation of the contents of the alimentary canal had taken place.

(*d*). This evacuation is, when still wet, of a reddish brown colour, of a viscous consistency, and contains small pieces of chewed leaves, and sometimes half-formed fæces.

(*e*). On opening a larva, whether young or nearly full-fed, the contents of the alimentary canal are bright green, but upon exposure to the air they turn to the red-brown colour of the evacuations seen in the breeding-cages. By washing out the contents of the alimentary canal, and filtering out the *débris* of food, a clear green filtrate was produced, which turned red-brown in the course of some minutes. There can be no doubt that this change is connected with oxidation, for it takes place more rapidly if the test-tube containing the fluid is shaken, and immediately if yellow nitric acid is added. Moreover, if the contents of the alimentary canal are placed on a glass plate, the surface soon turns in colour, while the lower part next the plate may be seen to be still green. The change from green to red therefore results from oxidation.

The actual origin of this colouring matter in the alimentary canal is not easy to determine. There are two chief possibilities; first, that the green colour is a substance (such as bile, for example) secreted by the animal; or, secondly, that it is formed from the food. The first of these is almost certainly disproved by the fact that there is no green substance in the walls of the gut, or in the tissue adjacent to it, which undergoes the change described; whereas, if the substance were the result of secretion, it would be expected that this would be the case. Filling the tissue-spaces surrounding the gut there is indeed a green fluid, but this retains its colour on exposure unchanged, not even turning to black, as do the body-cavity fluids of so many larvæ.

If, then, the colouring substance is not a secreted body, but is formed in some way by digestion from the food, the question naturally suggests itself, is it a chlorophyll product? That this is so is on the whole likely, but I know no way by which it might be proved to be so. For since the whole gut is filled with chewed leaves, there is of necessity much chlorophyll present, and it is not possible to obtain the colouring substance free from chlorophyll.

In this connexion it should be remembered that the brown colour of the cocoons is a very good match with the brown to which hawthorn leaves turn in winter, and it is not unlikely that the change from green to brown undergone by the colouring substance of the cocoons may be akin to that which takes place in the leaves. This suggestion is, of course, merely made for what it is worth.

If the contents of the gut are dried, the brown substance remains perfectly soluble in water.

(*f*). The proof that the green colouring matter from the gut is used to dye the cocoon brown rests on the following observations:—If a larva is irritated it ejects from the mouth a green glairy fluid, which turns red-brown, like the contents of the gut. If a piece of a *white* cocoon be laid in this fluid for some minutes, it soon acquires the brown colour of a brown cocoon, from which it is indistinguishable. The same is true of a fibre of silk drawn from a spinning animal, which can be dyed in the same way. The colour is then insoluble, and cannot be washed out, having stained the silk like a mordant. In the previous experiments, in 1891, I was puzzled by finding the colour soluble in the evacuations, but insoluble in the cocoons; but this is no doubt the explanation.

(*g*). Lastly, it is to be considered how the colour gets from the animal's gut to the silk. As to this, I have no decisive evidence. I know that a caterpillar may spin brown threads without touching them with the posterior end of the body, and it is therefore clear that the colour may be given out from the mouth, just as it is when the larva is irritated. But the appearance of the interior of a cocoon rather suggests that a large quantity of the size-like matter has been poured out at once. It seems possible, therefore, that there may be a final discharge from the intestine after the cocoon is finished. I am inclined to think that some of the threads are often spun white, and smeared with the colour afterwards, for I have seen threads of a cocoon lately begun, first white and then brown after an absence of an hour, and the animal may often be seen, as it were, "mouthing" over its threads. This is not always the case, for I have seen very dark threads lying adherent to the surface of paper, in such a position that they could not have been gone over again without staining the paper, but must have been put down brown while still viscous.

I think, then, it may be safely concluded (1), that the brown colour of the cocoons is derived from the alimentary canal; (2), that it is produced in the digestion of the food, and that it is *probably* a chlorophyll-derivative; (3), that it is imparted to the silk from the mouth of the larva, and perhaps by evacuation from the intestine also.

I have to thank Dr. A. Sheridan Lea for kindly advising me in the examination of this substance.

II. *The colours of pupæ of* Vanessa urticæ.

The pupæ of *V. urticæ* and of some other butterflies are known to be sometimes much pigmented, and sometimes very light, with little or no pigment. Apart from the pigmentation, they also vary greatly in the extent and brightness of the metallic lustre, which is so marked a feature of these forms. Poulton* has described experiments showing that there is a relation between these variations and the colours of the linings of the cages in which the larvæ pupated. In the past summer I made experiments of the same kind on *V. urticæ*, and the results fully bore out Poulton's account, to which I can add little.

The larvæ were collected when about half-grown, and were put into shallow cardboard boxes, through one end of which the stem of a nettle was passed. The boxes were lined with one or other of the following papers:—(1) gilt, (2) silver, (3) yellow, (4) white, (5) black, or (6) painted with Indian ink. The face of each box was covered with a pane of glass, and the boxes were all placed upright in a row facing a south window. During the three weeks through which the experiments continued there was generally a bright sun, so that the boxes became very hot. In some of them there was a good ventilation maintained, while others were kept very close, so that by the transpiration from the plant the atmosphere of the box was saturated with moisture, which also trickled continually down the glass. I did not find that the condition of moisture or dryness affected the colours of the pupæ. It is perhaps unnecessary that these experiments should be described in detail, as Poulton's description is complete.

One series of experiments, made by way of control, have, however, some interest, as materially confirming the view that the change in the colours is really due to

* E. B. Poulton, Phil. Trans., 1887, vol. clxxviii., B, p. 311.

the action of light. A number of larvæ were shut in gilt boxes as described, and these were immediately placed in a dark, closed cupboard, which was not opened again until the larvæ had pupated. With few exceptions all these pupæ belonged to the darkest class (see table). Other larvæ were put in a black box and similarly treated, with the same result.

The larvæ were collected from various places round Cambridge, and belonged to some dozen or more batches of larvæ, but I distributed the families among the boxes so as to test the existence of any congenital differences as regards pupal colour, but found none.

Some interest attaches to the fact that the great proportion of larvæ collected by me were infested with *Tachinæ*. Probably, in round numbers, five or six larvæ died from *Tachina* for one that pupated, but those that did pupate almost without exception emerged. There is therefore no reason to suppose that either the gilt pupæ or the dark ones are diseased.

	Much Pigment.			Some Pigment.			Little or no Pigment.		
Amount of Gilding.	None.	Some.	Much.	None.	Some.	Much.	None.	Some.	Much.
Gold paper ..		2		2	5	9		9	14
Silver do. ..				2	2			2	3
White do. ..				4				2	2
Yellow do. ..					1				5
Black do. ..	9	5			1	1			
Indian Ink ..	10	6	1	2	3		1	2	
Shut in the dark:—									
Gold	26	3			1				
Black	9								

Taken together—gold, silver, yellow, and white papers gave 2 dark, 16 moderate, 23 light; black paper and Indian ink gave 31 dark, 5 moderate, 3 light; gilt paper, shut in the dark, gave 29 dark, 1 moderate; black paper, shut in the dark, gave 9 dark.

There are, of course, two things to be thought of: first, the pigmentation; secondly, the metallic colours. As the table shows, both these qualities seem to be affected by the surroundings. As Poulton has mentioned, the metallic appearance is an interference-colour, disappearing when the pupæ are dried, returning when they are wetted. Of the physiology of these phenomena I have gleaned no hint at all.

The whole question touching the putative utility of these colours as a protection, seems to me an unprofitable field for study. As to the enemies of these creatures, other than insect-parasites, there is almost no evidence, and as to the senses by means of which these parasites seek their prey, there is still less. Of enemies to any of these forms in the pupal state, there is, so far as I know, no direct evidence at all. The pupal state is very short, lasting about a fortnight or three weeks, according to the weather, and the view that these peculiar colours have been developed by these creatures to conceal them from imaginary enemies during that brief time is, in my judgment, quite unsupported by fact. This view is applied to the case of these pupæ by an indiscriminate extension of deductions made in other cases fairly enough, as, for example, in that of the larvæ of *A. betularia* (*v. infra*).

After experience of these pupæ, the doubt whether the metallic colour can in any way lead to their concealment is stronger than it was. The gilded pupæ, so far as I can see, do not by reason of their gilding approximate to the appearance of any natural substance, either of flakes of mica, or to the dried slime left by slugs, or to any other bright objects to which they have been compared by ingenious persons. If Mr. Poulton had spoken of this gilding as a "warning coloration," I should have been less surprised.

One thing more may be said. In the case of the sole, in the case of the larvæ of *A. betularia*, and the like, there can be no doubt that the change of colour represents an "attempt" on the part of the animal to approximate to the colour of its surroundings. Now, in the case of these gilt pupæ, do we really know that the change represents any such effort at approximation? I confess that, though as regards the deposit of pigment this may be so regarded, the change in the degree of metallic colouring does not seem to me to be an approximation of this kind at all. It is true that gilt paper makes some approach to the look of these pupæ, but the yellow paper, and silver or white papers, do not in the least. In this connexion a circumstance, which I saw several times, may be mentioned. In several cases a larva in a gilt box pupated, not on the gilt paper, but on leaves of the food-plant, so that it was not anywhere exposed to the paper; sometimes, indeed, when practically surrounded by a leaf or leaves, and among these were some of the most golden pupæ. Notwithstanding, therefore, the clear evidence that the proximity of brightly illuminated surfaces promotes the production of the metallic appearance in these pupæ, I cannot see that there is any reason to suppose that this is a "protective resemblance," or, indeed, that it is a "resemblance" at all.

In his work on this subject, Mr. Poulton, indeed, admits that by reason of their metallic lustre the pupæ do not resemble any substance to which they are attached in nature; but he suggests that perhaps they may have come through a phylogenetic phase in which they did attach themselves to such substances. Though nothing forbids anyone from framing such an hypothesis, it is surely evident that if conjectures of this kind are to be admitted as a basis for argument, all zoological science will be thrown into confusion.

III. *The colours of larvæ of* Amphidasys betularia (*the Pepper Moth*).

Mr. Poulton was kind enough to send me some newly-hatched larvæ of *A. betularia*, with the suggestion that I should repeat his interesting experiment described in 'The Colours of Animals,' 1890, pp. 152 and 153. Larvæ reared among green leaves and green twigs only, were said to be green through life, while larvæ reared on leaves amongst which darkly coloured sticks were placed were stated to assume a dark colour.

My experiment has substantially verified Mr. Poulton's account. When the larvæ came to me they were of a kind of medium brownish green colour, being rather more brown than green. They were divided into four lots on the 12th of July.

Two lots (A) were fed on green leaves (*Populus nigra*) without black sticks, and two lots (B) were fed on green leaves amongst which black sticks were placed. Care was taken that the leaves given to all were from shoots of similar age.

It is scarcely necessary to describe the course of the experiment in detail, as Mr. Poulton has already done so; but I may give the conditions seen at two examinations:—

24th July. *Lot A.* Originally 13. Of these 8 were of the full bright green colour, 2 were brown-green, and 2 were brown.

Lot B. Originally 14. Of these 12 were very dark in colour, 1 was green, and 1 was dead.

I then took all the sticks out from among the B lot, and put them with Lot A. On the 7th of August the result was as follows:—

Lot A. 7 very green, 2 medium brownish green, 1 darker, but not of the full dark colour; 2 dead.

Lot B. 12 still very dark, 1 green as before.

No further change in colour took place, so far as I could judge. The effect therefore, once produced, seems not to be reversible, as it is in the case of the sole and the like. The change of colour is, as Poulton says, produced by the deposit of dark pigment in the one set of larvæ, and by the absence of it in the other.

It should be mentioned that these larvæ, like many other *Geometræ*, are almost exclusively night-feeders, and rarely move by day. Those provided with black sticks sat *either* on them or on the green twigs of their food throughout the day. Of course, in this case the resemblance to sticks in the one case and to green twigs in the other is unquestionable, and I think it may be fairly argued that this resemblance may contribute to the protection of the animal.

My best thanks are due to Mr. Poulton for giving me an opportunity of making this experiment, which I have watched with great interest.

XIII. *Experiments in* 1890 *and* 1891 *on the colour-relation between certain lepidopterous larvæ and their surroundings, together with some other observations on lepidopterous larvæ.* By Lilian J. Gould. Communicated by Edward B. Poulton, M.A., F.R.S., &c.

[Read October 5th, 1892.]

Plate XI.

CONTENTS.

In the summer of 1890 I undertook to make some observations on the colour-relation between certain lepidopterous larvæ and their surroundings, at the suggestion of my friend Mr. E. B. Poulton, of Oxford. The experiments, of which the following is an account taken from notes made day by day at the time, were conducted under the kind direction of Mr. Poulton, to whom I was constantly indebted for help and advice, and may be of interest chiefly as confirming results already obtained by him (with larvæ of *R. cratægata* and others), and partly also as bringing forward evidence affecting colour-relation in species of which no results had been published hitherto (*M. brassicæ*).

The experiments extended over 1890 and 1891, and are here presented in diary form, together with drawings of the larvæ made at the time. In addition to the summary of results given at the end of each experiment, a total summary of results will be found at the conclusion of the whole series of experiments on colour-relation.

During the whole period of experiment all the larvæ were kept in numbered glass cylinders, supported on plates over vessels of water, like those used by Mr. Poulton in previous experiments. A hole through the plate allowed the stems of the food-plant to reach the water, and thus it was kept fresh. The tops of all cylinders were covered with fine white muslin, held in place by elastic bands; and to prevent the escape of larvæ, when very small, between the cylinder and the plate, the junction was surrounded by very fine sand.

Section I.

Notes on larvæ of Rumia cratægata.

On June 23rd, 1890, I received, from Mr. Poulton, fertile ova of *R. cratægata*, from one parent, for purposes of experiment.

June 24th.—22 larvæ hatched. These were all placed in one cylinder, and fed on hawthorn, the sprigs of the food-plant not being chosen at this time with any regard to colour. The larvæ were examined several times daily, and days on which no alteration in their condition was observable were noted as "no change"; these are omitted in the present account.

July 1st.—The first ecdysis occurred; all the larvæ having hatched out on the same day, moulted at the same time, with only a difference of hours.

July 7th.—I divided the larvæ into two sets, placing 11 in cylinder 9, and 11 in cylinder 5. The following observations refer to those in cylinder 9, which were supplied from this time with green leaves only, very young shoots of hawthorn being selected for this purpose. My intention was to exclude every colour but green from their surroundings, but this was rather difficult, as the stalks of the leaves of hawthorn were too short to admit of their being gathered and kept fresh in water separated from the twig, and the stems were always liable to be brown or brownish in colour. This difficulty was obviated as far as possible by selecting only the very youngest shoots of hawthorn, in which the leaves were very bright green, and one side of the stem was always bright green, the other side of the stem and the thorns being of a crimson colour.

July 9th.—The second ecdysis occurred. From this time the larvæ began to show signs of change of colour, and became greenish in hue, the original colour having been varying shades of brownish grey or dusky brownish green.

July 18th.—Length of largest larva, 14 mm. Two larvæ disappeared, probably having escaped through some crevice, or been lost in changing the food.

July 19th. — The third ecdysis took place. The nine larvæ left showed a distinct change of colour to green.

July 22nd.—All 9 larvæ were of shades of green or greenish brown. They varied a good deal in shade; three were very bright green, exactly matching the leaves of the food-plant, and had the dorsal tubercles, the head, and the thoracic legs of a crimson-red, perfectly corresponding to the colour of one side of the hawthorn-shoots and of the thorns. The other six were of a green, more or less bright, and all were touched with red on the parts above mentioned. None were brown, or even brownish green.

July 26th.—The fourth ecdysis occurred.

July 27th.—I drew the brightest green larva, namely, that figured in Pl. XI., fig. 1.

July 31st. — One of the larvæ left off feeding, and mounted to the roof of the cylinder.

Aug. 2nd.—A second larva did the same; and by Aug. 22nd all the larvæ had pupated, spinning pinkish-white cocoons in close proximity to each other on the roof of the cylinder.

The total results of the experiment with these 9 larvæ were as stated below:—

Colour.	No. of larvæ.
Brilliant green	1
Lighter green, but very bright	2
Duller shades of green	6
Brown and other colours	0
Total	9

Of the 22 larvæ divided on July 7th, 11 were placed in cylinder 5, and reared among *dark* surroundings. They were supplied, from the time of separation, with hawthorn from the same tree as that used for the larvæ with green surroundings. But in this case older twigs were chosen, which had very dark green leaves and brown woody stems; and further, with the sprigs of the food-plant were mixed a number of small dark-coloured sticks. It was desirable to have these sticks as dark as possible, and, as natural twigs were not easily procurable dark enough in colour, I used dry stems of furze, taken from places on a neighbouring moor where the gorse had been burned in patches; in these places the stems and twigs alone remained, and of course were perfectly dead-black. When the superficial powdery charcoal had been wiped off with a cloth, the larvæ crawled as readily upon these sticks as upon living twigs, and generally rested upon them in preference to the leaves or stems of the food-plant. The following notes refer to these larvæ in No 5:—

July 8th.—The second ecdysis took place, and the larvæ began to darken in colour perceptibly, varying from the usual dusky hue to shades of brown, and brownish slightly mottled with green; two were green, but very dark.

July 16th.—The third ecdysis occurred. The larvæ continued to darken, one having become very dark indeed, so that it was almost the colour of the sticks.

July 20th.—One larva died; thus 10 were left.

July 24th.—The fourth ecdysis occurred.

July 26th.—I drew the darkest specimen, figured in Pl. XI., fig. 2. The length of the smallest larva at this time was 16 mm.

July 29th. — The first larva pupated, spinning a whitey-brown cocoon on the upper surface of a leaf.

Aug. 3rd.—Two more pupated between the sticks. Unfortunately I omitted to record the exact shade of colour of these three, but they were certainly all brownish.

Of the 7 larvæ left, 3 were very dark brown, so nearly approaching to black as to be quite indistinguishable, except by the closest search, from the sticks on which they rested; two were brown, with a slight tinge of green; and two were distinctly green, though less bright green than the dullest green larva in No. 9.

Aug. 9th. — 3 more larvæ pupated; one dark brown one and one green one were left.

Aug. 13th.—The green larva pupated between leaves.

Aug. 16th.—The last larva pupated.

Total results of the foregoing experiments :—

Colour.	No. of larvæ.
Dark brown approaching to black	3
Brownish, shade unrecorded	3
Brown, with green tinge	2
Green	2
Other colours	0
Total	10

The change of colour in both sets of larvæ became perceptible at the commencement of the third stage of larval life (after the second ecdysis), and the resemblance to surroundings seemed to increase very gradually in perfection up to the fourth ecdysis, after which the colour underwent no further change, except the usual and easily distinguishable darkening or alteration preceding pupation.

My experiments with this species fully confirmed those previously carried out by Mr. Poulton, and mentioned by him in the 'Report of the British Association,' 1887, p. 756, and in 'Nature,' vol. 36, p. 594, now being published in full. The larvæ attained a really wonderful degree of resemblance to their surroundings ; in the case of my larvæ with green surroundings this likeness was greatly heightened by the touches of red, which exactly matched the thorns and one side of the stem of the young hawthorn shoot.

The resemblance in shape, as well as colour, is extremely protective, the angular attitude of the larva at rest rendering it almost indistinguishable from the twig; a fact also mentioned by Mr. Poulton (Trans. Ent. Soc. Lond., 1887, p. 291).

2. *Notes on larvæ of* Catocala nupta.

In May, 1890, I procured, from Mr. E. Edmonds, of 31, Park Street, Windsor, 48 fertile ova of the Red Underwing Moth (*Catocala nupta*), with a view to making experiments in colour-change, the species being recommended to me for trial by Mr. Poulton.

From May 27th to June 25th, 46 larvæ hatched out, and two of these died ; so that 44 remained for experimental purposes. These I divided into three sets, giving to the first set black sticks with the food-plant ; to the second set green leaves only ; to the third green leaves and *white* sticks, carefully peeled to remove the coloured bark, and changed for freshly prepared ones whenever they became yellowish or discoloured by drying.

At first all three sets were fed on willow (*Salix vitellina*) from the same tree, but after a time, having discovered a kind of willow with whitish silvery leaves (*S. regalis*), I fed the third set (those with white sticks) with the white willow also, in order to see if any difference of shade would be produced between these and the larvæ on green willow without sticks. The larvæ of *C. nupta* being rather large, it was necessary to have a great number of cylinders, to avoid overcrowding. The larvæ with dark surroundings were placed in cylinders 7 and 12, the larvæ with green surroundings in cylinders 3, 8, and 10, and those with white surroundings in cylinders 11 and 16.

As the hatching-out had extended over a period of nearly four weeks, it was necessary to divide the larvæ as nearly as possible according to age, so as to render observations as to times of ecdysis, &c., easier and less liable to error. The experiments with *C. nupta* were not as satisfactory as those made with other species, as the larvæ were never so healthy, and very many died when nearly full-fed, from some cause which I could not discover.

The following notes refer to larvæ with dark surroundings:—

Cylinder 7.—June 17th.—Six larvæ hatched, and were placed in cylinder 7. The newly-hatched larvæ measured not quite 6 mm., and their colour was uniform dark brown. They were fed on *Salix vitellina*, the darkest green leaves being selected, and given on the twig.

June 20th.—The first ecdysis occurred, with no change of colour.

June 30th.—I gave black sticks of the same kind as those used for *R. cratægata* in previous experiments. Later in the day the second ecdysis took place.

July 1st.—The larvæ began to darken perceptibly, and the adjustment of colour gradually increased in perfection during this and the succeeding stage.

July 9th.—The third ecdysis occurred. The larvæ were all distinctly brown, and darker than any of those with other surroundings.

July 18th.—The fourth ecdysis took place.

July 19th. — I drew one of the largest larvæ. This larva (figured in Pl. XI., fig. 4) was the darkest I obtained, and measured 7½ cm. in length. By this time all the six larvæ were very dark, that is, darker than the darkest of those with green or white surroundings. The whole ground colour of the body was a clear brown, not brownish merely or brownish grey; the two wavy dorsal lines were broadly and distinctly marked in very dark brown in one larva, and less darkly but distinctly in the other five. The head and dorsal humps were tawny, outlined and marked with black.

From the time of the last ecdysis, the larvæ had been showing signs of unhealthiness, and now they died off one by one. By Aug. 3rd only one was left—the darkest —and this larva died on Aug. 6th. I was not able to discover the cause of death, and up to this time they had fed as usual, and seemed to thrive well.

Total results of the foregoing experiment :—

Colour.	No. of larvæ.
Dark brown (dorsal lines very dark)	1
Brown (dorsal lines distinct, but not so dark) ...	5
Total	6

Cylinder 12.—June 25th.—I put six larvæ (hatched on one day) in the second stage into cylinder 12, and gave black sticks with the food-plant (*Salix vitellina*). Up to this time they had had leaves without sticks or attention to the colour of the leaves.

July 4th —The second ecdysis took place.

July 7th.—With this set I was using the plan adopted by Mr. Poulton in some of his earlier experiments, *viz.*, that of surrounding the cylinder with tissue-paper of the shade required, with a view to deepening the effect. On this day I applied brown tissue-paper to the cylinder containing the larvæ, and placed it in a strong light, as otherwise the paper made the cylinder almost dark.

July 9th.—Acting on advice from Mr. Poulton, under whose kind direction I was working, I removed the tissue-paper, as he had come to the conclusion that the shadow caused by it rather hindered than increased the effect of the surroundings. At this time the length of the largest larva, fully stretched, was 6½ cm., and that of the smallest nearly 5 cm. A darkening of colour had begun to be apparent in three of the larvæ; the other three were not as yet affected by the colour of the sticks, although these three rested on them as constantly as did the darker larvæ.

July 12th.—Two larvæ died. The larvæ had seemed healthy up to this time, but now began to die off, just as those in cylinder 7 did. One of the two which died was light-coloured, the other dark.

July 13th.—The four larvæ left moulted for the third time.

July 22nd.—A third larvæ died, and another was looking very sickly. The dead larva was a light one.

July 23rd. — The fourth ecdysis occurred. Of the three remaining larvæ, one was very dark brown, and two much lighter.

July 29th.—The dark larva died, and the last two larvæ pupated between leaves. All these six larvæ were darker than any with green or white surroundings, but the general ground colour was not so dark as the darkest in cylinder 7, though the dorsal lines in the dark individuals were nearly as dark as those of the darkest specimen in 7. None of these larvæ were figured. The head and dorsal humps were as those in 7.

Total results of the foregoing experiment:—

Colour.	No. of larvæ.
Darkish brown (dorsal lines dark)	1
Lighter brown (dorsal lines dark)	2
Very light brown (dorsal lines very faint) ...	3
Total	6

The larvæ with green surroundings.

Cylinder 3.—June 27th.—I placed six larvæ in the second stage in cylinder 3. The second ecdysis occurred the same day. The larvæ up to now had been uniform dusky brown. Two began to become lighter in colour.

June 30th.—Three larvæ were of a light clear brown; markings light. Three were rather darker. Heads and dorsal humps as before.

July 4th. — The third ecdysis took place. One larva very light indeed, two nearly as light, two dark brown with dorsal lines indistinct, one dark brown, with dark distinct dorsal lines.

July 13th.—The fourth ecdysis occurred.

July 20th. — I drew the lightest larva (figured at Pl. XI., fig. 5), which was of a very light delicate shade of brown, and had scarcely a trace of the dorsal lines. The length of the largest larva at this time was 6½ cm., of the smallest 5½ cm.

July 23rd.—One larva died—a dark one, with dark dorsal lines.

July 30th.—The lightest larva was spinning up on the roof.

July 31st.—Another larva was spinning up on the roof.

Aug. 3rd.—Two more larvæ left off feeding. Of these four larvæ, three were very light in colour, with the dorsal lines very faint; one was dark, with distinct dark dorsal lines. One dark one left.

By Aug. 11th all had pupated, and the last larva did so on the floor without forming any cocoon. The food of all was *S. vitellina*.

Total results of the foregoing experiment:—

Colour.	No. of larvæ.
Very light brown, with very faint dorsal lines ...	1
Light brown, with faint dorsal lines	2
Dark brown, with dark dorsal lines	2
Dark brown, with indistinct dorsal lines	1
Total	6

Cylinder 8.—June 25th.—I placed six larvæ in the first stage in cylinder 8.

June 26th.—The first ecdysis took place.

June 29th. — The larvæ (until now uniform dusky brown) began to show signs of lightening in colour; one quite light.

July 2nd.—The second ecdysis occurred.

July 4th.—I was using tissue-paper for this set also, and on this day applied green tissue-paper, doubled, round the cylinder and over the roof, and placed the cylinder in a strong light.

July 8th.—The third ecdysis occurred. Two larvæ were light, three darker brown, one lightish brown.

July 9th.—I removed the tissue-paper on Mr. Poulton's advice. The length of the largest larva at this time, when fully stretched, was 5 cm., that of the smallest, 4 cm.

July 15th.—The fourth ecdysis took place. Two larvæ were quite light, four fairly dark brown.

July 27th.—One larva was spinning up on the roof. One died—a light one. Five larvæ were left, one light and four dark ones.

Aug. 1st.—Another larva was spinning up on the roof.

Aug. 3rd.—The first larva pupated. Another larva died; this was a dark one.

Aug 6th.—The last two larvæ died; both dark ones.

Aug. 7th.—The second larva pupated.

Total result of the foregoing experiment:—

Colour.	No. of larvæ.
Clear light brown, light dorsal lines ...	... 2
Darker brown, dark dorsal lines ...	... 1
Dark brown, dark dorsal lines ...	... 3
Total ...	... 6

The lightest of these larvæ were nearly, but not quite, as light as the extreme one in cylinder 3, and the darkest about matched the darkly marked two in cylinder 3. None were so dark as the dark larva figured (from cylinder 7) with *dark* surroundings. The change of colour was perceptible a stage earlier than any others. The food was *Salix vitellina*.

Cylinder 10.—June 27th.—I placed six larvæ in the second stage in cylinder 10.

July 4th.—The second ecdysis occurred. The colour until now had been uniform dusky brown, like the others. From this time the larvæ began to get lighter.

July 8th.—For this set also I was intending to use tissue-paper, and on this day applied green, doubled tissue-paper round the cylinder and over the roof, on which larvæ were resting, and placed the cylinder in a strong light.

July 9th.—I removed the tissue-paper on Mr. Poulton's advice. The length of the largest larvæ, fully stretched, at this time was 6 cm., that of the smallest nearly 3 cm.

July 12.—The third ecdysis took place. The larvæ were all as nearly as possible of the same shade of brown, a shade intermediate between the darkest and lightest in cylinder 8. The dorsal lines in all were distinct, but none very dark.

July 19th.—The fourth ecdysis occurred. The length of the largest larva, fully stretched, was 7 cm., that of the smallest $4\frac{1}{2}$ cm. The large larva measured was the largest I ever obtained of this species.

July 23rd.—The first larva left off feeding.

Aug. 3rd.—One larva died.

By Aug. 12th all the larvæ had pupated.

Total results of the foregoing experiment :—

Colour.	No. of larvæ.
Light brown, with dark dorsal lines	5
Slightly darker brown, dark dorsal lines ...	1
Total	6

All these were fed on *Salix vitellina.*

The larvæ with white surroundings.

Cylinder 11.—July 2nd.—I placed twelve larvæ in the second stage in cylinder 11, feeding them on *Salix vitellina*, but mixing white sticks with the food-plant.

July 9th. — I changed the food, giving the larvæ the silver-leaved *Salix regalis* instead of *S. vitellina*, with a view to increasing the effect of the white surroundings.

July 13th.—The second ecdysis took place. The larvæ till now were of a uniform dusky brown, like all the rest. After ecdysis they were all very slightly lighter.

July 20th. — The length of the largest larva, fully stretched, was $4\frac{1}{2}$ cm., the length of the smallest, $2\frac{1}{2}$ cm. Four were dark brown, three lighter brown, but with distinct dorsal lines, and five were quite light.

July 22nd.—The third ecdysis occurred.

July 29th.—Two larvæ died, one dark, one light. I had had more larvæ than usual in this cylinder, being short of cylinders; but, as I was afraid they died from overcrowding, I removed five of the ten left to cylinder 16, still giving them white sticks and white willow. Five larvæ remained in this cylinder.

Aug. 1st.—The fourth ecdysis took place. One larva died, one of the intermediate forms, between dark and light.

Aug. 6th.—Three larvæ died, two light ones and an intermediate.

Aug. 20th.—The last larva died, an intermediate one.

Total results of experiment (not counting the five removed):—

Colour.	No. of larvæ.
Light brown, faint dorsal lines	3
Darker brown, distinct dorsal lines	3
Dark brown, dark dorsal lines	1
Total	7

Cylinder 16.—July 29th.—I placed five larvæ from cylinder 11 in cylinder 16, still giving white sticks and white willow.

Aug. 1st.—The fourth ecdysis occurred. Three were dark brown and two light; none were intermediate.

Aug. 6th.—Three larvæ died, two dark ones and a light one.

Aug. 13th.—A fourth larva died; it was dark.

Aug. 18th.—The last larva, a light one, died.

Total results of experiment:—

Colour.	No. of larvæ.
Light brown, faint dorsal lines	2
Dark brown, dark dorsal lines	3
Total	5

It will be seen from the above descriptions that none of the larvæ with green surroundings attained a green colour, or even the slightest tinge of green—a change only as yet known to be possible to a few species; the change consisted merely in their normal colour becoming lighter or darker in depth, and the markings varying in the degree of intensity. The difference between the most extreme forms from dark and light surroundings was striking, but the difference between those from green and white surroundings slight, if any; indeed, the extreme light specimen figured came from green, not white surroundings. The intermediate forms were very variable in shade of ground colour, and also in depth of markings. It is remarkable that in the larvæ of cylinder 8 the colour-change became perceptible three days after the first ecdysis, in the second stage of larval life, instead of after the second ecdysis (the third stage) as was the case in the others of *C. nupta*.

3. *Notes on larvæ of* Catocala fraxini.

On May 21st, 1890, twenty-four fertile ova of the Clifden Nonpareil Moth (*Catocala fraxini*) were supplied to me by Mr. E. Edmonds, of 31, Park Street, Windsor. The larvæ began to hatch out almost immediately on arrival, and by May 26th seven had emerged from the eggs. These were placed together in a cylinder, like those used for other species, and were supplied at first with the common ash. This food-plant was continued for a week, but the larvæ refused to eat any of it, and four died. This was curious, as ash is supposed to be the normal food-plant, and the one from which the species takes its name. I then changed the food, giving the remaining three larvæ leaves of the common poplar, on which they fed readily. By June 4th the total number of larvæ which had emerged was sixteen, and no more were hatched. One more larva died, and one was lost in changing the food; so that the total number remaining for purposes of experiment was ten.

On June 13th, I divided the larvæ into two sets, placing five in cylinder 2 and five in cylinder 6. Those in cylinder 6 were supplied with very young shoots of poplar, in which the stems and the leaves were alike bright green, and no sticks. Those in cylinder 2 were given older twigs, in which the stem was brownish and the leaves much darker green, and perfectly black sticks (the same as those used in previous experiments) were mixed with the food-plant. The larvæ were divided as nearly as possible according to age.

The larvæ with dark surroundings.

Cylinder 2—June 13th.—I placed five larvæ in the first stage in cylinder 2 with black sticks. The first ecdysis occurred. When first hatched the larvæ were of a uniform dusky colour; after the first ecdysis they became very light green, which darkened gradually to almost brown. (This brownish hue did not alter, except in shade, in these larvæ after the second ecdysis; and in this, as will be seen, they differed from the larvæ with green surroundings. I considered that the colour-change began, therefore, at this period, unlike *R. cratægata* and most of *C. nupta*, in which it was perceptible only after the second ecdysis.)

June 21st.—The larvæ were all brownish, and nearly alike as to depth of colour.

June 30th.—The second ecdysis occurred. The larvæ were constantly resting on the sticks, but did not approach them in colour; only their general hue was slightly darker than that of the larvæ in green surroundings, and quite different, as seen in Pl. XI., fig. 6 (*cf.* fig. 7).

July 12th.—The third ecdysis took place. The five larvæ still varied very little as to depth of colour; the brown colour took a pinkish tinge, which gradually increased.

July 28th.—The fourth ecdysis. During the stage succeeding this moult the colour became intensified, and attained its greatest perfection. This species seemed to be susceptible to a later stage than others, in which the protective resemblance to surroundings did not increase very much after the fourth stage.

July 29th.—I drew the darkest larva (Pl. XI., fig. 6). The largest larva, fully stretched, measured nearly 7 cm. There was scarcely an appreciable difference of shade in the five larvæ.

Aug. 3rd.—The larvæ were now distinctly of a darker general shade than those with green surroundings. Their general ground colour was a brownish grey, or more correctly, perhaps, a pinkish drab; the heads were tawny, marked with black; the dorsal humps were black, and the whole dorsal surface finely mottled with very small dark specks.

Aug. 10th.—The first larva was spinning up on the floor between leaves.

Aug. 16th.—The cover of the cylinder accidentally slipped off, and two larvæ escaped and could not be found.

Aug. 17th.—All the larvæ had pupated.

Total results of experiment:—

Colour.	No. of larvæ.
Brownish grey or pinkish drab	5
Other colours	0
Total	5

The larvæ with green surroundings.

Cylinder 16.—June 13th.—I placed five larvæ in the first stage in cylinder 6, and gave young green shoots of poplar only only. The larvæ when hatched were of a uniform dark colour.

June 14th.—The first ecdysis occurred. The larvæ became very light green, with a row of dark spots along the back.

June 16th. — The larvæ had darkened a little, but showed no tendency to become brown.

June 26th.—The largest larva became quiescent. It had seemed quite healthy up to this time.

June 29th.—The largest larva pupated, the pupa being only a little over 1 cm. in length, but perfectly formed. I could not assign any reason for this early pupation.

July 2nd.—The second ecdysis took place. The row of spots disappeared, but the green colour was persistent. (These spots never appeared in the larvæ with dark surroundings.)

July 6th.—The larvæ were still all green, but paler.

July 14th. — The third ecdysis occurred. The shade of green of all the larvæ became very delicate and bluish.

July 20th.—Up to this time the food had been young green shoots with green stems, but now, finding it possible to procure leaves with stalks long enough to use singly, I gave leaves only for the rest of the time.

July 21st.—The fourth ecdysis took place, and was followed by a slight intensification of colour in all five larvæ.

July 22nd.—I drew the greenest larva (Pl. XI., fig. 7), but, like the larvæ in cylinder 2, these varied very slightly in depth of colour. Their general ground colour was a light and peculiarly delicate shade of bluish green; the dorsal surface was tinged with a shade of brownish grey, so light as to be barely perceptible, and was mottled with minute dark specks; the heads were tawny, pencilled with black; the dorsal humps black-marked; the legs and claspers green, of the same shade as the body. The largest larva measured nearly 7½ cm.; this was the largest larva obtained in the case of this species.

Aug. 9th.—The first larva was spinning up on the floor.

Sept. 2nd.—The second larva pupated. I saw it immediately after pupation; the pupa then was of a bright deep shade of yellowish green. It had come out from its partially-spun cocoon and pupated outside.

Sept. 3rd. — The second pupa had turned to the permanent colour, *viz.*, plum-colour, with a blue bloom on it.

Sept. 4th.—The last three larvæ pupated among leaves on the floor.

Total results of experiment :—

Colour.	No. of larvæ.
Bluish green	5
Other colours	0
Total	5

This experiment would have been more satisfactory if I could have had more material to work upon. As I had only two sets of larvæ, I could not satisfy myself as to whether the darkening to brown or remaining green in the second stage was normal. Mr. Poulton experimented with the same species, the results of which are now to be published.

4. *Notes on larvæ of* Mamestra brassicæ.

In June, 1891, some fertile ova of the Cabbage Moth (*M. brassicæ*), from one parent, were sent me by Mr. Poulton, for purposes of experiment in colour-relation.

June 28th.—Thirty larvæ hatched, and were placed together in cylinder 1, and fed on cabbage. The colour of the larvæ was uniform dusky brown; they had blackish heads.

July 5th. — The first ecdysis occurred; the larvæ having been hatched the same day, moulted together, with a difference of hours only. The larvæ were now light green, with yellowish heads.

July 7th.—I divided the larvæ (now all in the second stage), placing fifteen in cylinder 2, and giving them very dark brown earth as a floor. It was of no use to give black sticks to this species, as they never rest on sticks; so the earth was intended to serve for dark surroundings. Fourteen larvæ were left in cylinder 1; one was lost during the operation, and could not be found again. Total, 29.

The larvæ with dark surroundings.

Cylinder 2.—July 13th.—The second ecdysis occurred; the larvæ changed to a deep green, with lighter longitudinal markings; heads yellow. Of the fifteen larvæ, two were somewhat darker green than the rest, and one was very dark olive-green, with a brown head.

July 15th.—The larvæ from this time fed only at certain times, generally about three times a day, and in the intervals of feeding all descended from the leaves, and buried themselves in the earth on the floor of the cylinder.

July 21st.—The third ecdysis took place, and the larvæ all became of varying shades of brownish green, olive-green, and dirty greenish brown; all were fairly dark, but these were darker than the rest. Their heads were also brown, and the longitudinal striping was much darker. The larvæ were large, and getting crowded; so I removed the seven darkest to cylinder 4, giving them dark green leaves and a dark earth floor. Eight larvæ remained in cylinder 2.

July 26th.—The fourth ecdysis occurred. There was no change of colour. The colour had not darkened or altered at all since the change at third ecdysis.

Aug. 12th.—Three larvæ pupated.

Aug. 13th.—The last five larvæ pupated. There was no change of colour due to surroundings in any.

Cylinder 4.—July 21st.—The seven darkest larvæ from cylinder 2 were placed here with dark green leaves and dark earth.

July 26th.—The fourth ecdysis took place. No change of colour either before or afterwards. The larvæ still remained slightly darker than those in cylinder 2, but were otherwise like them.

Aug. 11th.—Four larvæ pupated.

Aug. 12th.—The last three larvæ pupated. No change of colour due to surroundings occurred in any.

The larvæ with green surroundings.

Cylinder 1.—July 7th.—Fourteen larvæ in the second stage were left in cylinder 1, with light green leaves only; no earth was given to these.

July 13th.—The second ecdysis took place. The larvæ changed to a green more or less dark, with slightly lighter longitudinal striping; heads yellow to yellowish brown, as in the larvæ with dark surroundings. From this time the larvæ adopted stated times of feeding, like the others, and in the intervals descended from the leaves and remained quiescent on the floor. This set had no earth in which to bury, but they constantly covered themselves as much as possible with their excreta, which was brownish green in colour, and always of great quantity; so that it had to be continually cleared out.

July 21st.—The third ecdysis took place, and the larvæ changed to various shades of very dark greenish brown or olive-green; heads brown. Two were very dark. I removed seven of the lightest to cylinder 3, with light green leaves only. Seven were left here.

July 26th.—The fourth ecdysis occurred. No change of colour, which had been quite normal ever since the alteration at third ecdysis.

Aug. 13th.—Five larvæ pupated.

Aug. 14th.—The two last larvæ pupated. No change of colour due to surroundings was perceptible in any of them.

Cylinder 3.—July 21st. — Seven of the lightest larvæ were placed here from cylinder 1, and were given light green leaves and no earth.

July 26th.—The fourth ecdysis took place. The colour had been quite normal since the change at third ecdysis, and no change took place now.

Aug. 12th.—Three larvæ pupated.

Aug. 13th.—The last four larvæ pupated.

Total results of experiment:—

Colour.	No. of larvæ.
Various shades of olive-green to brown ...	29
Other colours	0
Total	29

It will be seen that the above results were entirely negative. The shades of colour are difficult to describe in this species; but all my larvæ, variable as they were in shade, were more brown than green, even when in green surroundings, and this was the case with any larvæ I captured and compared with them. The lack of resemblance to surroundings in this species may be partly due to the burying habit; the greenish brown is sufficiently protective while on the earth, and once buried the colour would be of less importance. Mr. Poulton made some previous experiments with *M. brassicæ*, the results of which are shortly to be published.

Summary of Results.

R. cratægata.

Total number of larvæ experimented with, 19.
Number in dark surroundings, 10.
Number in green surroundings, 9.

The larvæ in dark surroundings.

Very dark brown, approaching to black ...	3
Light brown	3
Intermediate shades of brown	2
Exceptions (green)	2
Total	10

The larvæ in green surroundings.

Brilliant green, with red touches	1
Lighter green	2
Intermediate shades of green	6
Exceptions	0
Total	9

C. nupta.

Total number of larvæ experimented with, 42.
Number in dark surroundings, 12.
Number in green surroundings, 18.
Number in white surroundings, 12.

The larvæ in dark surroundings.

Very dark brown, dark dorsal lines	2
Light brown, faint dorsal lines	3
Intermediate, darkish dorsal lines	7
Total	12

The larvæ in green surroundings.

Light clear brown, light dorsal lines	10
Dark brown, dark dorsal lines	5
Intermediate, darkish dorsal lines	3
Total	18

The larvæ in white surroundings.

Light clear brown, light dorsal lines	5
Dark brown, dark dorsal lines	1
Intermediate, darkish dorsal lines	6
Total	12

C. fraxini.

Total number of larvæ experimented with, 10.
Number in dark surroundings, 5.
Number in green surroundings, 5.

The larvæ in dark surroundings.

Brownish grey or pinkish drab.	5
Exceptions	0
Total	5

The larvæ in green surroundings.

Delicate bluish green	5
Exceptions	0
Total	5

M. brassicæ.

Total number experimented with, 29.
Number in dark surroundings, 15.
Number in green surroundings, 14.

The larvæ in dark surroundings.

Dark brownish green ... ... 15.

The larvæ in green surroundings.

Dark brownish green... ... ... 14.

Section II.

1. *Notes on a possibly protective habit of larvæ of* Rumia cratægata.

In the course of experiments in colour-relation, in June, 1890, I made some observations on a peculiar habit adopted by the young larvæ of *R. cratægata*, which seemed to me possibly significant. Mr. Poulton made numerous observations in previous years on the irregular or spiral attitudes assumed by young Geometer larvæ, mentioning the habit as occurring in *Ephyra pendularia*, *E. omicronaria*, *E. orbicularia*, *Aspilates citraria*, and *A. gilvaria* (Trans. Ent. Soc. Lond., 1884, Part I.), and again in *Selenia lunaria* and *R. cratægata* (Trans. Ent. Soc. Lond., 1887, Part III.). But in my larvæ of the latter species I found this attitude associated with a habit which, so far as I am aware, has not been observed before.

During the third stage the larvæ in cylinders 5 and 9 (*viz.*, those with dark and those with green surroundings), continually adopted the above-mentioned attitude when at rest, forming themselves into an irregular spiral (Pl. XI., fig. 3), the fore part of the body being bent round so that the head and first five segments were erected almost vertically. This position was retained for hours at a time, either when the larvæ were resting on leaves, or when they were hanging by a supporting thread from the leaf or a stick, which they frequently did, something after the manner described by Mr. Poulton in *E. pendularia* (Trans. Ent. Soc. Lond., 1884, Part I.). The spiral twist was maintained, as well when hanging by the thread as when resting on a leaf; it was most prevalent during the third stage, but some individuals continued it through the fourth and even fifth stages. The spiral attitude was common to both sets of larvæ, green and brown, but was continued much later by the brown larvæ, which also adopted the hanging position much more frequently than the green. In fact, the brown larvæ hung in the spiral attitude almost constantly, and it was when in this position that they adopted the habit I observed. This was that, whenever I examined them, which I did many times every day (without removing the cylinder), the hanging larvæ took to spinning round on their threads with a circular or vibrating motion. I supposed the motion to be accidental, and probably caused by my touching or jogging the cylinders. But I soon noticed that the larvæ spun whenever I examined them, and it seemed to me as if the movement were voluntary, since it occurred when I did not touch the cylinder at all, and when I approached so as not to cause any vibration perceptible to me. The movement appeared circular, but it was so rapid that it might have been vibratory, the rapidity giving a deceptive appearance; the movement caused by jogging or shaking was, however, a to-and-fro one, quite unlike the spinning. The latter motion was not unlike that noticeable in young spiders (*Epeira diademata*), when observed or interfered with in their web; they set the web violently shaking with a round-and-round motion, which confuses the enemy, and renders the spider scarcely distinguishable. The likeness of the brown larvæ, when spinning, to the bits of dead leaves, sticks, or rolled-up spiral leaf-cases one sees hanging on a thread or web in a hedge, and spinning or vibrating in the wind, struck me at once, and it seemed to me that the likeness might possibly be a protective one. The idea was confirmed by the fact that I found the green larvæ, though adopting the spiral attitude on leaves, hung comparatively seldom, and *never spun at all.* I cannot say positively that the brown larvæ never spun when I did not observe them, but I do not think that they did. At the same time it has been represented to me that it is difficult to conceive how a voluntary motion of the kind can be caused by a larva hanging loose at the end of a thread, and also difficult to see how the larvæ can have become aware of the presence of what they supposed to be an enemy unless by vibration, which did not seem to be the case, or by shadow, which is possible, as I looked very closely at them. I hope to investigate the subject further, and to endeavour to show whether the movement is related to the existence of some disturbance, as, if so, I think it would prove strongly protective.

If the resemblance really is to objects spinning in trees and bushes, the fact that the green larvæ do not spin is exactly what we should expect, for *green* leaves or objects are rarely, if ever, seen in the position described. A green larva would be rendered more easy of detection by the habit, for it would attract the attention of enemies by spinning, and would run some risk of doing so by hanging at all; while on green leaves it is sufficiently protected by its colour. The suggestion is, however, a purely tentative one, and the observation has not much value without further investigation as to the exact nature and causes of the movement.

2. *Notes upon the red spots in* Smerinthus *larvæ.*

On July 30th, 1890, at Mr. Poulton's suggestion, twenty-three newly-hatched larvæ of *Smerinthus tiliæ*, the parents of which had been spotted as larvæ, were sent me by Mr. R. C. L. Perkins, a friend and former pupil of Mr. Poulton. I worked at the ontogeny of these larvæ, with a view to throwing further light, if possible, upon the question of the origin and development of the red spots which sometimes occur in this species.

Since the appearance of Professor Weismann's Essay on 'The Origin of the Markings of Caterpillars,' and Professor R. Meldola's notes on it (' Studies in the Theory of Descent,' vol. i.), Mr. Poulton made various observations on this species and others of the genus (Trans. Ent. Soc. Lond., 1884, Part. I.; 1885, Part II.; 1886, Part II.; and 1887, Part III.), and his latest conclusion was that the spots in *S. tiliæ* probably arose from a modification of a normal coloured border to the oblique stripes, hence that we have in *S. tiliæ* "a fading away of the character (*i.e.*, coloured borders) instead of its origin."

Unfortunately nineteen of the larvæ sent me by Mr. Perkins were injured in the transit by post, and only four were reared; but all these were spotted. I watched their development very closely, and recorded every change however slight. My observations did not agree in all points with the descriptions of the young larvæ given by Prof. Weismann ('Studies in the Theory of Descent,' vol. i., p. 233). This may have been due to variability in the larvæ; yet certain appearances, either not mentioned by him, or mentioned as occurring at different periods, were found in each of my larvæ; and, as some were transitory, it is possible they mav have been overlooked by him, especially as his descriptions are not very detailed.

The following is a record of the appearance of the larvæ day by day:—

July 30th.—I received from Mr. Perkins twenty-three larvæ of *S. tiliæ* just out of the eggs; they were placed in cylinder 15, and fed on elm. Nineteen were injured in transit and were dying or dead. The larvæ were green all over, and the caudal horn was very long and dark violet in colour. No oblique stripes. The dorsal vessel showed through the skin.

Aug. 4th.—Only four larvæ were living; these continued healthy. The first ecdysis of the first larva occurred. It now became light green, with the caudal horn pure green. (This stage is described by Prof. Weismann as occurring *before* first ecdysis, and before the horn becomes violet). The oblique stripes were now faintly discernible, and were green like the ground-colour, only of a more yellowish shade. There was no trace of a subdorsal line as described by Professor Weismann. Length of larva before ecdysis 6 mm. The dorsal vessel still showed through; Prof. Weismann describes this as appearing now for the first time.

Aug. 5th.—The horn of the first larva had acquired a dark rough dotting on the upper surface near the base; the tip and under side were still green. Shagreening appeared.

Aug. 6th.—The horn of the first larva became yellower; the dotting remained the same and became no darker. The length of the larva at this time was 9 mm.

Aug. 9th.—The first ecdysis of the second larva occurred; the horn changed to pure green as in the first larva. Shagreening appeared. The head was brighter green than the rest of the body. No subdorsal line. The horn of the first larva was now reddish at the base, but not darker towards the tip, and the under side of it was quite light and greenish still.

Aug. 11th.—The first ecdysis of the third and fourth larvæ took place; the horn in both changed to pure green as in the others. Shagreening appeared. No subdorsal line. The second ecdysis of the first larva occurred; there was scarcely any change, only the oblique stripes became primrose-yellow and more distinct, and the horn blacker on the upper surface. The apex of the triangular head was very slightly bifid. The length of the larva was 1½ cm.

Aug. 22nd.—The third ecdysis of the first larva took place. A perfect row of nine reddish-yellow spots appeared. Eight were in the position of the spiracles, and one on the supra-anal plate. They were present on the thoracic segments, and the first to eighth abdominal. Spots 1—10 were spiracular in position, and those on the abdominal segments were posterior to the oblique stripes. The spot on abdominal segment eight was the brightest and most distinct, and next in distinctness was that at the base of the horn; towards the head they became less bright, though still distinct. The length of the larva was 2½ cm. The horn was less dark on the upper surface, and there was a very distinct red line on each side of the base; the ground colour was greenish yellow. The oblique stripes were primrose-coloured; they were never at any time white or "whitish" as described by Prof. Weismann, but distinctly pale yellow.

Aug. 24th.—The second ecdysis of the third and fourth larvæ. The change in appearance was exactly the same as in the first and second.

Aug. 25th—Sept. 2nd.—I was absent from home, and meanwhile the third ecdysis of the second, third, and fourth larvæ occurred. In all three, red spots were found in the spiracular row only, exactly as in the first larva, both as to number and position; the red spot on the supra-anal plate was also present. The change in the horn was also exactly as in the first larva.

Sept. 3rd.—The fourth ecdysis of the first larva occurred. The ground colour was bright yellowish-green; the stripes and shagreen dots pale primrose-yellow. The character of the spiracular spots was slightly changed; whereas in the fourth stage the spiracle itself only showed as an orange-red spot outlined with a deeper green than the body-colour (Pl. XI., fig. 9); each spiracle was now distinctly margined with orange-red, the red area having increased, but being still outlined with deep green (Pl. XI., fig. 10). The most striking change was the development of an upper row of large bold red spots, seven in number, on abdominal segments 1—7, one anterior to each stripe, the second largest being those in front of the third, fourth, and fifth stripes, counting the most anterior stripe as the first. The last spot was the largest, those in front of the first and second stripes much smaller, but distinct; the spot before the sixth stripe was a mere trace. The oblique stripes now took a slight upward bend at the places where the upper spots occurred, and the third, fourth, and fifth stripes were here slightly suffused by the spot, on which the shagreen dots showed up as on a background. The spots showed a slight tendency to lengthen vertically, but kept strictly to the lines of the rings of the body, of which there are eight in each segment. The spots in front of the third, fourth, and fifth stripes covered three rings in width, the last spot four rings, the first and second spots only two rings. The two sides of the larva corresponded exactly. The black dotting of the caudal horn entirely disappeared; immediately after ecdysis the upper surface was pure green, the under surface was yellow, and the red line up the sides was longer and more distinct. The length of the larva was nearly $4\frac{1}{2}$ cm.

Sept. 4th.—The horn of the first larva changed to bluish on the upper surface.

Sept. 5th.—Having been absent on the day the second, third, and fourth larvæ moulted, I recorded their exact appearance now. In the third larva the spiracular row of spots was faint in colour, but distinct; they were nine in number, on the first thoracic segment and abdominals 1—8, and were orange-red in colour. Those on abdominal segments 1—7 were posterior to each stripe. The shagreen pale yellow dots were placed in vertical lines following the rings of the body. The oblique stripes were primrose-yellow, and the first was the most distinct. I could see no trace of the eighth stripe observed by Mr. Poulton in *Smerinthus* larvæ and *Sphinx ligustri* (Trans. Ent. Soc. Lond., 1886, Part II., and previous papers). The caudal horn was black-dotted on the upper surface, yellow beneath; there were faint traces of the red line extending up the sides from the base. The apex of the head was bifid and faintly red. The thoracic legs were very faintly rosy; there was no red on the claspers. The length of the larva was 3 cm. The fourth larva was exactly as the third. The second larva was evidently nearer the fourth ecdysis; its general ground colour was darker green than that of the others, the stripes and shagreening yellower. The apex of the head was distinctly orange-red and bifid. Only the spiracular row of spots was developed, on the same segments as in the others, but a darkening under the skin was perceptible anterior to the fourth, fifth, and sixth stripes, where the upper row of spots ultimately appears. The caudal horn was black-dotted on a green upper surface, and the red lines from the base upwards were more distinct than in the third and fourth larvæ. The thoracic legs were also redder; there was no red on the claspers. There was no eighth stripe.

Sept. 6th.—The fourth ecdysis of the second and third larvæ took place. The second larva developed an upper row of five spots only; these were in front of the second, third, fourth, fifth, and seventh stripes, *viz.*, on abdominal segments two, three, four, five, and seven. The spots were very small and inconspicuous, also brighter and of a yellower tint than in the first larva, and so narrow in extent as to really appear more like borders than spots at all. Those in front of the second, third, fourth, and fifth stripes occupied three rings each, but were *vertically* a mere line in width, thus giving the border-like appearance. The seventh spot was a mere trace. The two sides of the larva corresponded. The thoracic legs were faintly red; there was no red on the claspers. The other characters were all as in the first larva. There was no eighth stripe. The third larva developed an upper row of seven spots, one anterior to each stripe, *viz.*, on abdominal segments 1—8. The third and seventh spots occupied four rings, the first two rings, and the rest three rings; nevertheless, the third, fourth, and fifth spots were the largest, because longer vertically than the others. All the spots were larger and more conspicuous than in the second larva, also deeper red. The sides corresponded. All other characters were just as in the first larva.

Sept. 9th.—The fourth ecdysis of the fourth larva took place. It developed an upper row of six spots, one in front of the first, second, third, fourth, fifth, and seventh stripes, *viz.*, on abdominal segments one, two, three, four, five, and seven. The spot in front of the first stripe (on first abdominal segment) was the smallest, occupying two rings; the others each occupied three rings. Other characters as in the first larva.

Sept. 10th.—The upper row of spots in the first larva increased in width; the third, fourth, and fifth spots (on abdominal segments one, two, and three) now covered four rings. This increase in the width of spots did not happen in any other larvæ.

Sept. 25th.—The first larva pupated.

Sept. 27th.—The second, third, and fourth larvæ pupated. The larva figured (Pl. XI., fig. 8) is the first.

Smerinthus populi.

On August 8th, 1890, I captured a red-spotted larva of *S. populi* in the fourth stage on poplar.

Aug. 12th.—I drew (Pl. XI., fig. 11) abdominal segments five and six to show the spots. There were two rows of spots, of ten each, the upper row being the largest. The upper row were placed one anterior to each oblique stripe, and four extra to these placed irregularly towards the head. The lower (spiracular) row were placed one posterior to each stripe, two extra on the last segment, and one extra towards the head. The spots in both rows were irregular and roundish.

Aug. 19th.—A change took place in the spiracular spots without any moult. The lower row became like eyes, of which the pupil was yellowish red, *viz.*, the spiracle itself; the iris green, boldly outlined with red (Pl. XI., fig. 12).

Aug. 22nd.—The fourth ecdysis occurred. Both rows of spots slightly increased in size, lengthening vertically so as almost to connect stripe with stripe, but not increasing horizontally. The appearance was not in the least border-like.

Sept. 5th.—The spiracular row of spots was now eleven, another having appeared; there was a spot on each of thoracic segments two and three, the one on thoracic segment three being a mere trace. (On these segments there were no spots in *S. tiliæ*). The spots were still more eye-like, being more broadly margined with red. The upper row of spots now numbered eleven also, the extra spot occurring on the last segment, vertically above the last of the lower row. The last spot but one occupied five rings (two in the penultinate segment, and three in the last); this was the only one which invaded another segment. The first, second, third, fourth, and fifth spots occupied four rings, and the eleventh, first, second, third, and fourth only three rings. But the tenth, eighth, seventh, and sixth were the largest, owing to vertical extension, and these slightly suffused the stripes. Both sides corresponded. The head was suffused with red. The thoracic legs were red, and there was a red spot on each of the claspers. The ground colour of the caudal horn was yellow, the base was blackish above and reddish beneath, and a red line ran up from in front of the seventh stripe to the base, connecting it with the tenth spot. This line was the only attempt at extension borderwise, for the widening on August 22nd was accompanied by great vertical extension, which quite prevented a border-like appearance. The larva ceased feeding on Sept. 8th, and pupated during the night of Sept. 14th. The spots in *S. populi* were unlike those in *S. tiliæ* in general effect, being rounder, bolder, and not in the least linear, and I noticed, as had been previously done by other observers (notably Mr. Peter Cameron, as stated by Prof. Meldola in his notes to Prof. Weismann's 'Essay on the Markings of Caterpillars'), that they were strongly protective, from their resemblance to the dark spots or blotches commonly seen on the leaves of the poplar. Viewed from underneath, with the light shining through them, the leaf-spots were of a red exactly corresponding to that of the larva-spots, and much the same size. I did not, however, see the likeness to *galls* (*Phytoptus*) suggested by Mr. Cameron (Trans. Ent. Soc. 1880, p. 69), for the effect produced by a flat spot and a raised object such as a gall would, I think, be very different. But my larva was quite difficult to find, even on a small twig, when viewed from below, and it would have been admirably concealed from enemies below it at any rate.

In *S. tiliæ* I could see nothing in the spots which would have led me to connect them with coloured borders until the second larva reached its last stage, but the appearance of the spots in this individual was so linear and so unmistakeably border-like, that it seemed impossible to doubt the correspondence.

It would have been natural to conclude, from appearances, that the spots are merely protective in *S. populi*, and in *S. tiliæ* have either degenerated from coloured borders, or are on the way to become such; but that it seems unlikely that the character can have a different significance in the two species. It seems to me more probable that spot-marking is the most ancestral, as Prof. Weismann originally suggested, and that *S. tiliæ* represents a stage of its modification into stripes. The fact that the spots do increase in area in both species, though in two directions, seems to point to the character being a developing one. If we had to do with a gradual shortening of borders contracting into spot-markings, it seems more likely that if any change in area of the spots took place it would be in the direction of contraction, which was never the case in my larvæ. There seemed to be no vestige of a former extension along the stripe; even when a stripe was suffused with red, it was so vertically downwards, and never partially affected an extra ring so as to lead one to suppose the spot had once been broader. But the number of larvæ reared was too limited to draw conclusions from safely, and it is possible that if I had had more individuals under observation, some of them might have presented different appearances.

4. *Experiments as to the palatability of conspicuous larvæ.*

In May and June, 1890, I made experiments with larvæ of *Diloba cæruleocephala* and *Cucullia verbasci* on a tame jackdaw. The bird in question had been taken unfledged in June of the previous year, and reared in captivity. He had never seen larvæ, except those I gave him, unless some might occasionally drop from a beech tree, the boughs of which overhung his cage in the garden.

May 30th. — I took some larvæ of *D. cæruleocephala*, feeding freely exposed on pear trees; they were blue, yellow, and black, not hairy, very conspicuous. One was given to the jackdaw, which had been fed early in the morning (this was midday), and so was not very hungry. The bird looked at the larva suspiciously for a long time, and would not take it. Then he seized it, and, on tasting it, shook his head violently, evidently disliking it. He then dropped it, but picked it up and tried it again, shook his head as before, and finally put it down on the floor of the cage and refused to eat it.

May 31st.—I tried the jackdaw with a common smooth green larva (species unknown); he ate it at once with avidity.

June 20th. — I took two larvæ of *Cucullia verbasci*, feeding together exposed on upper side of leaves of mullein; they were green, yellow, and black, very conspicuous, not hairy.

June 21st.—The jackdaw was purposely not fed, and by the middle of the day he was very hungry, for he carried his empty food-vessel and stood it up against the bars of the cage, an invariable habit when really hungry. The largest larva was offered to him. At first he refused it, then took it, but dropped it instantly, shaking his head, and never touched it again. He appeared quite subdued for a time, and sat shaking his head and swallowing. Nor would he take anything else offered him at all for a little while, but finally ate a gooseberry with relish.

The unpleasant attribute in both species seemed to be taste. Mr. Poulton mentions (Proc. Zool. Soc. Lond., March 1st, 1887) Mr. J. Jenner Weir having experimented with *D. cæruleocephala*, "using many species of birds and lizards," and says the larvæ were "disregarded by all the birds," or "examined when moving, but not eaten." This, he says, gave "strong support" to Prof. Wallace's suggestion, "that brilliant and conspicuous larvæ would be refused by some at least of their enemies," while it afforded "no evidence" for Mr. Poulton's suggestion "that a limit to the success of this method of defence would result from the hunger which the success itself tends to produce."

My experiment affords strong support to Mr. Poulton's suggestion, since the larva was tasted twice, and that when the bird was not especially hungry, which points to its being eaten if he had been excessively hungry.

Mr. Poulton says that Mr. Jenner Weir also experimented with *Cucullia verbasci*, on "many species of birds and lizards," and that the larvæ were "disregarded." He refers to this as "strong support" to Prof. Wallace's suggestion, and as "no evidence" for his own.

My experiment afforded some support to Mr. Poulton's suggestion, since the larva was tasted once, and tasting would put a limit to the success of the method of defence as well as eating, because it would be fatal to the larva. I do not think, however, that this species would have been eaten in any degree of hunger.

Both my experiments supported Prof. Wallace's suggestion also, as the larvæ were in both cases refused at first; and, if the bird had not been very hungry, I do not think he would even have tasted *C. verbasci.*

In September, 1892, I also made some experiments with larvæ of *Acronycta psi* and *Bombyx rubi* on three slowworms (*A. fragilis*), and one lizard (*Z. vivipara*). Both species were entirely disregarded by all the animals, though they were kept very hungry, and the larvæ left with them for days.

It may not be out of place to note here that during this experiment I had incontestable evidence of the nature of the food taken by *A. fragilis* in the natural state. The slowworms received rather rough handling when captured, and immediately afterwards cast up a quantity of half-digested food, among which I found a perfectly uninjured adult shell of *Zonites radiatulus.* Remains of slugs were also recognizable. It is rather remarkable that *A. fragilis* should be able to swallow so large and hard an object as the snail-shell.

Explanation of Plate XI.

Fig. 1.—Green larva of *R. cratægata*, last stage, nat. size.

Fig. 2.—Brown larva of *R. cratægata*, last stage, nat. size, resting on black stick.

Fig. 3.—Larva of *R. cratægata* (brown form), in spiral attitude, resting on stick, × 4 diameters.

Fig. 4.—Larva of *C. nupta* (dark surroundings), nat. size, fifth stage.

Fig. 5.—Larva of *C. nupta* (green surroundings), nat. size, fifth stage. (The first abdominal segment has been inadvertently omitted).

Fig. 6.—Larva of *C. fraxini* (dark surroundings), nat. size, last stage, resting on black stick.

Fig. 7.—Larva of *C. fraxini* (green surroundings), nat. size, last stage. (This larva was only placed on a stick for convenience of drawing).

Fig. 8.—Larva of *S. tiliæ*, nat. size, last stage.

Fig. 9.—Fifth and sixth abdominal segments of larva of *S. tiliæ*, fourth stage, immediately after ecdysis, showing first appearance of spiracular spots, × 4 diameters.

Fig. 10.—Fourth and fifth abdominal segments of larva of *S. tiliæ*, fifth stage, showing first appearance of upper row of spots, × 4 diameters.

Fig. 11.—Fifth and sixth abdominal segments of larva of *S. populi*, fourth stage, × 4 diameters.

Fig. 12.—Fifth and sixth abdominal segments of larva of *S. populi*, fourth stage, shortly before last ecdysis, × 4 diameters.

Fig. 13.—Same segments, fifth stage, after last ecdysis, × 4 diameters.

XIV. *Notes on a protean Indian butterfly,* Euplæa (Stictoplœa) harrisii, *Felder.* By Lionel de Nicéville, F.L.S., C.M.Z.S.

[Read October 5th, 1892.]

I have asked my friend Mr. E. Y. Watson to exhibit on my behalf, to the Fellows of the Entomological Society of London, a series of forty-five specimens of a protean species of butterfly, *Euplæa* (*Stictoplœa*) *harrisii*, Felder, consisting of thirty-three males and twelve females, which I have selected out of a collection of upwards of two hundred caught in the Khasi Hills, Assam, by the native collectors of the Rev. Walter A. Hamilton. These specimens were almost certainly all caught at or close to the village of Chela-punji, at the foot of the hills on the Sylhet side, and at an elevation but slightly above sea-level.

On examination the specimens will be seen to exhibit considerable variation in outline, the wings being broader, and the fore wing more produced at the apex (less rounded) in some specimens than in others. With regard to the markings, the variations are almost bewildering. I have arranged the specimens in two series, the males first, then the females. I have placed at the head of the series the most sparsely-marked specimens, which, as far as the fore wing goes, represent the oldest-named form, and are characteristic of Burma and the Malay Peninsula; and next those with the heaviest-marked fore wing, which are characteristic of Sikkim, at the other end of the geographical range of species. In the Khasi Hills—as demonstrated by the specimens now exhibited—the extremes of both forms with intermediates between them occur. This extraordinary variation in markings is not, in my opinion, due to seasonal or climatic causes, but is probably inherent in the nature of the butterfly itself. This mutability of character has been noted and commented upon in the writings of every field naturalist who has seen these butterflies in life, but it does not appear to be realised by some cabinet naturalists in Europe.

Dr. Felder, who was the first to describe this species, named the southern form, the one extreme, *Euplœa harrisii;* and the northern form, the other extreme, *E. hopei.* In this he was fully justified, as his material was very limited, as I can testify, having seen his type-specimens in Vienna; and these, taken by themselves, are quite distinct. Mr. Butler then added to the synonymy by describing *Stictoplœa microsticta*, with three submarginal spots to the hind wing on the upper side, and *S. binotata* with two. Lastly, Mr. Moore described *S. regina*, with no spots at all on the hind wing; *S. pygmæa*, which is simply a dwarf of the northern form; and *S. crowleyi*, which combines the characters of the two, having the fore wing of the southern and the hind wing of the northern form. In his 'Lepidoptera Indica,' Mr. Moore admits six of these species as distinct, rejecting only *S. microsticta*, on the ground that it was described from a specimen without locality, and has broader wings than *S. hopei;* and he devotes two plates to the illustrating of them. In the series now exhibited,—taken, let me repeat for the sake of emphasis, in a single spot,—every one of these species can be accurately matched; and, as they are now proved to intergrade one into the other, and also are not confined to any geographical region, these seven species must be reduced to one. If stay-at-home naturalists would only pay a little more heed to the observations of field naturalists, such results would not have to be deplored. Messrs. Wood-Mason, Marshall, Elwes, Adamson, Watson, and the writer have all drawn attention to the fact that the species of certain groups of *Euplœa*, including this one, are eminently variable, as our field observations had proved them to be; and yet these expressed opinions of competent naturalists are persistently passed over in silence, and ignored by those who have never seen an *Euplœa* alive in its native home.

XV. *New light on the formation of the abdominal pouch in* Parnassius. By Samuel H. Scudder, F.E.S., of Cambridge, Mass., United States.

[Read November 2nd, 1892.]

Captain Elwes, in a paper on the genus *Parnassius* (Proc. Zool. Soc. Lond., 1886, 6—53, pl. 1—4), has based his classification of the species largely on the structure of the abdominal pouch of the female, and given a very interesting and useful *résumé* of what was known with regard to its formation. From this, and the new observations by Thomson and Howes given in his paper, as well as from some notes of his own, it would appear to be the general conclusion that the abdominal pouch seen on the under surface of the subterminal segments of the abdomen of the female of *Parnassius* is not present when the butterfly emerges from the chrysalis, but is constructed during the prolonged pairing of the sexes by a secretion formed at the time, and which hardens into a definite form, varying according to the species. Whether this secretion proceeds from the body of the male or of the female, and by what means it takes on its definite shape, there is more variance of opinion, but the weight of testimony appears to be in favour of regarding it as formed by the male, and moulded upon the shape of the terminal segments of his abdomen. Siebold, who was the first, more than forty years ago, to make scientific observations on this point, believed that the secretion was poured out from under the two lateral valves of the male (ergiesse sich . . . . das gerinnende Secret unter die beiden seitlichen Klappen), by which he means the expanded and prolonged side pieces of the eighth abdominal segment.

My attention was specially directed to this matter by the field observations of Mr. David Bruce in Colorado, communicated to me by Mr. William H. Edwards, who asked me to verify and explain the same by dissection of the male abdomen. Mr. Bruce, whose interesting observations will be detailed in full in Part xiv. of the current series of Mr. Edwards's 'Butterflies of North America,' reported that during the mating of the sexes in *Parnassius smintheus* he saw a "scimitar-like" organ working *beneath* the membrane which formed the pouch, and apparently moulding the same from the interior into the definite shape which it assumes; and this organ, which he believed to be no part of the genitalia proper, worked with a piston-like action in each division of the pouch, which yielded to its motion. This would seem to be directly opposed to Mr. Thomson's statement regarding the formation of the pouch in *P. apollo*, as given by Capt. Elwes (*l. c.*, p. 13), for he describes a membranous sheet attached to the male body containing a green fluid, covering the female pouch on the *outside*, and forming a "mould in which the pouch is formed during copulation."

Mr. Edwards having placed in my hands abundant dry material during the past winter, I soon reached a conclusion which seemed to throw some new light upon the matter, and perhaps to reconcile the apparently contradictory statements of the two observers mentioned. My dissections were almost entirely of specimens of *P. smintheus*, but, as they left many points still unexplained, I was anxious to examine living examples, which alone could furnish an answer, and verify or disprove my conclusions. At Mr. Edwards's solicitation, therefore, Mr. Bruce sent me last spring on several occasions living males of *P. smintheus* from Colorado, and Mr. Wright one lot of living males of *P. clodius* from California. Unfortunately none reached me alive, excepting a single moribund example of *C. smintheus*, too far gone to be useful; and since the failure of this experiment leaves it improbable that an opportunity for my examination of a living male *Parnassius* will soon occur, I venture to publish my observations in the hope that some one more favoured by position will be moved to further investigation.

The structure of the abdomen of the male *Parnassius* is remarkable for having, as in the Euplœid genus *Anosia*, the sides of the eighth segment expanded and posteriorly extended, forming a kind of false claspers concealing the greater part of the genitalia proper; in *P. smintheus* and *P. apollo* embracing also the inferior surface of the true claspers, and thus here giving to the eighth segment a length twice as great along the ventral as along the dorsal region. It is beneath these "Klappen," or false claspers, that von Siebold says the secretion is poured forth; and he is certainly right, for all the crevices existing between the inner surface of these expansions and the outer surface of the organs beneath, which it closely clasps, are often filled completely, in all specimens I have examined to some extent, with a coagulated secretion, which, when compared under the microscope with a fragment from the pouch of the female, is of essentially the same character as it.

In *S. clodius*, *S. mnemosyne*, and other species, the false claspers do not embrace the under surface of the true claspers, which are thus not at all concealed on an inferior view, and therefore there is in these species considerable modification of the parts I am about to describe, in remarks which are based wholly upon an examination of *P. smintheus*.

If the eighth abdominal ring is carefully removed bit by bit (which can hardly be done without rupturing some of the coagulated secretion, but often leaves broad sheets intact), all the accessory organs of generation are exposed to view; it will then be seen that the sternal portion of the ninth segment (the segment to which are attached the claspers proper) is split along the median line, and sends two anterior shafts side by side to the hindmost edge of the overlapping eighth segment. Directly beneath it, beneath in the sense of towards the middle line of the body, *i. e.*, lying between the lower anterior ensiform process of the ninth segment and the lower surface of the true claspers, is a pair of lamellate scimitar-shaped organs diverging at tip, and so closely connected with the sheet of coagulated secretion, and of so nearly the same colour and texture as it, as to appear a part of the same. It is only when the processes of the ninth segment are in their turn removed that the form and structure of these parts can be made out; it is then seen that they have a membranous or tendonous structure, hardly chitinous, and certainly not the same as the hardened, jelly-like, structureless condition of the secretion, which is continuous with their edges, and permeates the crevices in the region about. By uncovering the parts in front, *i. e.*, toward the base of the abdomen, it is seen to be formed mainly of two slender blades, curving in opposite senses, which lie under the protection of the anterior processes of the ninth segment, but, when they pass forward, dilate into triangular expansions which nearly fill the lozenge-shaped space left vacant between the curved base of the anterior processes of the ninth segment (following the similar curve of the eighth segment) and the slightly emarginate apex of the seventh ; at their base they appear to be attachments of the seventh segment ; the opposite sides of the triangular basal expansion are thicker than the middle, as if there were a two-branched basal attachment connected by a slight membrane to give greater support and rigidity to the attachment.

This organ, which, so far as I know, has no homologue whatever among Lepidoptera, seems to lie in just the place and to be of just the form to serve as the apparatus for moulding on its interior the abdominal pouch of the female out of the secretions which flow either from it or through it or around it from glands in close connection with it; and consequently I suggest for it the name of peraplast (*πήρα, πλάσσω*), indicative of its use. The attachments and the mechanism by which it may act, together with the precise position and relation to it of the adjoining secretory glands, can of course only be told from fresh specimens; and fresh specimens would doubtless serve also to correct in some particulars this preliminary description. It will perhaps be found that the "membrane" mentioned by Thomson "containing a dark green fluid" is an evaginable gland extended from near the base of the false claspers (precisely as the evaginable pencil of bristles in *Anosia*), and that when it protrudes beyond their tip—as Thomson's description would seem to imply—it secretes from its inner surface the material of which the pouch is formed, which is then moulded into shape by the scimitar-shaped peraplast; this must have an extensile movement, surpassing even that of the true claspers. This is a point which only an examination, first of living males and next of pairs in union, can fully satisfy: and it will then remain for the histologist to scrutinise the organs themselves.

The problem still remains, to understand the purpose of the feminine pouch in *Parnassius*, and the homologous flaps in *Euryades*. Although they take on a definite form, distinctive for each species, it has not only never been shown that they possess any function, but it is known that oviposition occurs without them, and they are apparently quite independent of that. Such extraordinary formations, moulded by the male upon the body of the female during pairing, and through the agency of special structures and special glands in the body of the male, cannot have arisen for anything but some most useful purpose. But for what?

XVI. *Additions to the Longicornia of Mexico and Central America, with notes on some previously-recorded species.* By Charles J. Gahan, M.A., F.E.S.

[Read November 2nd, 1892.]

Plate XII.

The present contribution may be taken as a supplement to the paper by the late Mr. H. W. Bates, which has already appeared in the 'Transactions' for this year. Twenty new species are described, of which nineteen belong to the family *Lamiidæ*; the remaining species is placed in a new genus of *Prionidæ*. One new genus of *Lamiidæ* is characterised. With these additions the number of Longicornia recorded from Mexico and Central America is brought up to a total of 1372 species.

Lasiogaster, gen. nov.

(Male). Mandibles and front of head subvertical, the latter transversely depressed near the base, feebly concave between the antennal tubercles. Last joint of the palpi in the form of an elongated triangle. Eyes large, encroaching considerably upon the cheeks, which are reduced to two small triangular processes, one on each side. Antennæ surpassing but little the middle of the elytra; first joint short and stout, third to fifth subequal, each much shorter than the first; sixth to tenth gradually increasing in length; eleventh as long as the four preceding joints taken together; each of the joints from the third to the tenth provided at its outer distal angle with a long slender ramus, which is slightly flattened and dilated towards its free extremity. Prothorax transverse, somewhat rounded at the sides, slightly uneven above, anterior margin very feebly sinuate; the lateral carina of each side confined to the posterior half, where, commencing just above the outer angle of the cotyloid cavity, it passes obliquely upwards to join the basal margin, and at its junction with the latter forms a slightly projecting angle. Elytra moderately elongate, parallel-sided, rounded at their extremity, with the sutural angles briefly spined; each with three very distinct costæ, of which the innermost is much shorter than the other two. Legs of moderate length, somewhat compressed; the femora slightly dilated above the middle. Prosternal process slightly arched. Metathoracic episterna narrowly truncate behind. Abdomen rather broadly subtruncate at the apex; each of the first three segments with a large and sharply limited tomentose depression in the middle.

This genus will be best placed in the group *Monodesminæ*, of which it possesses all the essential characters. It may be easily distinguished from the other genera belonging to this group by the structure of the male antennæ. The median tomentose depressions on the first three abdominal segments of the male form a character unique, so far as I at present know, among the *Prionidæ*.

Lasiogaster costipennis, sp. n.

Nigro-fuscus sparse pubescens; capite antennisque dense scabrosoque punctatis; prothorace dense minus valde punctato; elytris (sutura margineque et costis tribus utrinque, fuscis, exceptis) albido-testaceis, nitidis, sat dense punctatis, inter costas subplanatis vel longitudinaliter depressis. Long. 23, lat. 7.5 mm.

Hab. British Honduras, Corosal (*obtained from Mrs. C. V. Wickham*).

The inner costa of each elytron begins at its basal margin, and does not extend for more than about one-third of its length; the median costa arises in the basal depression above the shoulder, takes a course backwards, at first directed slightly towards the suture, and then almost parallel to the suture for the remainder of its length, and ends at a short distance before the apex; the outer costa commences below and a little behind the shoulder, and ends, like the median costa, at a short distance from the apex.

Deliathis pulchra, Thoms.

Two additional examples, one from Trapiche grande, Vera Paz (*Conradt*), the other from Escuintla, Guatemala (*Conradt*), agree with the Guatemalan specimen placed in this species by Bates, in having a bluish grey tomentum in the place occupied by the black and glabrous elytral vittæ of the ordinary form. In the specimen from Escuintla the two yellowish tawny bands of each elytron have widened out and coalesced along the posterior half.

Deliathis Batesi, Gahan.

Ann. & Mag. Nat. Hist., ser. 6, vol. ii., p. 398.

Hab. Mexico, Acapulco in Guerrero (*Höge*).

The single specimen sent by Herr Höge presents all the characters of the two examples from which the species was originally described. For these two examples no more precise locality than Mexico was known.

The species is easily to be recognised by the unicolorous yellowish tawny pubescence of the elytra, which is interrupted by numerous rounded shining black spots. The mesosternal process is only slightly produced forwards at its antero-inferior border.

Deliathis diluta, sp. n. (Pl. XII., fig. 11).

D. buqueti similis sed vittis fulvis elytrorum pallidioribus, maculisque nigris glabris majoribus, et præcipue mesosterno antice recto, non producto. ♀. Long. 32—40, lat. 10—11·5 mm.

Hab. Mexico, Amula, 6000 ft., and Omilteme, 8000 ft., in Guerrero (*H. H. Smith*); Acapulco (*Höge*).

This species somewhat resembles *D. Buqueti*, Taslé, in its style of coloration. The pubescence of the elytra consists of two very pale tawny-yellow longitudinal bands on each elytron, alternating with two of a bluish white colour. These bands are much interrupted by rather large, more or less rounded glabrous black spots, so that in some specimens their character is not so evident, the pubescence in such cases appearing in the form of irregular reticulating patches.

The species may be distinguished from *D. Buqueti* and allied forms by the structure of the mesosternum; this has its ventral face horizontal, its anterior face vertical, so that the angle between them is almost exactly a right angle, being usually slightly less, sometimes a little greater.

In *D. Batesi* and *D. pulchra* the mesosternum is distinctly, though occasionally but slightly, produced forwards at its antero-inferior angle; in *D. Buqueti* it is more strongly produced forwards; while in *D. nivea* it is so strongly directed downwards and forwards as to form a large and conspicuous tubercle.

Parysatis perplexa, sp. n.

Angusta, pube fulvo-brunnea sat dense obtecta; prothorace lateraliter minute obtuseque tuberculato, supra sparsim punctato; elytris modice sat irregulariterque punctatis, apicibus truncatis. Long. 12, lat. 3 mm.

Hab. Mexico, Cuernavaca in Morelos (*Höge*).

Clothed with nearly uniform tawny brown pubescence. Prothorax feebly and somewhat obtusely tubercled on the middle of each side; sparsely and not very strongly punctured above along each side of a longitudinal median smooth space. Elytra moderately and somewhat irregularly punctured; each with a feebly raised longitudinal costa at a short distance from the suture, and with a few almost obsolete lines external to it. Apices of the elytra truncate. Antennæ a little longer than the body; the scape about a fourth shorter than the third joint; the joints succeeding the third each narrowly ringed with pale grey at the base. Upper side of tarsi greyish.

This species may be recognised by its nearly uniform fulvous brown pubescence, combined with its moderate and somewhat irregular punctuation. (The punctures of the elytra, though placed along definite lines, are at very irregular intervals; so that an appearance of irregularity is given to their whole distribution.) In general facies the species more nearly resembles *Esthlogena albisetosa* than any species of *Parysatis*, but the presence of a narrow cicatrice at the apex of the scape requires that it should be placed in the latter genus.

Parysatis nigritarsis, Thoms.

Physis., ii., p. 120.

= *Parysatis flavescens*, Bates, Biologia C. A., Col., v., p. 112.

The Central American examples from which Bates described *P. flavescens* are specifically identical with specimens from Brazil and Bolivia in the British Museum collection. The latter answer very well to Thomson's description, and moreover carry the manuscript name *Hebestola nigritarsis* of Chevrolat, which has been quoted by Thomson.

Ptericoptus fuscus, Bates.

Biologia C. A., Col., vol. v., p. 345.

Hab. Mexico, Xucumanatlan, 7000 ft., and Amula, 6000 ft., in Guerrero (*H. H. Smith*); Cuernavaca in Morelos (*Höge*).

This species was described from a single Mexican specimen, the precise locality of which was not known.

Ecyrus arcuatus, sp. n. (Pl. XII., fig. 2).

♀. Brunneo cinereoque pubescens; capitis fronte et vertice ochraceo-albis; hoc postice leviter bituberculato; elytris fascia submediana transversim fortiterque arcuata, sordide-alba, et antice linea brevi nigra transversim arcuata; utrisque lineis quatuor breviter penicillatis. Long. 8—11 mm.

Hab. Mexico, Temax in North Yucatan (*Gaumer*).

This species resembles *E. dasycerus*, Say, but is somewhat larger, and may be distinguished by the distinct backwardly-bowed band of dirty white pubescence which crosses the elytra just in front of the middle. In front of this band the elytra have a brownish pubescence like that of the prothorax; behind it they are more or less cinereous. Midway between the band and the base there is a short transversely arcuate black line. The elytra are somewhat coarsely punctured, and each has (including the sutural rows) four series of short backwardly-directed pencils of fulvous brown hairs. The antennæ of the female are a little longer than the body, and have a thin fringe of greyish hairs underneath; on the inner ventral surface of the antennæ near the apex of the fourth and along almost the whole length of each of the succeeding joints there are narrow, slightly depressed, longitudinal areas, over which the ordinary coarse pubescence is replaced by exceedingly minute hairs. This character of the antennæ, which is met with also in the other two species* of the genus, and is apparently common to both sexes, recalls a somewhat similar character which is to be found in the *Ceroplesides*.

* *Ecyrus exiguus*, Lec., is (as was pointed out to me some time ago by Dr. Horn) the male of *Ecyrus dasycerus*, Say. Though the former is stated by Thomson to be the type of his genus *Œbaceres*, the characters given for this genus by no means apply to it. Leconte's *Ecyrus exiguus* and Thomson's *Œbaceres exiguus* are evidently two very distinct species, and neither seems to me to be identical with the species which I find in the Dejeanian collection under the name of *Exocentrus exiguus*, Dej.

Spalacopsis similis, sp. n.

Fusco-ferruginea, pube fulvo-grisea haud dense pubescens; prothorace dense punctato, quam basi elytrorum haud angustiori, supra lineis tribus pallidioribus; elytris dense sublineatimque punctatis, utrisque lateraliter unicostatis. Long. 12 mm.

Hab. Mexico, Acapulco in Guerrero (*Höge*).

Dark reddish brown, with a greyish or fulvous grey pubescence, which is somewhat uniformly spread and scarcely thick enough to conceal the punctuation of the head and thorax, while it leaves the stronger punctures of the elytra clearly visible. The elytra at the base are not broader than the base of the prothorax; they are slightly constricted a short distance behind the base, and attain their greatest width a little distance beyond the middle; their apices are cut away very obliquely from the suture, so that they appear somewhat divergent. Each elytron has a single longitudinal costa, disappearing in front, which is placed along the angle between the dorsal and lateral face. The row of punctures contiguous to this costa on the dorsal side is more conspicuous than the rest.

From *S. variegata*, Bates, which it somewhat resembles in shape, this species may be distinguished by its much more uniform coloration, and by the absence of the second (dorsal) costa from the elytra.

Spalacopsis fusca, sp. n.

Precedenti similis sed minor, nigro-fusca, griseo tenuissime pubescens. Long. 7½—9 mm.

Hab. Mexico, Acapulco in Guerrero (*Höge*).

Blackish brown, with a faint greyish pubescence. Head and prothorax rather thickly punctured. Elytra distinctly punctured, and having the punctures arranged in rather closely approximated rows, with an impunctate and scarcely raised interval along the dorso-lateral edge; this subcostiform interval disappears anteriorly and posteriorly. The dark colour of the elytra is lightened by a faint reddish tint.

This species differs from the preceding by its smaller size, scantier pubescence, and darker coloration. The prothorax is without lines of paler pubescence. The impunctate interval between the dorsal and lateral face of each elytron is not distinctly raised nor costiform, as in *S. similis*.

Tessarecphora arachnoides, Thoms.

To the localities previously known for this species may be added Acapulco in Guerrero, from which Herr Höge has sent one example. This appears to be the most northern limit yet recorded.

Homœophlœus, gen. nov.

Female. Form broad and robust. Head flattened in front, widened out at the base, with the cheeks rather long and prominent. Eyes emarginate, with the lower lobes somewhat transverse. Antennæ about one-third longer than the body, ten-jointed, with the tenth joint very short, the first joint stout and clavate, the third longer than the first, and slightly thickened towards the apex. Prothorax transverse, with two tubercles on the disk, and furnished on each side with a median conical tubercle, and, lower down, a smaller anterior tubercle. Elytra much broader across their base than the base of the prothorax; their length to their united breadth in the ratio of about 3 to 2; sides subparallel; apices broadly and conjointly rounded. Femora strongly clavate; tibiæ regular, those of the middle pair grooved obliquely on their outer face. Claws of tarsi divaricate. Intercoxal processes of the pro- and mesosterna very broad and flat. Cotyloid cavities open on the outside.

This genus appears to be allied to *Onychocerus*, Serv., the species of which it closely resembles by its rather short robust form, the inequalities of its elytral surface, and its general bark-like style of coloration; it has, however, much broader sternal processes than *Onychocerus*, and is further to be distinguished by the less number of joints to, and the absence of a claw-like terminal joint from, the female antennæ.

Homœophlœus licheneus, sp. n. (Pl. XII., fig. 6).

Cinereo-pubescens, atro fuscoque plagiatus; prothoracis disco medio fusco tuberculis duobus nigris nitidis munito; elytris basi sparsim granulatis, utrisque tuberculo magno basali et costis tribus obtusis, munitis. Long. 21, lat. 10 mm.

Hab. Mexico, Amula in Guerrero, 6000 ft. (*H. H. Smith*).

Pubescence ashy grey in colour, with blackish and brownish patches. Head sparsely punctured, ashy grey on the sides and lower part of the front, brown above. Prothorax sparsely punctured, the punctures almost wholly confined to the sides and margins of the pronotum. Elytra with small shining black granules sparsely spread on the basal fifth or sixth, and extending on to the summits of the two large tubercles or humps, which are placed—one on either side—a little behind the base; behind these tubercles there is on each elytron a large oblique depression, succeeded by three broad irregular longitudinal grooves or depressions, which form the intervals between the costæ. The elytra appear to be without punctuation beyond a few scattered punctures near the middle of their length. The dark patches are almost absent from the basal fourth of the disk of the elytra, but there is a large almost black patch extending from the base backwards on each side below the shoulder.

Oreodera affinis, sp. n. (Pl. XII., fig. 14).

Capite, prothorace, elytrisque basi et corpore subtus fulvo-brunneis; elytris pone basin albo-griseis utrisque plagis tribus viridi-fulvis; prothorace supra tuberculis duobus distinctis; elytris utrisque pone basin fasciculato-cristatis; apicibus obliquiter truncatis fere rotundatis. Long. 12·5 mm.

Hab. Guatemala, Coban in Vera Paz (*Conradt*).

Head, thorax, base of elytra, and under side of body clothed with a fulvous brown pubescence. The rest of the elytra with a close greyish white pubescence, interrupted on each by three greenish or fulvous green transverse plagæ or fasciæ, the first of which immediately succeeds the basal fulvous brown band, and reaches the suture on the inner side; the second, placed just behind the middle, is more distinct, but does not reach the suture; the third forms a spot at the apex. The colour of these bands and spots seems to be due to a fulvous brown pubescence laid on a dark olive-green derm; while the part of the derm covered by the whitish pubescence is apparently of a testaceous colour. Near the base of each elytron there is a short crest surmounted by a tuft composed chiefly of fulvous hairs with a few darker hairs behind.

This species seems closely allied to *O. costaricensis*, Thoms., from which it is to be distinguished by the colours of the elytra, and by the more distinct basal crest and tuft on each elytron. The punctuation also is scarcely evident, except along the lateral margins of the elytra.

Acanthoderes piperatus, sp. n. (Pl. XII., fig. 4).

Griseo-fulvescens, punctis numerosis fuscis maculatus; prothorace lateraliter subacute tuberculato, supra bituberculato dense punctato, medio haud carinato; scutello fusco, marginibus fulvescentibus; elytris supra convexis, haud costatis, griseo fulvescenteque pubescentibus, dense sat fortiterque punctatis, punctis fuscolimbatis; utroque elytro macula parva pone medium fusca; corpore subtus pedibusque fuscis griseo subtiliter pubescentibus; antennis (♂) quam corpore paullo longioribus, fuscis, articulis basi griseis. Long. 12 mm.

Hab. Mexico, Ventanas in Durango (*Höge*).

Head sparsely punctured in front; vextex with two closely approximated dark brown spots. Prothorax without a median dorsal carina; thickly and rather strongly punctured above, and with two tubercles on the disk. Elytra convex, without costa or basal umbone, deeply and rather thickly punctured anteriorly, with the punctures posteriorly as thickly distributed, but somewhat shallower, and each surmounted by a fuscous border; in addition to the numerous dark brown points thus spread over the whole elytra, there is a small irregularly rounded spot on each just behind the middle, while the conjunction of some of the points forms a similar but less distinct spot on each near the apex. Apices of elytra slightly obliquely truncate, the angles not produced. Prosternal process gradually declivous posteriorly; the mesosternal somewhat more abruptly declivous in front.

In addition to this species there is only one other of the genus, so far as I know, in which the elytra are without either a costa or basal umbone. This species (*A. morrisii*, Uhler), which I have not seen, has a distinct zigzag or M-shaped band behind the middle of each elytron, and so appears to differ sufficiently from the present species.

Acanthoderes signatus, sp. n. (Pl. XII., fig. 3, ♀).

♀. Supra albo-cinereus, nigro ornatus; prothoracis disco vittis tribus nigris, medio carinato et utrinque tuberculato; scutello nigro, medio griseo; elytris basi sparsim granulatis, utrisque maculis vel plagis septem et punctis minimis nigris, apicibus truncatis; antennis medium elytrorum paullo excedentibus, articulis 3o—5um apice subtus dense fimbriatis. Long. 13 mm.

Hab. Mexico, Xucumanatlan in Guerrero, 7000 ft. (*H. H. Smith*).

Greyish white, with black markings. Prothorax with a median narrow black vitta, which ends in a small triangular dilatation in front and behind, and with a shorter black vitta passing from the summit of each of the two conical tubercles of the disk to the base of the prothorax. Elytra each with an obtuse costa, which anteriorly is somewhat more prominent, and furnished above with minute granules; some similar granules are placed over the shoulders. The black spots or markings are seven in number on each elytron; four (1st, 3rd, 5th, and 7th) being placed along the side, and three on the disk; the second is shaped somewhat like the Greek letter γ, the sixth like a v. Some small black points form a row on each side of the apical half of the suture. Apices of the elytra truncate. Legs and under side of body with a greyish white pubescence; tibiæ ringed with fuscous; tarsi above, first joint excepted, dark brown. Antennæ in the female extending a little beyond the middle of the elytra, grey, with the last two joints and the apices of the preceding joints brownish black; apices of the third, fourth, and fifth joints with a short thick fringe of black hairs underneath.

A small specimen from Chiapas (length, 8 mm.), in the British Museum collection, appears to be the male of this, or of a very closely allied species. In this specimen the last three joints of the antennæ, as well as the apices of the preceding joints, are rather thickly ciliate underneath; the dorsal costæ of the elytra can be distinguished only near the base, and the basal granules are wanting; the fourth and fifth black spots of each elytron are united to form a very irregular transverse fascia extending from the outer margin almost up to the suture; the sides of the prothorax below the lateral tubercles are entirely fuscous; the under side of the body and the femora underneath are so scantily furnished with greyish hairs that they appear almost entirely black.

Acanthoderes sp.

One imperfect example of this species was taken at Mexico city (*Höge*). It appears to be closely allied to, and may perhaps be only a variety of, *A. nigritarsis*.

Acanthoderes nigritarsis, White.

Cat. Longic. Col. Brit. Mus., ii., p. 363.

= *A. sylvanus*, Bates, Biol. Cent. Amer., Col., v., p. 141.

Leptostylus arciferus, sp. n. (Pl. XII., fig. 8).

Fulvo-brunneo-pubescens, elytris inter medium apicemque fascia angusta nigra valde sinuata, et paullo ante hanc fascia minus distincta Λ-formante; prothorace lateraliter obtuse tuberculato, disco inæquali antice binodoso; elytris utrisque lineis tribus leviter elevatis, fasciculis minutis pilorum nigrorum munitis; apicibus obliquiter truncatis, subrotundatis; antennis griseo-testaceis, articulis apice angustim fuscis. Long. 9—10 mm.

Hab. Mexico, Cuernavaca in Morelos (*Höge*); Chilpancingo in Guerrero (*H. H. Smith*).

With a fulvous brown pubescence, mixed with grey on the front of the head and towards the middle of the elytra. The elytra with two narrow black bands placed between the middle and the apex, the anterior less distinct and somewhat chevron-shaped, the posterior strongly bowed forwards in the middle, and at the sides curved round so that its outer extremities take a slightly forward direction. For a short distance in front of the anterior band the elytral pubescence has a paler greyish tint. Each elytron has two or three slightly raised lines, along which at intervals are placed minute tufts of short black hairs, with one somewhat larger than the rest near the anterior extremity of the innermost line. Body underneath and legs with a greyish pubescence. Antennæ (♂) half as long again as the body, testaceous, with a grey pubescence, which is somewhat unequally distributed over the basal joints, these having in consequence a rather mottled appearance; apices of all the joints fuscous.

Leiopus Batesi, sp. n. (Pl. XII., fig. 9).

Leiopus sp., Bates, Biol. Cent. Amer., Col., vol. v., p. 393.

Brunneo-testaceus, cinereo-pubescens; elytris maculis punctisque fuscis adspersis; prothorace lateraliter paullo ante basin acute tuberculato; antennis quam corpore plus duplo longioribus, griseo-testaceis, articulis apice late infuscatis. Long. $4\frac{1}{2}$—6 mm.

Hab. Mexico, Iguala in Guerrero (*Höge*); Ventanas (*Forrer*).

Brownish testaceous; clothed with a rather dense pubescence, varying in colour from ashy white to brownish grey. Elytra with a number of small points and a few spots of a dark brown colour. Of the larger spots, one is placed dorsally on each elytron near the base, another a little further back at the side, and a third, slightly transverse and oblique, is placed behind the middle. The sides of the prothorax are almost straight and gradually divergent from the front margin up to the summit of the lateral tubercles, behind which they are abruptly constricted. The apices of the elytra are somewhat obliquely truncate.

Anisopodus brevis, sp. n. (Pl. XII., fig. 12).

Depressa; prothorace supra griseo, maculis duabus fuscis; elytris cinereo-fulvis, vitta laterali, fascia angusta transversa sub-basali, et plaga pone medium conjunctis nigro-fuscis; apicibus obliquiter truncatis, angulis obtusis. Long. 5—7 mm.

Hab. MEXICO, Amula in Guerrero, 6000 ft. (*H. H. Smith*).

Head and prothorax with a greyish pubescence. Pronotum with two fuscous spots, which are sometimes almost obsolete. Elytra fulvous grey above; with a broad dark brown vitta on each side, which does not extend to the apex, and which is dilated above near its hinder extremity to form a plaga on the outer part of the flattened disk of the elytron; a similarly coloured narrow band crosses the elytra close up to the basal margin. The apices are cut obliquely backwards from the suture, with all the angles obtuse.

Sympleurotis armatus, sp. n. (Pl. XII., fig. 10, ♂).

S. rudi affinis et similis sed differt prothorace lateraliter pone medium tuberculo parvo conico armato; segmento ultimo abdominis (♂) lamina dorsali profundius emarginata.

Hab. MEXICO, Omilteme in Guerrero (*H. H. Smith*): GUATEMALA, San Gerónimo (*Champion*).

Head with a somewhat greyish or fulvous grey pubescence in front, passing into brownish above. Disk of prothorax with a median area covered with close brownish pubescence, at the outer limit of which, towards each side, are two small velvety black spots placed one in front of the other, and each marking the position of a small very feebly raised tuber; the sides of the prothorax have an ashy white pubescence, interrupted by a number of black points, and each is furnished, a little behind the middle, with a small conical tubercle (rather larger and more easily seen in the female example). Scutellum dark velvety brown, with a light brown or greyish centre. Elytra closely punctured, carinate on each side from the shoulder up to the middle. Anterior half of the disk of elytra brownish, with fuscous and ashy points; this is succeeded at the middle by an ill-defined greyish band; the sides and posterior part of the elytra are of a dark olivaceous colour, varied with greyish and fuscous; near the apex is a fuscous olivaceous spot with a margin of pale fulvous. Body underneath with a greyish pubescence. Dorsal plate of the last abdominal segment of the male narrowly but very deeply emarginate, ventral plate feebly emarginate. Last abdominal segment of the female produced as in *Astynomus*, the dorsal valve attenuated and sharpened at the extremity, the ventral valve narrowly emarginate.

Phæa phthisica, Bates.

Biologia C. A., Col., vol. v., p. 197.

To the localities previously recorded may be added Mexico, Tapachula in Chiapas, and Jalapa in Vera Cruz (*Höge*).

A number of examples of the variety described by Bates (*l. c.*, p. 425) have also been taken by Mr. H. H. Smith at Teapa in Tabasco. In this variety there is a fulvous vitta on each side of the disk of the prothorax, and the anterior margin of the disk is also fulvous. In the normal form the anterior margin only is fulvous, though sometimes there are traces of the lateral vittæ.

Phæa unicolor, sp. n.

P. tenuatæ affinis sed major et omnino nigra. Long. 8·5 mm.

Hab. Mexico, Omilteme in Guerrero, alt. 8000 ft. (*H. H. Smith*). One example.

Entirely black and nitid; slightly obscured only by some faint greyish setæ. Strongly and closely punctured. Prothorax cylindrical, slightly constricted at the base, where there is a tolerably distinct transverse groove; with a much feebler transverse groove close to the anterior margin; the disk without any trace of an umbone.

This species has a similar elongate and slender form to *P. tenuata*, Bates, and agrees very closely with this species in most other respects. It is, however, somewhat greater in size, and is entirely black.

Tetraopes femoratus, Lec.

Journ. Acad. Philadelphia, ser. 2, vol. i. (1847), p. 93; vol. ii., p. 157; Horn, Trans. Amer. Ent. Soc., vol. vii. (1878), pp. 48 and 49.

To the previously known localities may be added Mexico, Durango city, Aguas calientes city, Monterey in Nuevo Leon, and Tula in Hidalgo (*Höge*).

Bates had already, with some doubt, but, as it proves, correctly, referred a single example from Northern Sonora to this species. The considerable series of examples since sent by Herr Höge are mostly from Durango city; a few only from the other localities cited. These specimens all agree in having the first antennal joint and the femora red; the two front pairs of tibiæ are usually dark red, but are in some cases almost entirely blackish; the hind tibiæ are generally more or less black. The full number of elytral spots are usually present, and of a fair size; but one or both of the two antemedian spots of each elytron may be absent or much reduced in size. The prothoracic umbone is somewhat oblong in shape, its sides, which are sharply limited, being only slightly convex in outline; it is traversed along the middle by a feeble groove or depression, so that its surface is usually slightly concave from side to side. Many of the Mexican specimens agree very closely in every respect with a Californian example in the British Museum collection. In order to feel quite sure of the identity of the species, I have submitted a couple of specimens to Dr. Horn for his inspection, and he has kindly replied that they are without doubt to be referred to the *Tetraopes femoratus* of Leconte. The Mexican specimens come nearest, I think, to the varieties *basalis* and *oregonensis* of Leconte, as distinguished by Dr. Horn (*op. supra cit.*); and I have reason to believe that one or more of the other Mexican species will, on comparison with authentic North American specimens, prove to belong to other varieties of *femoratus*.

Mecas marmorata, sp. n. (Pl. XII., fig. 7).

Elongata, pube grisea fulvo-varia obtecta; capite prothoraceque et elytris punctatis, his supra planis, medio leviter depressis; antennis (♂) quam corpore paullo longioribus, articulis 1o, 2o, 11oque nigro-fuscis, articulis 3o ad 7um subtus cinereis, supra testaceis vel fuscis, articulis 8o ad 10um omnino cinereis. Long. 10—13 mm.

Hab. Mexico, Amula (6000 ft.) and Xucumanatlan (7000 ft.) in Guerrero (*H. H. Smith*).

Elongate, narrow. Prothorax with the sides parallel. Elytra flattened above and slightly depressed towards the middle. The entire body clothed with a mixed pubescence of grey and pale fulvous, the latter being condensed in places to form numerous small patches. Antennæ a little longer than the body in the male, with the first, second, and last joints blackish brown, with the under sides and bases of the joints from the third to the seventh, and the whole of joints eighth to tenth, pale cinereous; the upper side of the joints third to seventh, especially towards their apices, fuscous testaceous; the last joint is slightly thicker and scarcely longer than the preceding joint.

Cirrhicera conspicua, sp. n. (Pl. XII., fig. 13, ♀.).

Nigra, fasciis flavo-ochraceis ornata; antennis nigris, articulis 5o, 6oque subtus dense, articulis 1o ad 4um minus dense ciliatis. Long. 15—16 mm.

Hab. Mexico, R. Papagaio in Guerrero, 1200 ft. (*H. H. Smith*).

Head (excepting a narrow median portion of vertex), sides of prothorax, a broad triangular plaga at the base of the elytra, a spot under each shoulder, and a broad transverse fascia behind the middle, clothed with a thick bright ochreous yellow pubescence. Sides of the meso- and meta-sterna, and of the first two abdominal segments, similarly clothed in the male. Legs in the male testaceous yellow.

The female differs from the male by its slightly shorter antennæ, its rounded (instead of slightly sinuate) apical margin to the abdomen, and by having the first three abdominal segments clothed with yellow pubescence; while the last two have each a spot of the same colour on each side; the femora also in the single female before me are almost black, and the first three joints of the tarsi dark brown.

Cirrhicera basalis, sp. n. (Pl. XII., fig. 5, ♂).

Fusco-testacea, griseo subtiliter pubescens, niveo ornata; prothorace utrinque vitta lata nivea; elytris macula parva nivea utrinque ad basin extremam, et maculis duabus sutura conjunctis paullo pone medium; lateribus meso-, metathoracisque et maculis duabus abdominis utrinque niveis. Long. 7—10½ mm.

Hab. Mexico, Venta de Peregrino and R. Papagaio, both in Guerrero (*H. H. Smith*); Acapulco (*Smith and Höge*).

This species somewhat closely resembles *C. niveo-signata*, Thoms., but may be at once distinguished by the position of the basal white spots of the elytra. These are placed at the extreme base in the former, while in the latter they are a short distance from the basal margin.

In addition to the usual difference in the length of the antennæ, and the shape of the abdomen, the males of the present species differ from the females by the thicker pubescence on the front of the head, which may be greyish or even whitish in colour, and by having the lateral spot on the first abdominal segment equal to or larger than the spot on the second segment. In the female the first spot is much smaller than the second. In the females also the femora are more or less black, while in the males they are pale testaceous.

Malacoscylus humilis, Bates.

Biologia C. A., Col., vol. v., p. 223.

One male specimen only was known to Mr. Bates when he wrote his description. Mr. H. H. Smith has since sent a long series, including both male and female examples, from the following localities in Guerrero:—Omilteme (8000 ft.), Xucumanatlan (7000 ft.), and Chilpancingo (4600 ft.).

The female differs from the male by its somewhat shorter and relatively broader form; by its shorter, thicker, and more densely fringed third antennal joint; the front of the head also is black and glossy, excepting a slight patch of greyish or fulvous pubescence on each side beneath the antennal tubercle; the lateral fulvous vittæ of the prothorax only exceptionally extend on to the humeral depression at the base of the elytra in the female, while they very generally do so in the male; the tarsi of the females are entirely black, while in the males the first three joints of the anterior tarsi are more or less yellowish. In some examples of both sexes the fulvous vittæ of the prothorax have extended dorsally so as to cover part of the anterior half of the disk; while in one small male almost the whole upper surface of the head and prothorax is covered with fulvous pubescence. These examples differ in no other respect from the typical form, with which they are, in fact, connected by almost insensible gradations. It is otherwise with the two following varieties, which might indeed, with some show of reason, be regarded as distinct species.

Malacoscylus humilis var. *grisescens.*

M. humili typico differt prothoracis disco elytrisque pube grisea vel fulvo-grisea obtectis, corpore subtus versus latera (♂) cinereo pubescente.

Hab. Mexico, Omilteme (8000 ft.), Chilpancingo (4600 ft.), and Xucumanatlan (7000 ft.), in Guerrero (*H. H. Smith*).

The specimens which I have placed together under the above name agree very closely in general form and structure with the more typical forms of *M. humilis.* Their coloration is, however, so distinct that I have thought it well to give this variety a separate name. The whole of the upper side, with the exception of the usual fulvous vittæ on the prothorax, is covered by a more or less dense dark grey or fulvous grey pubescence; the under side of the female has a somewhat similar pubescence, but in the male the pubescence of the under side varies from pale greyish to ashy white, with always a distinct patch of the latter colour, sometimes mixed with fulvous, along the sides of the meso- and metathorax.

Malacoscylus humilis, Bates, var. *fulvescens.*
(Pl. XII., fig. 16, ♀).

M. *humili typico* differt elytris testaceis, pube fulvescente fere omnino denseque obtectis.

Hab. Mexico, Omilteme and Chilpancingo in Guerrero (*H. H. Smith*).

Three examples only of this very distinct variety were taken. The elytral derm, which is almost entirely testaceous in colour, is so closely covered by a pale tawny pubescence that the punctuation is very inconspicuous, and in places quite invisible. In the ordinary form, and in the preceding variety, the rather close and moderately strong punctuation is clearly enough discernible, though it should be mentioned that in one female example of the var. *grisescens* the punctuation is almost as much concealed as in the present variety.

This variety has a strong resemblance in colour and facies to *Hemilophus prolixus*, Bates, from which it may, however, be easily distinguished by the structure of the antennæ.

Malacoscylus bivittatus, sp. n. (Pl. XII., fig. 15, ♂).

Niger, griseo vel fulvo-griseo sat dense pubescens; capite supra vittis duabus albidis, antice convergentibus et inter antennas conjunctis; prothorace elytrisque utrinque albido-vittatis; elytris ad apices angustim rotundatis; carinis lateralibus paullo pone apicem evanescentibus. Long. 11—14 mm.

(♂). Antennis quam corpore vix brevioribus; articulo 3o quam 1o vel 4o sesqui longiori; articulis 3o, 4oque basi testaceis.

(♀). Antennis dimidium corporis vix excedentibus; articulo 3o incrassato dense sed breviterque nigro-fimbriato, quam articulo 1o vel 4o paullo longiori; articulis 4o ad 6um plus minusve testaceis.

Hab. Mexico, Omilteme (8000 ft.) and Chilpancingo (4600 ft.) in Guerrero (*H. H. Smith*).

The diverging dingy white vittæ of the vertex of the head are continuous behind with the two vittæ, one on each side, of the prothorax; these again join at the base the two vittæ which run along the elytra, one on each side immediately above the lateral carina. The prothorax and elytra are rather strongly and thickly punctured, the prothorax somewhat less thickly than the elytra. At the apex each elytron is narrowed to an obtuse point, and in this region the punctures are almost obsolete.

This species differs from the other members of the genus in the rather narrow apices of its elytra; and, in common with the preceding species, it differs in one or two other important respects from the more typical representatives of the genus. The third joint of the antennæ is relatively much shorter in both sexes, and in the female it is very distinctly thickened. The head also does not exhibit the broad depression above between the antennal tubercles, which is to be seen in *M. cirratus*, Germ., and other South American species.

Lycidola levipennis, sp. n. (Pl. XII., fig. 1).

Nigra, fulvo-fasciata; elytris pone tertiam partem basalem fortiter dilatata, apice late nigro-cyanea, submetallica; antennis (♀) apicem elytrorum haud attingentibus, articulis tertio quartoque crassatis, subæqualibus, dense ciliatis, utrisque quam primo paullo longioribus. Long. 26, lat. ad hum. 9 mm.

Hab. Panama, Chiriqui (*Trötsch*).

Head black, with the front, the cheeks, a short vitta behind each eye, and a median dorsal vitta fulvous. Prothorax black, with a broad fulvous vitta on each side. Elytra with their sides straight and parallel to about the end of the anterior third, and thence strongly diverging to enclose the posterior flattened and laterally rounded expansion, which occupies about the hinder two-thirds of the elytra. The upper surface exhibits scarcely any indication of raised lines, and is crossed by two fulvous bands—one at the base, the other somewhat broader and with a strongly indented posterior margin—placed just behind the middle. Between the latter band and the apex the elytra are dark blue, with a somewhat metallic tint. Body underneath black, with the middle of the metasternum and the hind part of the prosternum yellowish testaceous. Last abdominal ventral segment strongly convex, its hind margin angularly incised in the middle.

In this species the lateral expansion of the elytra commences farther back from the base than in the other members of the genus, and this character, together with the almost complete absence of raised lines from the elytra, will serve for its recognition.

Note.—Dr. Horn has directed my attention to an error in synonymy, which occurs in Bates's last paper (*ante*, p. 161). Bates places *Cyllene robiniæ*, Forst., and *C. pictus*, Drury, as synonyms of the same species, having evidently overlooked Horn's paper (Trans. Amer. Soc., viii., 1880, p. 136), in which the two forms are shown to be quite distinct. The species which Bates had in view, and which is to be recorded as occurring in Mexico is *Cyllene pictus*.

Explanation of Plate XII.

Fig. 1. *Lycidola levipennis.*
2. *Ecyrus arcuatus.*
3. *Acanthoderes signatus*, ♀.
4. " *piperatus.*
5. *Cirrhicera basalis*, ♂.
6. *Homœophlœus licheneus.*
7. *Mecas marmorata.*
8. *Leptostylus arciferus.*
9. *Leiopus Batesi.*
10. *Sympleurotis armatus.* ♂.
11. *Deliathis diluta.*
12. *Anisopodus brevis.*
13. *Cirrhicera conspicua*, ♀.
14. *Oreodera affinis.*
15. *Malacoscylus bivittatus*, ♂.
16. " *humilis*, var. *fulvescens*, ♀.

XVII. *Contribution to a knowledge of the Homopterous family* Fulgoridæ. By W. L. Distant, F.E.S.

[Read November 2nd, 1892.]

Plate XIII.

The species and a new genus described in this paper are all from the Oriental and Australian regions, and embrace the discoveries made in the family *Fulgoridæ* by Mr. Hampson on the Neelgiri Hills, Mr. Lewis in Ceylon, Dr. Townsend in Perak, Mr. Whitehead on the Kina Balu Mountain in Borneo, Mr. Doherty on the Naga Hills and the Island of Sangir, and by other travellers and collectors, of whose names I am unfortunately ignorant. Dr. Stâl generically studied this family with excellent result, and his genera have now been followed by the late Mr. Atkinson, who did so much for the Indian fauna, and all other competent students of the Homoptera. That arrangement is of course followed here.

Fam. FULGORIDÆ.

Subfam. FULGORINÆ.

Cynthila viridimaculata, n. sp.

Head ochraceous, cephalic process above with a central longitudinal blackish sulcation, an indistinct line on each lateral margin, and with two or three indistinct dark spots beneath; two central black lines preceded by a basal black spot between the eyes, which are fuscous. Pronotum ochraceous, with two central black lines near anterior margin interruptedly continued in triangular manner to base, and with scattered blackish spots. Mesonotum reddish ochraceous, spotted and marked with black. Margins of metanotum black. Abdomen blackish, with the posterior segmental margins green. Body beneath and legs ochraceous; central area of the face, base of rostrum, lateral margins of sternum, sternal spots, spots and annulations to femora and to anterior and intermediate tibiæ, the tarsi, and apex of rostrum, fuscous or castaneous. Tegmina with rather more than anterior half brownish ochraceous, irregularly spotted with fuscous, remaining area hyaline, with the venation ochraceous and irregularly spotted with fuscous. Wings pale hyaline, the venation fuscous, their bases somewhat shining pale green. The cephalic process is almost equal in length to the distance from its base to the apex of the mesonotum, and its apex is distinctly incrassated, but laterally compressed.

Long. excl. tegm. from eyes to apex of abdomen, 14 millim. Long. ceph. proc., 5 millim. Exp. tegm., 40 millim.

Hab. Malay Peninsula; Perak.

Allied to *C. ferocula*, Stål, but separated, apart from other structural characters, by the basal green coloration of the wings.

Scamandra diana, n. sp. (Pl. XIII., fig. 4).

Body above brownish ochraceous, the mesonotum darker in hue; pronotum with two faint dark discal spots on each side; anterior segmental margins of the abdomen pale castaneous. Body beneath ochraceous or pale castaneous; a broad central fascia to face, margins of sternum and the femora blackish, the tibiæ olivaceous, bases of the posterior femora castaneous. Tegmina with about basal two-thirds olivaceous green, containing a reddish ochraceous spot at costal base, and a large basal claval streak, followed by two small spots, a discal spot, and a transverse fascia, all pale ochraceous; the green area terminates by a much waved and sinuate narrow black fascia; apical third pale brownish ochraceous, the venation very finely reticulate and paler in hue. On the under side of the tegmina the discal spot and transverse fascia are bright creamy white. Wings with about half or basal area olivaceous green, shaded with blackish, the extreme base narrowly testaceous, and the inner, outer, and apical (the last very broad) margins pale brownish ochraceous, reticulated as on apex of tegmina. The tubercle at the base of the posterior tibiæ is in the form of a more or less acute spine; the mesonotum is distinctly rugulose.

This species is allied in general coloration to *S. daphne*, Stal, but the apex of the tegmina is considerably narrower, the sculpture of the frontal part of the head quite different, and the pronotum has a distinct central carina on its posterior half. In general structure and size it is more closely allied to *S. arcuigera*, Stal.

Long. excl. tegm., 21 millim. Exp. tegm., 60 millim.

Hab. Malayan Archipelago; Sangir (*Doherty*).

Birdantis pallescens, n. sp.

Head and thorax brownish ochraceous; eyes fuscous. Pronotum with two small central blackish discal spots. Mesonotum with four fuscous spots, the central pair largest. Abdomen black, apical half with a double series of pale discal spots, and a series of similar spots on the lateral margins. Head beneath, sternum, and legs ochraceous; femora and anterior and intermediate tibiæ annulated with fuscous. Abdomen beneath black. Tegmina with about basal two-thirds ochraceous, irregularly mottled with darker brown; apical third fuscous, with the reticulated venation ochraceous. Wings pale hyaline, the venation fuscous, the basal third blackish, containing a pale greenish white fasciate spot. Disk of front distinctly subrugose; anterior margin of pronotum with a distinct central notch.

Long. excl. tegm., 17 millim. Exp. tegm., 42 millim.

Hab. MALAYAN ARCHIPELAGO; Batchian.

B. pallescens can at once be distinguished from the other two species described by Stål by the differently coloured base of the wings.

Desudaba maculata, n. sp.

Body above, with the head, thorax, and base of abdomen, black; remainder of abdomen and the eyes ochraceous. Body beneath ochraceous; the head, prosternum, and legs, black; nostrum fuscous, its base black. Tegmina black, the apical third fuscous, the black portion ornamented with seven to nine bright red spots, the extreme base also streaked with the same colour. Wings hyaline, with the venation fuscous, the basal third dark fuscous, containing a large basal reddish patch streaked with greyish.

Long. excl. tegm., 13 millim. Exp. tegm., 34 millim.

Hab. AUSTRALIA; Peak Downs.

Allied to *D. psittacus*, Walk., but at once separated by the spotted tegmina and the larger fuscous basal area to the wing.

Subfam. DICTYOPHARINÆ.

Dichoptera nubila, n. sp.

Body above dark ochraceous. Head, with the anterior and lateral margins of vertex, a small spot at anterior angles, and two central fasciæ to same, black; a central fascia to front, a small spot at each anterior angle, and a lateral fascia in front of eyes, black. Pronotum, with the central keel, margined with two pairs of elongate spots, the anterior margin and irregular discal markings, black. Mesonotum, with the space between the three central carinæ darker in hue, and containing four ochraceous spots margined with black, a large black spot on anterior margin, and a strongly sinuated black fascia on each lateral area. Abdomen with four macular black fasciæ, two central and one on each lateral margin. Body beneath ochraceous, spotted with black; tibiæ annulated with black at base, centre and apex, the annulations on posterior tibiæ faint above; femora spotted with black. Tegmina hyaline, the venation and costal membrane ochraceous, spotted with fuscous; a waved and somewhat broken dark fuscous transverse fascia at base of apical area; beyond this the costal area is dark fuscous, with an intermediate ochraceous spot; the whole apical area irregularly shaded with fuscous. Wings hyaline; the venation, anal margin, and the apex, fuscous. The anterior prolongation of the head is somewhat foliaceous, the length of the head being a little less than that of the pronotum.

Long. excl. tegm., 17 millim. Long. head, 2 millim. Exp. tegm., 48 millim.

Hab. Continental India; Upper Assam. Burma; Ruby Mines.

Allied to *D. hyalinata*, Spin., but differing by the more foliaceous head, different colour, markings, &c.

Dichoptera hampsoni, n. sp.

Allied to the preceding species, but with the head much longer and less foliaceous, and without the anterior spots to vertex, which has its anterior prolongation ovate, and not subquadrate as in *D. nubila;* the pronotum has a black fascia on each side of the central keel. The tegmina are a little longer and more slender, with the fuscous markings somewhat paler. The wings have the apex a little darker fuscous. The length of the head is equal to that of the pronotum.

Long. excl. tegm., 20 millim. Long. head, 2¾ millim. Exp. tegm., 53 millim.

Hab. Continental India; Neelgiri Hills, Southern Slopes, 3000 feet (*Hampson*).

This species is also allied to *D. picticeps*, Stål, from the Philippine Islands, but differs by the annulated tibiæ, the shorter head, &c.

Mr. Hampson captured the species at sugar.

Dichoptera nasuta, n. sp.

Body above ochraceous; head very long, cephalic process with a central triangular fascia, the apex and the lateral margins dark fuscous. Pronotum suffused with fuscous, the central keel and the lateral areas ochraceous. Mesonotum suffused with fuscous, and with some basal spots and the apex ochraceous; abdomen above with four macular fuscous fasciæ. Body beneath ochraceous, spotted with fuscous; tibiæ annulated with fuscous (intermediate and posterior tibiæ obscurely annulated); femora spotted with fuscous. Tegmina and wings as in the preceding species, but the fuscous markings rather larger. The head is about equal in length to the whole thorax above; the cephalic process is ascending, irregularly triangularly channelled for more than two-thirds its length, and its apex slightly gibbous above, with the lateral margins spatulate.

Long. excl. tegm., 22 millim. Long. head, 6 millim. Exp. tegm., 50 millim.

Hab. Malayan Archipelago; Celebes.

The great prolongation of the head distinguishes this species from any other previously described.

Dictyophora præferrata, n. sp.

Head and thorax above ochraceous; cephalic process, with the lateral margins and sometimes the apex, fuscous. Pronotum, with the central keel and margins, somewhat paler in hue, the disk wrinkled. Mesonotum, with three central keels, triangularly united posteriorly, and pale ochraceous. Legs ochraceous, femora striated with fuscous. Tegmina and wings hyaline, the venation fuscous; their apices—broadly in the tegmina and narrowly in the wings—fuscous. The cephalic process is distinctly and broadly grooved above, the apex very slightly widened and subacutely convex; in the neighbourhood of the eyes it has three distinct keels.

Long. excel. tegm., 12 millim. Long. head, 5 millim. Long. tegm. 9 millim.

Hab. Australia; Peak Downs.

Dictyophora bifasciata, n. sp.

Body above ochraceous, with a broad lateral fuscous fascia on each side, from behind eyes to near apex of abdomen; body beneath and legs ochraceous, margins of the sternum fuscous. Tegmina ochraceous, with a broad central longitudinal fuscous fascia, widenod at apex. Wings hyaline, with a large fuscous spot at apex. Structure of cephalic process much as in preceding species.

Long. excl. tegm., 9 millim. Long. head, 3 millim. Long. tegm., 7 millim.

Hab. Australia; Peak Downs.

Dictyophora insignis, n. sp.

Closely allied to the preceding species, but the cephalic process more nodulose at the base, which, together with the lateral areas, are castaneous; tegmina without the longitudinal fasciæ, but with the apical and one-third of the inner margin and the stigma fuscous.

Long. excl. tegm., 7 millim, Long. head, 3 millim. Long. tegm., 6 millim.

Hab. Australia; Peak Downs.

Subfam. EURYBRACHYDINÆ.

Messena radiata, n. sp. (Pl. XIII., fig. 1.)

Head and thorax above ochraceous, with irregular darker markings; face ochraceous, its anterior margin speckled with fuscous. Abdomen sanguineous, its lateral margins and anal appendages orange-yellow. Sternum and legs pale ochraceous, anterior femora and tibiæ speckled with blackish; posterior tibiæ —excluding base,—rostrum—excluding apex,—and posterior coxal spots black. Abdomen beneath orange-yellow, the segmental margins and apex somewhat fuscous. Tegmina with almost basal half ochraceous, shaded with purplish towards its margins, and with a few scattered discal small purplish spots; remaining area pale greyish brown, with a central subapical spot, a spot near apex of inner margin, and some very small scattered spots on apical margin, black. Wings pale greyish, with three subapical marginal black spots.

Long. excl. tegm., 12 millim. Exp. tegm., 36 millim.

Hab. Continental India; Neelgiri Hills (*Hampson*).

Most nearly allied to the *Eurybrachys rubrescens*, Walk., which belongs to this genus.

Kandiana, gen. nov.

Allied to *Messena*, but with the tegmina very long and narrow, much longer than the wings, which are also narrower than the tegmina. Posterior tibiæ—in specimen here described—with five spines on one tibia and six on the other; probably six in normal specimens.

Kandiana lewisi, n. sp. (Pl. XIII., fig. 2.)

Body and legs warm ochraceous; head and thorax mottled with darker hue; eyes pale fuscous. Tegmina obscure ochraceous, with two broken macular pale fuscous fasciæ near apex, and with some apical marginal spots of the same colour. Wings pale obscure ochraceous, the apex greyish, preceded by an elongate fuscous spot, the apical margin narrowly of the same colour.

Long. excl. tegm., 9 millim. Exp. tegm., 32 millim.

Hab. Ceylon (*Lewis*).

Loxocephala castanea, n. sp.

Body and legs ochraceous; anterior margin of front, central portion of anterior margin of pronotum, transverse fasciæ to abdomen above, a longitudinal fascia to the anterior tibiæ, apices of tarsi, and base of apical segment of the abdomen beneath, black. Tegmina bright castaneous, minutely spotted with greyish, the apical area bright ochraceous, containing a central black macular fascia, the apical margin also black. Wings greyish white, the apex bright ochraceous, with its margin black.

Long. excl. tegm., 10 millim. Exp. tegm., 28—30 millim.

Hab. Continental India; Naga Hills (*Doherty*).

Allied to *L. decora*, Walk., from which it differs by the different colour of the tegmina, absence of the basal black fascia to same, and also by the absence of the black subapical spot to the wings, and the black fascia to the mesonotum.

Eurybrachys apicata, n. sp.

Body and legs dull sanguineous; head—excluding eyes—pale ochraceous. Tegmina pale olivaceous green, the extreme base and a broad transverse fascia at apex dull reddish. Wings pale greyish, with nearly the basal half dull reddish.

Long. excl. tegm., 8 millim. Exp. tegm., 18 millim.

Hab. "India," *sic.!*

A species to be readily recognised by its distinctive colour markings.

Platybrachys signata, n. sp.

Head, thorax and legs fuscous, speckled with testaceous; abdomen sanguineous; coxæ, base of anterior and intermediate tibiæ, and the posterior legs, pale sanguineous. Tegmina brownish, speckled and irregularly spotted with fuscous; a series of small greyish spots on costal margin, of which one is very large at about two-thirds from base, a transverse greyish fascia a little before apex, after which the colour is dark fuscous, containing either one or a few very small greyish spots. In some specimens there is a distinct and somewhat large fuscous spot at about centre of clavus. Wings blackish, the basal area ochraceous, and with two large greyish marginal spots, one at apex and the other at about centre of posterior margin.

Var. *a.* Tegmina with a transverse fuscous fascia near base.

Var. *b*. As var. *a*, but the wings are without the apical grey spot.
Long. excl. tegm., 7 millim. Exp. tegm., 20 millim.

Hab. AUSTRALIA; Peak Downs.

Allied to *P. transversa*, Walk., but much larger, and always to be recognised by the different coloration of the wings.

Platybrachys insignis, n. sp.

Head and thorax above brownish, speckled with ochraceous; face ochraceous; abdomen and legs sanguineous; apices of the femora, tibiæ—excluding base—and the tarsi, fuscous; anal appendages to the abdomen ochraceous. Tegmina ochraceous, much spotted with fuscous, especially on the costal and claval margins, and the apical area; the whole disk is thickly, often confluently, spotted with paler fuscous. Wings dark fuscous, the base narrowly sanguineous, and with two prominent greyish white spots on the apical margin.

Long. excl. tegm., 9 millim. Exp. tegm., 22 millim.

Hab. AUSTRALIA; Peak Downs.

This species may be superficially recognised by the two apical greyish white spots to the wings.

Platybrachys ærata, n. sp.

Head and thorax above brownish ochraceous; abdomen ochraceous; face obscure ochraceous or pale olivaceous; legs testaceous; apices of femora, subconfluent spots to tibiæ, and apex of the abdomen, dark fuscous. Tegmina bronzy brown, with an oblique transverse greyish fascia, extending for a little beyond the middle of the costa half across the disk, and subobsoletely continued by greyish spots to inner margin; a distinct greyish spot on costa at apex, and a less distinct spot near apex of inner margin. Wings ochraceous, with a fuscous outer marginal fascia, which is broadest at apex.

Long. excl. tegm., 7 millim. Exp. tegm., 22 millim.

Hab. SAMOA ISLANDS and AUSTRALIA; Peak Downs.

Dardus albomaculatus, n. sp.

Head, thorax, and legs, brownish ochraceous; abdomen pale sanguineous; pronotum, with the posterior margin and a central linear fascia, greyish white; apices of the femora, anterior and intermediate tibiæ and tarsi, and bases and apices of the posterior tibiæ, fuscous. Tegmina brownish ochraceous; a claval streak and spots, a short broad fascia between clavus and costa, a broad transverse macular fascia near apex, and some marginal apical spots, greyish white. Wings pale fuscous.

Long. 6 millim.

Hab. Australia; Peak Downs.

Allied to *D. abbreviatus*, Guer., but distinguished by the differently marked tegmina, &c.

Dardus obscurus, n. sp.

Head above, thorax, and tegmina, dark castaneous; face, abdomen, and legs, pale sanguineous; face with a broad castaneous fascia at base; eyes pale ochraceous.

Long. 5 millim.

Hab. Australia; Peak Downs.

Subfam. RICANIINÆ.

Ricania (Pochazia) flavocostata, n. sp.

Body blackish, legs and eyes pale fuscous, apex of abdomen greyish tomentose. Tegmina pale fuscous, the apical and outer areas dark fuscous; costal margin for about two-thirds from base ochraceous. Wings pale fuscous.

Long. excl. tegm., 10 millim. Exp. tegm., 35 millim.

Hab. Malay Peninsula; Sungei Ujong. Borneo; Kina Balu Mount.

Allied to *R. fumata*, A. & S., but differing by the broad ochraceous costal margin to the tegmina, which are also more distinctly sinuate before apex.

Subfam. FLATINÆ.

Phromnia parmata, n. sp.

Body and legs pale ochraceous; eyes, antennæ, anterior and intermediate tibiæ and tarsi, and the posterior tarsi, black. Tegmina pale ochraceous, the apical margin and a double curved discal fascia on outer half very pale fuscous; a black central spot a short distance from base. Wings greyish white, the venation very pale ochraceous.

Long. excl. tegm., 11 millim. Exp. tegm., 44—50 millim.

Hab. Philippine Islands; Palawan.

Allied to *P. hamifera*, Walk., but differing by its smaller size, the black subbasal spot to the tegmina, &c.

Phromnia montivaga, n. sp. (Pl. XIII., fig. 5.)

Head and thorax above reddish; abdomen and legs pale ochraceous; eyes, antennæ, anterior and intermediate tibiæ and tarsi, and the posterior tarsi, black. Tegmina ochraceous, reddish ochraceous on disk of basal half and the clavus; the costal area and the apical half thickly powdered with greyish tomentose, the basal disk very sparingly so; the apical margin and a double curved discal fascia on outer half very pale fuscous, and very indistinctly seen through the tomentose covering; a black central spot near base. Wings greyish white.

Long. excl. tegm., 13 millim. Exp. tegm., 50 millim.

Hab. Borneo; Kina Balu Mount (*Whitehead*).

By the ground colour of the tegmina this species is allied to *P. tricolor*, White, and by the markings of the same to the previously described species, *P. parmata*.

Flata radiata, n. sp.

Body and legs pale tawny; abdomen clothed with greyish tomentose. Tegmina greyish, with a pinky hue and two bright ochraceous ray-like fasciæ; one bounding lower portion of radial area, the other on the inner claval margin, neither extending beyond middle. Wings greyish white.

Long. excl. tegm., 14 millim. Exp. tegm., 43 millim.

Hab. Borneo; Sarawak.

A species of unique coloration and markings.

Flata labeculata, n. sp.

Body and legs pale greenish; the eyes and tarsi blackish. Tegmina creamy white, the margins and a curved subapical fascia very pale reddish ochraceous; six irregularly shaped spots crossing radial area, and a spot near apex of same, two irregular spots beneath radial area situate at centre and near apex, and four elongate spots above clavus, dark reddish ochraceous. Wings creamy white.

Long. excl. tegm., 13 millim. Exp. tegm., 50 millim.

Hab. Celebes; Minahassa.

The tegmina are broad and rounded apically, and the venation is close and somewhat reticulated on the apical area. A very distinctly marked species.

The two species of *Flata* above described belong to that portion of the genus represented by *F. modesta*, Don., and *F. helena*, Walk., in which the apices of the tegmina are more or less rounded, and the posterior angle not angularly produced.

Flata (*Colobesthes ?*) *semanga*, n. sp. (Pl. XIII., fig. 6.)

Body and legs greenish ochraceous. Tegmina pale green, the margins very narrowly ochraceous and with five large discal spots, and an outer submarginal fascia, greyish white tomentose; of these five spots the first is oblique and at about middle of disk, the other four being between it and the submarginal fascia. Wings greyish white.

Long. excl. tegm., 12 millim. Exp. tegm., 50 millim.

Hab. Malay Peninsula; Province Wellesley.

The tegmina are very broad, and their posterior angles at apices of inner margins are angularly dilated, as in *Col. falcata*, Guer. The striking coloration of this large and handsome species renders it very distinct.

Cenestra ligata, n. sp. (Pl. XIII., fig. 3.)

Body and legs ochraceous; two longitudinal fasciæ to the face continued to vertex of head, two longitudinal spots to pronotum, and two much larger ones to mesonotum, blackish. Tegmina creamy white, with the base ochraceous; the margins, a curved fascia a little before apex extending from costal margin to about middle, and a longitudinal fascia between this and base, blackish. Wings creamy, tinged with ochraceous.

Long. excl. tegm., 12 millim. Exp. tegm., 37 millim.

Hab. Malay Peninsula; Perak (*Townsend*).

Allied to *C. circulata*, Guer., but differing by the much narrower tegmina and the different markings of the same.

Cenestra copulanda, n. sp.

Closely allied to the preceding species, but with the tegmina shorter and broader, the subapical curved fascia extending to near inner margin, and with the central transverse fascia shorter and straighter; mesonotum with two additional black spots on each lateral margin; anterior and intermediate tibiæ blackish.

Var. *a.* Tegmina and wings with the ground colour pure greenish white.

Long. excl. tegm., 7—10 millim. Exp. tegm., 26—32 millim.

Hab. Java.

Copsyrna ochracea, n. sp.

Body and legs ochraceous; eyes and two contiguous central spots on vertex of head, two central spots to pronotum, two elongate central spots to mesonotum, four spots on posterior margin of same, and the apices of the tarsi, black. Tegmina greyish white, with transverse spots on basal portion of the costal membrane, scattered, irregular and reticulated spots on basal half of disk, four curved fasciæ on apical half,—the innermost shortest and most irregular,—and the apical margin (narrowly), dark fuscous. Wings ochraceous.

Var. *a.* Tegmina shaded with bluish grey, tomentose; face with a central longitudinal black fascia.

Long. excl. tegm., 11 millim. Exp. tegm., 45—48 millim.

Hab. Malay Peninsula; Sungei Ujong and Perak.

This species is allied to *C. maculata*, Guer., from which it differs by the much broader tegmina, the ochraceous wings, &c.

Explanation of Plate XIII.

Fig. 1, 1 *a.*—*Messena radiata.*
2, 2 *a.*—*Kandiana lewisi.*
3, 3 *a.*—*Cenestra ligata.*
4, 4 *a.*—*Scamandra diana.*
5, 5 *a.*—*Phromnia montivaga.*
6, 6 *a.*—*Flata (Colobesthes ?) semanga.*

XVIII. *The secretion of potassium hydroxide by* Dicranura vinula (*imago*), *and the emergence of the imago from the cocoon.* By Oswald H. Latter, M.A., Assistant Master at Charterhouse; late Tutor of Keble College. Communicated by Frederic Merrifield, F.E.S.

[Read November 2nd, 1892.]

The investigations of which I now publish the results were undertaken at the instigation of Mr. F. Merrifield, to whom I must at once acknowledge my utmost indebtedness, not only for his suggestion, but also for a most generous supply of material wherewith to conduct my experiments and observations. I must also thank my colleague, the Rev. S. D. Titmas, for much kind assistance and advice.

More than forty-five years ago Mr. Merrifield observed that the imago of *D. vinula* produced an alkaline fluid at the time of emergence from the pupa. The observation was, I believe, never published, and no further work, so far as I am aware, has been done on the subject until, at Mr. Merrifield's suggestion, I undertook its continuance. It is well known that the larva of *D. vinula* spins an exceedingly hard cocoon, composed partly of a tough semitransparent substance, which is, as I conceive it, virtually a mass of agglutinated silk, and partly of portions of bark gnawed off from the tree on which the cocoon is constructed. The whole forms a hard unyielding protection to the enclosed pupa. Notwithstanding the character of this wall, the imago pierces it at the proper season without difficulty. The means whereby this is accomplished I hope to show in the following pages.

Two distinct points present themselves for investigation. (1) The means by which the cocoon is softened; (2) the apparatus employed in tearing open the cocoon when softened.

I. *The softening of the cocoon.*

A number of pupæ were cut out from their cocoons, and enclosed in red litmus-paper in such a way as to compel the moths to pierce the paper in order to effect their escape. In each case the papers were moistened by the emerging imago with a fluid which produced a deep blue stain of varying dimensions. The alkalinity of the fluid was thus proved. These stained papers were useless for analysis owing to the impurities present in the litmus-papers. Accordingly some forty pupæ were enveloped in best Swedish filter-paper, which is entirely free from all impurities, and contains no substances soluble in water. There was a slight difficulty in arranging the paper so as to afford sufficient obstruction to the emerging imago. Double thickness of the paper was too much for the imago to penetrate, and a single thickness not sufficient to provoke the maximum discharge of the softening fluid. About ten pupæ were enclosed in glass tubes, with their heads against the closed ends. The majority of the pupæ emerged successfully from the papers, yielding me thirty-two papers, each stained very faintly by the ejected fluid. The pupæ in glass tubes did not succeed so well—only four hatched (one is still alive, and evidently going over to next year), and of these only one was of any use: the fluid in the other three cases being spoiled by mixture with excrementitious matter. The one tube I was able to make use of contained a few drops of clear watery liquid. This tube I obtained in a satisfactory condition by fortunately seeing the imago just struggling to get free. I accordingly waited till I judged that most of the fluid was ejected, and then withdrew the moth and pupa-case from the tube with a pair of fine forceps.

I then proceeded to analyse the stains on the papers. All stains of excrement were carefully cut away, and only absolutely pure stains were retained. These were placed in distilled water, and raised to a temperature of about 90° C.; at the same time the papers were kept in motion by stirring them with a glass rod, so as to reduce them to pulp. I then filtered off the liquid, and condensed it by evaporation at about the same temperature. When cool, analysis yielded the following results:—(1) The fluid was decidedly alkaline; (2) there was present a mere trace of a chloride—hardly enough to be sure of; (3) potassium hydroxide was present in considerable quantity. The presence of potassium was proved by (*a*) the platinum perchloride test; from the yellow crystalline precipitate so obtained after treatment with alcohol, the platinum was separated by heat, and potassium chloride recovered; (*b*) the sodium and hydrogen tartrate test; (*c*) the characteristic colour imparted to the flame of a Bunsen's burner; (*d*) the remainder of the liquid was evaporated to dryness, and yielded a whitish solid, which was strongly alkaline, and deliquesced on exposure to the air, eventually forming potassium carbonate. Having arrived at these results, I confirmed them as far as possible with the few drops of pure liquid in the glass tube, from which also I obtained the same results, including the presence of a very small quantity of a chloride—again almost too little to be quite sure about.

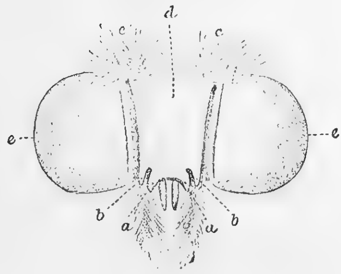
My next step was to try the relative caustic powers of potassium hydroxide and sodium hydroxide on the cocoons—applying the solutions to the inside. I took solutions of both substances of equal strength, and placed a few drops in four cocoons—two with each solution: the potassium hydroxide reduced the cocoons to which it was applied to a soft pulp in less than three minutes, whereas the sodium hydroxide took more than fifteen minutes to produce the same result. This of course was to be expected, owing to the superior caustic power of potassium hydroxide on most organic substances. It was thus proved that the imago of *D. vinula* produces caustic potash in order to soften its cocoon, and that this substance is better suited to this end than the other of the two commoner caustic substances.

II. *The apparatus employed in perforating the cocoon.*

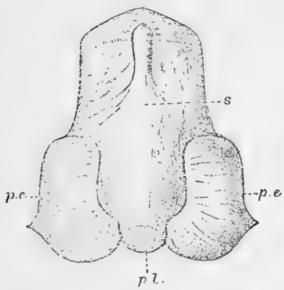
The imago invariably emerges from the cocoon wearing as a shield a portion of the pupa-case (see fig. 1, p. 291). This "shield" consists of the median dorsal piece (figs. 1—3, s) of the head of the pupa, extending as far as the labrum (p. l.) towards the ventral surface, and also of the two pupal eyes (p. e.), which project laterally further towards the ventral surface than the median labrum.

At first sight it appears that the "shield" is the tool used to thrust against the softened cocoon, but closer examination reveals a far more efficient apparatus. I placed one individual in absolute alcohol the instant it emerged from the cocoon, and so secured it with the "shield" still on. Examination of this specimen showed two small sharp points (figs. 1 & 2, *a a*) projecting in front of, and just ventral to, the pupal labrum from the labrum of the imago. These points are entirely concealed by the abundant fluffy scales on the head of the fully developed imago. If the head is "plucked," they are readily seen, even with the naked eye (see fig. 1). The points are about 0.5 mm. in length, and about 0·75 mm. apart, and project forwards and downwards: their outer margins are thickened, and the two together are carried upon a slightly thickened elevation of the imago's head. On each side of this elevation is an elongate pit (fig. 2, *b b*), open towards its ventral aspect, and running up dorsally towards the vertex of the head to end about a third of the way up in a socket. The total length from the socket to apex of points is about 1·2 mm. On the inner surface of the pupal "shield," *i.e.*, the side which is in contact with the underlying imago, is a pair of recurved hooks (fig. 4, *h h*), which fit accurately into the groove and socket of each side—the grooves serving as guiding lines towards the sockets. It is thus impossible for the "shield" to be removed by any upward pressure, for all pressure in that direction merely serves to lock the "shield" more firmly to the head of the imago below. On the other hand, downward pressure causes the hooks to come out of the sockets, to slide along the grooves, and the shield may be set free. These appearances warrant the conclusion that the imago attacks the softened inner surface of the cocoon with the above-mentioned pair of pointed processes, and that the "shield" serves to protect the eyes and head of the imago from injury which might otherwise result from friction against the walls of the cocoon. Probably each stroke is made in a downward and forward direction by the head of the animal, and probably fresh applications of the potassium hydroxide are made as each softened layer is in turn removed in order to soften the succeeding layers. I believe the potassium hydroxide is produced from the mouth—at any rate I could discover no other aperture of any kind: if this surmise be correct, it seems probable that the muscular efforts necessary for scraping at the cocoon may also serve to eject successive quantities of potassium hydroxide.

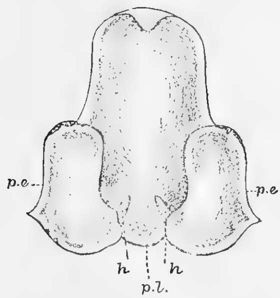
1



2



3



4

Fig. 1.—Ventral view of freshly emerged imago of *D. vinula*, showing pupal shield, *s*, pupal eyes, *p. e.*, and processes of labrum of imago, *a a*, just visible below shield.

Fig. 2.—Head of imago denuded of scales, showing, *a a*, the labral processes; *b b*, grooves terminating above in sockets for reception of *h h* in fig. 4; *c c*, basal joint of antennæ; *d*, median anterior region of head; *e e*, eyes.

Fig. 3.—Outer surface of pupal shield, slightly flattened to show its full extent: *p. e.*, pupal eyes; *s.*, points to same spot as in fig. 1. *p. l.*, pupal labrum.

Fig. 4.—Inner surface of same. *h h*, hooks for attachment of shield by locking with *b b*, fig. 2. Other letters as before.

I may mention that the whole surface of the body of a freshly emerged imago is damp with an alkaline fluid, but this is probably due to the whole body having to pass through the aperture in the cocoon which is moist with the hydroxide. I am not able to speak with certainty on the manner in which the imago gets rid of the "shield." The only one I saw free itself did so at the moment it met a vertical surface when crawling along a horizontal board; it looked as though the animal struck the shield accidentally against the vertical side of the box, and made an upward movement of the head prior to ascending in order to let the wings hang down. But from this single instance I cannot draw a general conclusion. In this case the shield was on till the vertical side was encountered, and then fell off at once. Certainly, if the "shield" were pressed against a surface, and the head drawn upwards, the former would easily be removed by withdrawal of the hooks from their sockets.

Summary.

I.—The imago of *D. vinula* produces a solution of potassium hydroxide, probably from the mouth, in order to soften the cocoon.

II.—The labrum of the imago bears two sharply pointed processes, used for scraping the inner surface of the cocoon in order to break a way through.

III.—The eyes and median portion of the head of the pupa are retained as a protecting shield over the same structures of the imago until emergence is completed.

XIX. *Further experiments upon the colour-relation between certain lepidopterous larvæ, pupæ, cocoons, and imagines and their surroundings.* By Edward B. Poulton, M.A., F.R.S., F.L.S., &c.

[Read October 5th, 1892.]

Plates XIV. & XV.

CONTENTS.

A. Introductory.

My attention was first directed to this subject by the writings of Meldola, and especially his editorial notes to Weismann's 'Studies in the Theory of Descent.' His statements recalled my own early experience of the variations in colour of the larvæ of *Smerinthus ocellatus* when found on different food-plants. I therefore determined to experiment upon this species and other *Sphingidæ* which were also known to vary under similar conditions. I first experimented (1884) upon *Smerinthus ocellatus* and *Sphinx ligustri*, and proved that the shade of green can be modified in both these species (Proc. Roy. Soc., No. 237, 1885, p. 269). At the same time I showed that the effect cannot be *phytophagic* in the strict sense of the word, but rather *phytoscopic* (*l. c.*, pp. 306—308), inasmuch as the colour of the surface of the leaf rather than its substance acts as the stimulus. In 1885 these results were extended and confirmed by further experiments on *S. ocellatus* (Proc. Roy. Soc., No. 243, 1886, p. 135). For some years I continued working at this species, and expended a vast amount of unproductive labour upon it. At some future time I hope to extract from the voluminous notes of several years' work a comparatively few details which may be of interest. At that time no one believed that this susceptibility was of common occurrence, and could produce far wider differences in many well-known larvæ, which were therefore more suited for an investigation into the conditions and limits of the change which takes place. A suggestion made by Lord Walsingham first turned my attention from the *Sphingidæ* in the direction of far better material. This suggestion was that the larvæ of *Rumia cratægata*, sometimes green and sometimes brown, might perhaps be found susceptible to these influences. I first experimented upon them in 1886, and in that and the subsequent years investigated many species of *Geometræ* and *Noctuæ*. The general results of this work have been very briefly stated from time to time ('Colours of Animals,' Internat. Sci. Series, London, 1890, pp. 150—153, British Assn., 1887, 1892, Trans. Ent. Soc., Lond., &c.), but the details have never been given. At the same time, the complete establishment of a principle such as this demands the publication of the fullest detail, at any rate as regards many of the species first investigated. When the principle has been proved, the same evidence is not necessary in all cases.

I am now therefore bringing together the results of all my notes of these experiments upon lepidopterous larvæ, omitting those upon the *Sphingidæ*. These details, together with the confirmatory results obtained by Mr. Perkins upon *Boarmia rhomboidaria* (unpublished), and by Miss Gould and Mr. Bateson as published in these Transactions for the present year (pp. 215 and 205), will, I think, leave no room for doubt as to the importance and prevalence of this principle as regards Lepidoptera. It will be interesting in the future to test its applicability to other species, but the greatest interest and importance now attaches to the attempt to acquire further knowledge of the physiology of the process. Certain solid contributions (so far as they go) towards this end will be found in the subsequent experiments, and especially those upon *Amphidasis betularia* in the present year (1892).

As regards the susceptibility of certain exposed pupæ, I began to experiment in 1886 upon *Vanessidæ* and *Pieridæ* (Phil. Trans. Roy. Soc., vol. 178 (1887), B, pp. 311—441). Since then I have again experimented upon the same species, as well as others, but, as in the larvæ, only the most general statement of results has been made ('Colours of Animals,' pp. 110—142). The details now published, together with the confirmatory results obtained by Mr. G. C. Griffiths (Trans. Ent. Soc., 1888, p. 247), Rev. J. W. B. Bell, Mr. Pembery (both in 'Midland Naturalist,' Dec., 1889, pp. 289, 290), Mr. W. H. Jackson (Linn. Soc. Trans., vol. v., 1890, pp. 156, 157), Mr. P. C. Mitchell, quoted by Mr. Jackson (*l. c.*), Mr. Bateson (these Transactions, 1892, p. 205), Mr. Merrifield (Proc. Ent. Soc. Lond., 1892, p. xxx), will leave no doubt about the importance of the principle as regards exposed pupæ of Lepidoptera, and here, too, future work will best be concentrated upon the attempt to make out the physiology of the process. In this case, however, far more has been done, as will be seen by an examination of my previous paper (Trans. Roy. Soc., *l. c.*), and the details of experiments during 1892 upon *Vanessa io* and *V. urticæ* which are to be found in this paper.

My conclusions as regards the modification of colours of cocoons have been shown to be erroneous by Mr. Bateson (Trans. Ent. Soc., 1891 and 1892); although there was no doubt about the colour-change itself. This he has shown, in the cases of *Eriogaster lanestris* and *Saturnia carpini*, to be due to disturbance of the larvæ, and not to surrounding colours. It is probable that this criticism affects the conclusions as regards other species (*Liparis auriflua* and *Rumia cratægata*). It is likely, however, that the principle still holds good in the genus *Halias*, inasmuch as my earlier observations (Proc. Ent. Soc., 1887, pp. l, li) have been confirmed by Mr. Tutt's recent publication ('Journal of Variation'), as well as by a few experiments of my own during 1892, published in this paper. The negative results of certain other experiments upon cocoons are also given.

The details of experiments upon the colours of the imago are also recorded below. The species selected was *Gnophos obscurata*, and the results were completely negative.

In certain cases the investigation of the susceptibility of one stage has given information as to that of other stages. Thus in the case of *Gnophos obscurata*, the colours of the cocoon and of the larva were tested incidentally in testing those of the imago. In such cases the chief object of the research has determined the class into which it has been placed in the arrangement adopted below.

B. Experiments upon Lepidopterous Larvæ, 1886—1892.

In the following arrangement the experiments upon *Noctuæ* will be considered before those on *Geometræ*, and in each of these groups of experiments the order will chiefly follow that of time, and also to some extent the importance or completeness of the results, the earlier and less satisfactory results being considered first.

1. *Experiments in 1886 upon Mamestra brassicæ, Hadena oleracea, and Euplexia lucipara.*—The experiments were conducted upon captured larvæ, and were therefore far less satisfactory than those upon hatched larvæ. The progress of the investigation and its results are most concisely given in a tabular form.

I. Dark Surroundings. Dead leaves, &c., intermixed with food-plant.	II. Green Surroundings. Food-plant alone.	III. Green Surroundings. Food-plant alone.
Aug. 28.—5 green *M. brassicæ* (24·3, 23·75, 22·3, 16·25, & 12·5 mm. long), 4 green *H. oleracea* (19·0, 15·6, 11·3, & 9·7 mm. long), and a small brownish green *M. brassicæ*, all found on marigold, were placed in dark surroundings on the same food-plant. To these were also added 3 green *M. brassicæ* (23·9 mm. when found on Aug. 21, 23·0 and 13·5 mm. when found on Aug. 25), and 1 dark green *Euplexia lucipara* (24·5 mm. when found on Aug. 25), all from marigold, and placed up to this date with the *M. persicariæ* in dark surroundings described on p. 299.	Aug. 28.—4 green larvæ of *M. brassicæ*, 24·0, 22·0, 20·0, and 16·0 mm. long, found on marigold, together with 4 green larvæ of *H. oleracea*, 14·5, 13·25, 12·0, & 8·75 mm. long, were introduced into green surroundings; also another small greenish *M. brassicæ*.	
Aug. 29.—2 *M. brassicæ* had become dark, 1 large and 1 having just changed skin.		
Aug. 30.—1 small *oleracea* (17·25 mm.) was becoming darker; 4 *brassicæ* had now changed last skins, and 3 were dark; 1 *oleracea* and 2 *brassicæ* were changing skins, and resting on brown leaves; they were removed for examination: 1 large green *brassicæ* added.	Aug. 30.—2 *M. brassicæ* had changed skins and become dark (removed).	Aug. 30.—The 2 removed from II placed here.
Sept. 1.—The 3 larvæ removed Aug. 30 had changed skins, and were all brown; they were replaced. Of the rest, 4 *brassicæ* were brown (3 very dark); 1 *oleracea* was apparently darkening gradually instead of suddenly after an ecdysis. *E. lucipara* still green. 1 green *brassicæ* changing skin on a brown leaf was removed. The large *brassicæ* added Aug. 30 was still green: it was now pupating and removed.	Sept. 1.—1 *M. brassicæ* had changed last skin and become dark (removed).	Sept. 1.—They were a very greenish brown: the third dark larva from II. added.
Sept. 10.—2 *oleracea* alive; 1 about mature and brown, 1 changing skin and brownish. 6 *M. brassicæ*, all brown. 3 more green *oleracea* added (about 17·5 mm. long). The green larva changing skin and removed Sept. 1 was now dark; it was replaced.	Sept. 10.—3 *H. oleracea* about mature, 2 green, 1 brown. 2 *M. brassicæ*, 1 nearly mature, 1 small; both green. 1 green *oleracea* added, 20·0 mm. long when extended in walking; it was changing its skin.	Sept. 10.—Only 2 found; 1 darkish brown, 1 lightish brown. The latter died; the former was replaced in II.

I. DARK SURROUNDINGS. Dead leaves, &c., intermixed with food-plant.	II. GREEN SURROUNDINGS. Food-plant alone.	III. GREEN SURROUNDINGS. Food-plant alone.
Sept. 19.—1 *H. oleracea*, dead, was brown; 1 ditto, pupating, was brown; 1 ditto, changing skin, was brown; 2 ditto, feeding, were perhaps darkening. 1 *M. brassicæ*, dead, was brown; 2 ditto, feeding, were brown. There was also 1 pupa of *brassicæ*.	Sept. 19.—Only 2 brown larvæ, 1 *brassicæ* and one *oleracea*; the others remained green. All were dead except 3, but their colours could be made out.	

The results are not at all satisfactory or convincing, because the large proportion of deaths shows that the larvæ were not kept in a normal and healthy condition, and especially because of Miss Gould's negative results with more successfully conducted experiments upon *Mamestra brassicæ* (Trans. Ent. Soc. Lond., 1892, p. 215). At the same time, I should be glad for further experiments to be made, especially with *H. oleracea* and *E. lucipara.* The investigation is far more difficult with such *Noctuæ* as these than with the genus *Catocala* or with *Geometræ.* The larvæ tend to bury or conceal themselves low down on the plant. The abundant fæces very quickly produce the effect of dark surroundings, and, being moist, promote decay in the food-plant. Hence it is very difficult to keep the conditions uniform, and in addition to this, the larvæ are apt to become stained by the semi-liquid material on the floor of the case. All these difficulties could, of course, be obviated, but this would require much time and constant attention. These experiments were conducted at the same time with many other lines of work, and did not receive sufficient care.

I may, however, claim that the results point to the desirability of further investigation upon these or similar dimorphic species.

2. EXPERIMENTS IN 1886 UPON MAMESTRA PERSICARIÆ.

These experiments were also conducted upon captured larvæ, and are open to the same objections as those just described. They are given in a tabular form below :—

I. Dark Surroundings. Dead leaves, &c., mixed with food-plant.	II. Green Surroundings. Food-plant only.
Aug. 21.—A green larva of *M. persicariæ*, 17·5 mm. long, found on marigold, placed same day on same food with brown surroundings, dead leaves, &c.	Aug. 21.—A green larva of *M. persicariæ*, 11·3 mm. long, found Aug. 19 on *Ribes americana*, was fed on marigold in green surroundings at this date.
Aug. 25.—Brown paper floor substituted for earth. Larvæ still green. Added at this date 3 more green larvæ, measuring 44·3 (when much stretched), 24·25, & 15·0 mm., found on marigold, except the largest larva.	Aug. 25.—The larva was changing its skin; also introduced 2 green larvæ (20·0 and 22·0 mm. long), the smaller of which was found on marigold at this date.
Aug. 27.—4 larvæ still green, but the largest seemed darker.	Aug. 27.—Examined; all 3 green.
Aug. 28.—6 more larvæ, found on marigold, added, measuring 21·25, 19·5, 16·75, 14·25, and 2 of them 16·0 mm.	Aug. 28.—9 more green larvæ added (22·0, 20·0, 19·5, 17·3, 17·0, 16·0, 15·3, 14·3, and 14·0 mm. long), found at this date on marigold.
Aug. 30.—1 became brown, having changed the last skin, and 25·0 mm. long. The largest was pupating, remaining green (removed); 2 were changing their skins, and resting upon a brown and green leaf respectively; removed in order to note effect. Another larva, 19·0 mm. long, added.	Aug. 30.—1 larva, 26·3 mm. long, has changed skin and become brown (removed); 11 green.
Sept. 1.—Same as Aug. 30, all green but one; some of the green ones appeared to be darkening; 4 in last stage, 1 of which was eating a small larva of same species, although there was plenty of food; 1 in last stage but one; 3 changing last skin, 1 on green, 1 on brown surface; the other placed on a brown surface, and all 3 removed to note effects. The 2 removed Aug. 30 had now changed their skins, and were both green: they were now replaced.	Sept. 1.—All green; 1 dying and removed; 2 more green larvæ added, 16·75 and 23·5 mm. long, the latter changing last skin. The removed larva was now a very greenish brown.
Sept. 10.—8 larvæ advanced in last stage, 1 of which had changed in colour before pupation; 1 was dark brown, 4 greenish brown, and 2 brownish green. The greenest was darker than any among the 9 larvæ in II., except a small one in the latter. Of the 3 removed Sept. 1, 2 were dark brown and 1 was green; the latter was on a brown surface, and 1 of the former on a green surface. they were now replaced.	Sept. 9.—9 larvæ alive, all in last stage, 8 green, 1 brownish green (a small larva).
Sept. 19.—4 changed in colour before pupation; 4 brown and 1 green at earlier period of growth.	Sept. 19.—Only 2 still feeding, 2 pupating; the rest dead, but no more became brown.

These results are also unsatisfactory. I cannot point with any confidence to the colours of larvæ which had died in the course of the experiments, for the existence of abnormal conditions is only too evident. It is probable that such conditions are to be found in the numbers of the larvæ in these and the previous experiments. Having regard to the habits of the larvæ, in future work it will be well to place very few in each cylinder or case.

The results, however, clearly call for further work, and seem to hold out some hope of positive results. In one respect, however, negative results of much interest are to be gained from the experiments here recorded. In dimorphic (green and brown) species the change from one colour to another in the lifetime of an individual takes place, at any rate as a rule, rapidly in the transition from one stage to another. The larva changes its skin and assumes the other colour. Now, the analogy of the pupal changes of colour made it worth inquiring whether the larva was susceptible to the colours on which it rested during the period before ecdysis. Certain observations were directed to test this possibility in both these and the former series of experiments. In 1 the results were consistent with the existence of such susceptibility, but the evidence was far from strong, inasmuch as the conditions of the larvæ observed were such as to correspond with the general tendency to become brown in the last stage. In these experiments the results are clearly negative, and seem to prove, so far as this species is concerned, that no susceptibility exists at the time in question. In Experiment I. it is recorded that 2 green larvæ were resting, during the last ecdysis, on green leaves, and 1 became brown; while of 3 green larvæ similarly resting on brown surfaces, 2 became green.

3. Experiments in 1888 upon Catocala sponsa.

This experiment was conducted in the early summer of 1888. The larvæ were reared from eggs obtained by George Tate, of Lyndhurst. The food-plant employed was oak.

EXPERIMENT I.: DARK SURROUNDINGS.

May 15.—11 larvæ were placed on the food-plant intermixed with dark twigs.

May 16.—2 larvæ were removed and placed in green surroundings.

May 20.—More dark sticks were added.

May 27.—Larvæ placed in a larger cylinder with still more dark twigs: all the 9 were alive and healthy.

June 11.—The first larva spun up.

EXPERIMENT II.: GREEN SURROUNDINGS.

May 13.—1 larva hatched.

May 14.—5 larvæ hatched.

May 20.—Placed in green surroundings, *viz.*, only the leaves and green shoots visible.

May 27.—Combined with Experiment III. At this date some of the 6 larvæ were light coloured, while others were as dark as those of Experiment I.

EXPERIMENT III.: GREEN SURROUNDINGS.

May 16.—2 larvæ hatched, and 2 were transferred from I.

May 20.—Placed in green surroundings.

May 27.—The larvæ of Experiment II. added to these, making 10 altogether.

June 10.—All larvæ were now nearly mature, and were carefully compared together. There was a decided difference between the shade of larvæ exposed to dark surroundings (I.) and those exposed to green (II. and III.). The difference was not nearly so marked as in many other species, e.g., *Crocallis elinguaria*, but was nevertheless distinct, and in the same direction, dark surroundings producing darker larvæ, green surroundings lighter ones.

June 11.—1 became mature and spun up.

As in so many other cases in which these experiments have been made, the dark larvæ are far more perfectly concealed than the light ones, but the latter are much less conspicuous on the leaves than the dark ones would have been. The very rapid development of these large larvæ is somewhat remarkable.

4. EXPERIMENTS IN 1889 UPON CATOCALA ELECTA.

Eggs of this species were kindly sent me by my friend Mr. William White.

May 28: 2 larvæ, at this date about 21·7 mm. long, hatched May 12 and 13, together with 4 larvæ, about 14·5 mm. long, hatched May 16 (2 on this date), 18, and 20, were divided into two lots as equally as possible as regards size and colour, and were subjected to dark and green surroundings respectively.

Experiment I. Dark surroundings.	Experiment II. Green surroundings.
May 28.—3 of the larvæ mentioned above were introduced, abundant dark twigs being intermixed with the food.	May 28.—3 of the larvæ described above placed among leaves and green shoots only.
June 5. — The larvæ compared with those of II., and they were certainly rather darker than the latter. Another small larva was introduced, hatched May 25 or 26.	June 5. — Another small larva introduced, hatched May 25 or 26.
June 14. — Another comparison was made, these larvæ being distinctly, although not strongly, darker than those of II.	
June 17.—Again compared, with the same results: a very fair comparison could be made between the 3 largest of this and the 2 largest of Experiment II.	June 17.—1 has spun up. The difference between the large larvæ here and those of I. is not great, but it is all in the same direction.
June 25.—2 larvæ spun up. The small larva introduced June 5 is now 25·25 mm. long, and very dark, much darker than that in II.	June 25.—2 larvæ spun up. The small larva is 31·4 mm. long.
July 11.—The large larva pupated much earlier. The small one is now mature. The difference is very distinct, but not to be compared with that of *C. elocata*, in which the dark larva is far darker, and the light larva far lighter, showing greater susceptibility in both directions.	July 11. — The remaining larva spun up at this date.

The development of the larvæ is not remarkably rapid, like that of *C. sponsa*. The degree of susceptibility appears to be about the same as in this latter species.

5. Experiments in 1889 upon Catocala elocata.

Eggs were kindly supplied by Mr. William White. The very few larvæ which hatched were arranged in two lots, as in the case of *C. electa*. The food-plant employed was poplar (*Populus nigra*).

Experiment I. Dark surroundings.	Experiment II. Green surroundings.
June 14. — 1 larva introduced; hatched May 27, and 23·0 mm. long	June 14. — 1 larva introduced; hatched May 31, and 21·0 mm. long.
June 25. — The larva was *much* darker than that of II., its length being 32·5 mm. Another larva introduced; hatched June 5, and 22·25 mm. long. It was very light in colour, as up to this date it had been surrounded by leaves alone, *viz.*, under the conditions of II.	June 25. — The larva was 29·0 mm. long. The strong difference between this and that of I. was thus produced in 11 days. Another larva introduced; hatched June 8, and 13·0 mm. long. It was much darker than that introduced into I., but this was partly due to its youth.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings,
June 30.—The difference between the large larvæ of I. & II. continued to be very marked. The small larva was not seen, and was apparently lost.	
July 11. — Between this and the last comparison the difference between the 2 large larvæ had greatly increased, the dark one being almost black. The latter was apparently mature, being larger than that in II. They were therefore painted (July 11), and afterwards preserved (July 13). A few days earlier they were photographed.	July 11. — The large larva had been very light brown for some weeks. The small larva was equally light. Between this date and June 30 the two large larvæ were seen by many physiologists and others (Dr. Burdon Sanderson, Sir William Turner, Prof. C. Stewart, Prof. Gotch, Dr. Page, and Dr. Bradford). Everyone was much impressed with the extraordinary difference between them.

The difference between these larvæ is indicated in an uncoloured illustration to 'Colours of Animals' (p. 151). The larvæ were photographed for me by my friends Mr. F. J. Smith and Mr. G. J. Burch. In both cases they were induced to rest upon white paper spills, and were arranged so that the light fell on the same part of both from the same direction. The photographs did not show nearly so marked a difference as was seen in the larvæ themselves. A collotype reproduction from one of Mr. Burch's negatives is shown on Plate XV., figs. 1 (the dark) and 2 (the light larva). Apart from the colour difference the representation of the larvæ is extremely good.

The number of individuals experimented upon in the case of the *Catocalidæ*, and especially in *C. elocata*, would have been utterly inadequate for the purpose of proving the existence of colour susceptibility. But this principle having been firmly based on the results of experiments with other genera in which very large numbers of individuals have been employed, the evidence now obtained is sufficient to show that the principle applies to the *Catocalidæ*. The mere extension of a principle to fresh cases of the same class does not of course require anything like the same amount of evidence as that which was necessary in the first place to establish the principle itself.

6. Experiments in 1890 upon Catocala fraxini.

Similar experiments were conducted on this species, but I cannot now lay my hands on the notes. However, I remember clearly that the results were similar to those obtained by Miss Gould in the same year, except that my light larvæ did not exhibit a tendency to become greenish, but were very light brown. My results were, in fact, similar to those obtained in the case of *C. elocata*, and both these species may be regarded as extremely sensitive to the colours of their surroundings; while the other *Catocalidæ* investigated, including *C. nupta*, tested by Miss Gould, are far less susceptible. It is very remarkable that closely allied larvæ, belonging to the same genus, should differ so widely in the degree to which they are susceptible. It is possible, however, although not probable, that experiments upon larger numbers may modify these conclusions as regards *Catocala*. It is, however, known that the same difference obtains in the pupæ of certain species of the genus *Papilio* (Phil. Trans. Roy. Soc., 1887, B, p. 408).

We now pass to more numerous and satisfactory experiments upon the larvæ of *Geometræ*.

7. Experiments in 1886 upon the larvæ and pupæ of Ennomos angularia.

The ova were obtained from a captured female, and I believe that all the larvæ hatched from one lot of eggs. The food-plant employed in all cases was elm. The experiments were arranged May 8 and 9.

I. *Dark surroundings.* — The twigs of elm were introduced with the leaves. The larvæ were compared June 12, when there were 23 alive, and all decidedly darker than than those of II. By June 15 they were spinning up rapidly. I am not sure whether there were more twigs added in addition to those bearing the leaves, but probably not, considering the relative darkness of III.

II. *Green surroundings.*—The leaves alone of elm were used. 7 larvæ were alive on June 12, and much lighter than in I.

III. *Darkness.*—The same food-plant, twigs as well as leaves, was covered by a cylinder enclosed in two thicknesses of black tissue-paper. On June 19 they were examined, and 19 were found alive, and were distinctly darker than either of the other lots. This result is exceptional, for larvæ brought up in this way are usually lighter than those among an abundance of dark twigs in strong light.

Other experiments were made to test whether the pupa is susceptible to surrounding colours. I have already described and figured the pupa as dimorphic (Trans. Ent. Soc. Lond., 1885, p. 319, Pl. VII., figs. 20 and 21), "one form being light bluish green, covered with white dots, and the other dark brownish green, sprinkled with black dots." The brown larva becomes green in its cocoon before pupating (*l. c.*, p. 319, and fig. 19). Many larvæ in this condition, and in the earlier brown state, were placed in paper cocoons of various shades,—black, green, white,—but no corresponding differences were seen in the pupæ. I should be glad for this experiment to be tried again, employing more natural substances, such as brown leaves and bark, green leaves, &c., and applying these conditions to a somewhat earlier period of larval life.

There is no doubt that the larvæ of this species are highly sensitive to the greens and browns in their immediate surroundings, but there is at present no reason for the belief that the pupa is similarly susceptible.

8. Experiments in 1886 upon Selenia lunaria.

Moths bred from purchased pupæ paired and laid the eggs which provided the material for these experiments. I am not sure whether all were produced from the same parents. The experiments began June 8—11, when the larvæ were arranged as follows:—

I. *Dark surroundings.* — Fed on *Quercus cerris*, the dark twigs being present as well as the leaves. About 30 were introduced June 9, of which only 19 were alive June 26, and the same number July 13, when they were compared. These larvæ were extremely dark as a whole, and very different from those in II., being much darker than the darkest of the latter.

II. *Green surroundings.* — Fed on leaves of *Quercus cerris* without any dark twigs. Introduced June 9, and 18 alive July 13. They were very variable, but none very dark, and *much* lighter than the larvæ of I. It should be remarked that the leaves of this species of oak are very dark green.

III. *Green surroundings.*—Fed on leaves alone of elm, and from July 3 on variegated elm, the leaves of which are of course much lighter. Introduced June 8, and 5 alive July 13. These were much lighter than II., and 3 out of the 5 extremely light. These larvæ were advanced in size.

IV. *Green surroundings.* — Fed on leaves alone of *Quercus cerris*, in a cylinder surrounded by a single thickness of green tissue-paper, and a roof of the same. 20 larvæ were introduced June 10 and 11, but most had died by June 26, and, on July 13, only 3 small darkish larvæ were left. The paper screen had prevented the leaves from being seen, so that they had become brown and withered, accounting for the failure of this experiment.

There is no doubt that these larvæ are highly sensitive.

9. Experiments in 1887 upon the larvæ and pupæ of Ephyra omicronaria.

(*See Table, page* 307.)

In addition to the experiments of which details are given on the opposite page, there were others which are not noted. Dark surroundings were employed chiefly in the form of intermixture with dead brown leaves, principally of ivy and oak. There was also another set of 11 larvæ reared successfully in almost complete darkness (surrounded by one thickness of black tissue-paper). The larvæ in nearly all cases became pupæ, many dozens being produced, and giving rise to imagos; but, as with the above experiments, the results were invariably negative. Every larva and every pupa was green, and this although large numbers of the latter were fixed to brown leaves, on which they were conspicuous, and although most of the former had been surrounded by these dark objects for nearly the whole of their lives; for the leaves on which the stock of larvæ was kept often became brown, and dark twigs of the food-plant were invariably present during the early stages, if not always (as was the case with most larvæ). There is no doubt that *E. omicronaria* is not sensitive to the surrounding colours.

It must, however, be remembered that the species only exhibits a trace of the dimorphism which is so marked in the allied *E. pendularia* and *E. punctaria*. Nevertheless

9. Experiments in 1887 upon the larvæ and pupæ of Ephyra omicronaria.

The eggs from which these larvæ were obtained were laid by probably many moths bred from purchased pupæ. The larvæ began to hatch June 12, and continued to appear for several days. They were kept together until June 26, when the following experiments were arranged. The only food-plant employed was maple.

Dates.	I. Dark Surroundings: Black paper floor and roof, pieces of paper mixed with food-plant.	II. Dark Surroundings: Black paper nearly covering cylinder; black paper floor; dead brown leaves intermixed.	III. Darkness: Double black tissue-paper round sides, and forming roof; floor 1 thickness. Food-plant alone.	IV. Green Surroundings: Green paper floor and roof.	V. Green Surroundings: Green paper roof.	VI. Green Surroundings: White muslin roof. In no one of these Experiments was there apparently great care to exclude dark twigs of food-plant.
June 26	3 larvæ about 12·5 mm. long, and 12 from about 6·0 to about 7·0 mm. long were introduced.	22 larvæ introduced; none so large as the largest in I.	16 larvæ introduced.	Two sets of 3 and 12 larvæ of about the same size as I. introduced.	16 larvæ, rather smaller than those of previous experiments, introduced.	
July 7	All becoming mature and all green; 1 had pupated recently.	Only 7 larvæ found, all green; 12 more small ones added from the "stock" which was not exhausted June 26.	All green.	All green; 2 green pupæ recently formed.	11 alive, 1 about to pupate; all green.	21 larvæ, 1 ready for pupation.
July 14	11 pupæ, all green; 3 green larvæ.	16 green larvæ; 1 green pupa.	5 green pupæ; 8 green larvæ.	6 green larvæ; 8 green pupæ.	3 pupæ and all larvæ green.	5 green pupæ; 14 green larvæ.
Aug. 21	13 imagos had emerged.	5 imagos had emerged; 3 living pupæ.	All 13 emerged.	8 imagos had emerged: 4 pupæ had been preserved.	9 imagos had emerged.	6 imagos had emerged.

brown varieties of the larvæ of *E. omicronaria*, producing brown pupæ, are not unknown, for I bred one in 1883 (Trans. Ent. Soc. Lond. 1884, p. 51, and Plate I., fig. 10). It would be desirable to repeat these experiments upon other species of the genus.

10. Experiments in 1887 upon Melanippe montanata.

A female captured at Oxford laid the eggs from which the larvæ of these experiments were hatched.

Experiment I. Dark surroundings: dead leaves and bits of brown stick intermixed with food-plants (primrose and polyanthus).	Experiment II. Green surroundings: green leaves of food-plant alone, but these became brown from time to time towards end of experiment.
June 30.—27 newly hatched larvæ introduced.	June 30. — 23 larvæ from same batch of eggs introduced.
July 17.—27 larvæ; very remarkable difference between these and II., the latter being much lighter.	July 17.—23 larvæ; about 9 mm. long in both I. and II.
July 30. — 27 larvæ; still much darker than II.	July 30. — 20 larvæ; both lots were brown, but these far paler.
Aug. 21.—27 larvæ; the difference was now much less, although these were still probably the darker lot.	Aug. 21. — 19 larvæ; the larvæ had been somewhat neglected, and the leaves had partially become brown, hence the darkening of these larvæ, and smaller difference between the two sets.
Aug. 30. — 27 larvæ; still apparently slightly darker.	Aug. 30.—20 larvæ.

It is quite evident that these larvæ are very sensitive, and can adjust their shade of brown to that of their surroundings, becoming very light in a green environment. Two adjustments took place in the larvæ of Experiment II., for they became at first pale upon the green leaves, and then dark when the leaves were allowed to become brown. The first change is shown to have been complete in a little over a fortnight; it probably occupied a still shorter time.

11. Experiments in 1888 upon Boarmia roboraria.

A few larvæ were obtained from eggs laid by a female moth captured by Mr. Arthur Sidgwick, who kindly allowed me to experiment with them.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.
Aug. 19.—7 larvæ introduced; average length, 11·4 mm. Dark twigs intermixed with food-plant (oak).	Aug. 19.—7 similar larvæ introduced.
Aug. 24.—Older leaves of a darker green were offered at this date. On all other occasions, unless specially noted in this and other experiments, I was careful to use leaves of the same age.	Aug. 24.—Younger leaves of a lighter green were offered at this date.
Sept. 2.—Refed; the average length in both I. and II. was now 16·1 mm.	Sept. 2.—Also refed. The effects of surroundings were already very marked, the experiment having lasted about a fortnight.
Sept. 13.—The average length was now 20·6 mm. The difference in colour was very great. The lightest of these 7 were much darker than the darkest of II. These were rather variable, and marked with various shades of grey and brown. It is true here, as in all experiments with stick-like larvæ, that, except when feeding, they are almost invariably found resting on the twigs.	Sept. 13.—The general effect of the larvæ was greenish; their colour may be described as a light greenish grey; they were very slightly variable in colour and marking.
Sept. 30.—The average length was the same; it is therefore probable that they had ceased feeding for some little time.	Sept. 30.—The difference was as marked as before.
Nov. 12.—The larvæ were carefully compared for the last time: 1 had died. The 6 larvæ were various shades of dark brown, with patches of greenish brown often present, and far darker than those of II.	Nov. 12.—All 7 larvæ were of a light greenish brown. They had now been hybernating, and had not been offered food for a long time.

I had arranged to continue the experiments through the winter, some of the lightest larvæ being exposed to dark surroundings, and *vice versâ*. It would be very interesting to test whether there is any susceptibility at this period when concealment is so especially necessary. It is, however, improbable that any susceptibility exists at this time because of the physiological inactivity of hybernation. It must furthermore almost invariably happen that the larvæ remain resting throughout winter upon surfaces with which they had previously been brought into resemblance. The experiment failed, because only a single larva survived the winter. This individual spun a cocoon May 25th, 1889.

It would also be interesting to continue the experiment beyond hybernation. In the case of *Geometra papilonaria* it has been shown that the larvæ are sensitive to colour influences *before* hybernation but not after, when they become dimorphic. It is improbable that this is the case with *B. roboraria*, in which I anticipate that the susceptibility will be found to continue.

The species is certainly highly susceptible before hybernation.

12. Experiments in 1888 and 1889 upon Geometra papilionaria.

1888.

The experiments in 1888 were conducted upon the larvæ after hybernation, when it is well known to be dimorphic, appearing as green and brown forms.

The hybernated larvæ hatched from one set of eggs were placed in dark and green surroundings early in the spring of 1888, the date being unnoted. They were subsequently compared as follows:—

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.
May 22. — 6 larvæ, much larger than those in II., 3 nearly adult, 2 green and 1 brownish; 3 half-grown, green, with brownish on back.	May 22.—8 larvæ: 1 nearly mature and green; 3 half-grown and green, but more distinctly brownish on back than those in I.; 4 smaller and chiefly brown.
May 27.—1 green one has spun; 1 is brown and the rest green; no further change occurred after this date.	May 27.—4 large and all green, like those in I.; 4 much smaller, 1 brown (very small), 3 brown and green.
June 1.—1 green larva spun.	June 1.—1 green larva spun; 2 of the small ones had become green.
June 7. — The remaining larvæ spun.	June 7.—3 green larvæ spun; 1 small larva remains brown and 3 green.

The results are thus negative. Other experiments I have made, but not recorded, also led to negative results. It is probable that the green or brown form cannot be assumed by any individual as the result of susceptibility to surroundings during the stages which immediately precede that in which they become dimorphic (*viz.*, the last). It is still possible, although unlikely, that some predisposition towards either form may follow from the influence of environment during the earlier stages which are certainly susceptible (as will be shown below). Against such a view must be set the fact that both green and brown forms are found among larvæ which have been kept together in a muslin bag upon the same branch ever since hatching, or at any rate since the first stage. I have observed this several times in different years.

1889.

The experiments in 1889 were conducted upon the larvæ before hybernation. I had already shown that these younger larvæ are certainly susceptible and capable of becoming either light or dark brown, according to the colours of their surroundings (Trans. Ent. Soc. Lond., 1888, p. 593). I was anxious to test this conclusion still further.

On July 3rd about 24 newly-hatched larvæ were placed in a cylinder, and fed upon filbert leaves, surrounded by abundant dark twigs; while an equal number from the same batch of eggs were placed in a similar cylinder, containing the leaves alone. On July 11th the two lots were compared. The larvæ were about 5·25 mm. long, and those in dark surroundings were decidedly, but not strongly, deeper in tint, some effect having thus been produced in about 8 days. Later on in the summer (date unnoted) they were again compared, and the differences were more pronounced. The larvæ did not survive the winter.

It is therefore clear that these young larvæ are distinctly susceptible during the earlier stages, when they are not as yet dimorphic, but only exhibit various shades of brown.

13. Experiments in 1890 upon Phigalia pilosaria.

38 larvæ hatched in a cool cellar a few days before April 26th, when they were first fed (on *Populus nigra* and elm). The experiments did not begin until May 12th, when the larvæ were of an average length of 20 mm. in the curved position of rest. They were then divided among 4 cylinders as follows :—

Dates.	Experiment I. Dark Surroundings (dark twigs).	Experiment II. Dark Surroundings (dark twigs).	Experiment III. Green Surroundings (leaves, &c., alone).	Experiment IV. Green Surroundings (leaves, &c., alone).
May 12	10 introduced.	9 introduced.	10 introduced.	9 introduced.
,, 17	Average length of 31·5 mm. in all experiments. Larvæ on the whole rather darker than those in III. and IV.	As in I.	Distinctly but not greatly lighter when compared as a whole with I. and II. 9 alive.	As in III. 7 alive.
,, 23	All full-fed. As before, slightly darker than III. and IV., but little difference.	Full-fed. As in I.	Full-fed, and most of them seeking pupation.	Full-fed, and 1 seeking pupation.

The fact that there was some noticeable difference probably indicates considerable susceptibility, remembering the late period at which the experiments began, and the rapid growth which at once set in. It is likely that these experiments will prove to be chiefly interesting as showing, with some of those conducted upon *A. betularia* in 1892, the comparatively early stages during which the colours of the mature larvæ are determined in species which possess the power of individual colour-adaptation.

14. Experiments in 1887 and 1888 upon Crocallis elinguaria.

1887.

A batch of eggs of this species, laid by one moth, was sent me, in the autumn of 1886, by Professor Meldola. They hatched in the following spring, and were at first fed in a bottle, being offered privet, hawthorn, and lilac. The latter food-plant was preferred, and, after April 25th, was alone employed. The experiment was begun at this date. The tabular form is unsuited to the notes taken.

April 25.—The largest larvæ were about 15·0 mm. long; 8 were this size or rather smaller, while 4 were much smaller (about 8 mm. long), and 1 intermediate between these two lots. 4 of the larger larvæ and 2 of the smaller were placed in dark surroundings, while the remaining 7 were placed in green surroundings. The two small ones in the latter were subsequently isolated, although the surroundings were still green.

May 23.—5 in green surroundings and 4 in black were now nearly mature, being about 42·0 mm. long. There was a very marked difference between the 2 sets of larvæ, especially on the ventral sides. They were now (8 a.m., May 23) reversed, the 5 being put in dark and the 4 in green surroundings, to test whether rapid changes of colour could occur; 2 in black and the 2 solitary larvæ in green remained small, and were interchanged also.

May 24.—Noon. No change of colour in the interchanged larvæ. All, except 1 large and 2 small dark larvæ and 2 large light ones, were removed for painting.

May 26.—10·30 a.m. The smaller of the 2 dark small larvæ now seemed to have been affected slightly by the green surroundings, for it was somewhat lighter. The others were unchanged, and were now replaced in their original environments. The 2 now replaced in green were about mature, and very light coloured; the other 3, one of which was quite mature, being dark.

The other larvæ were subsequently replaced, and the pupæ of the two lots kept separate. Many eggs were obtained from moths which emerged from the pupæ of dark larvæ, and these formed the material from which the experiments were continued in the following year, as described below.

This experiment showed conclusively that the larvæ are very sensitive to the colour of their immediate environment, and also that the effects are gradual, and cannot be rapidly reversed by changing the surroundings. Greater effects might perhaps have been produced if the 8 larger larvæ had been subjected to experiment at an earlier age.

1888.

These larvæ were obtained from eggs laid by moths developed from the dark larvæ of the previous year. From the arrangement of the eggs it seemed probable that they were the product of a single pair of moths, but it was impossible to feel sure of this. The experiments are shown in tabular form below.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.	Experiment III. Green Surroundings in the dark.
Larvæ hatched and introduced April 27, 29, and May 2. *May* 6.—Dark twigs introduced; 17 larvæ alive. *May* 18.—Larvæ about 19·3 mm. long. A *very* marked difference between these and II.; seems to have appeared suddenly during the last 24 hours. *May* 19.—17 larvæ.	Larvæ hatched April 27, 28, and 29, and introduced same dates. *May* 14.—17 alive; 8 were separated and placed in lots of 3, 3, and 2 in 3 small cylinders, subject to the same conditions; 9 were left in the original cylinder.	Larvæ hatched and introduced April 30 and May 1; 1 added May 4. *May* 14.—15 alive; many had escaped. *May* 22.—14 larvæ.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.	Experiment III. Green Surroundings in the dark.
May 27.—16 larvæ; the least dark twigs were removed and replaced by very black ones. The larvæ were all very dark, 5 being extremely black. They were not quite so large as II.	*May* 27.—*Lot of* 9: Many nearly full-grown; 6 being large and very light, 1 darker. 2 smaller larvæ were much the darkest. A remarkable difference between these 9 and the larvæ of Experiment I. *First lot of* 3 (moderate-sized larvæ when separated May 14).—Larvæ becoming very light, perhaps more so than the lot of 9. *Second lot of* 3 (small larvæ when separated May 14). — Larvæ were still small. *Lot of* 2 (moderate-sized when separated May 14).—Both larvæ becoming *very* light, with a greenish tinge.	*May* 27.—11 larvæ; they were small, darker than II., but *much* lighter than I.
May 30. — 9 very dark, although 5 were still blackest. The remaining 7 were removed to another cylinder with similar surroundings; 2 of them were nearly mature and dark, although not so deep a tint as the 9. The 5 smaller larvæ were dark, but varied in depth.	*May* 30. — *Lot of* 9: 7 nearly mature; 6 very light; 1 large one and 2 smaller ones were distinctly darker than the 6, but not like the larvæ of I.	
June 2.—The 5 smaller larvæ were becoming very dark; the 2 large ones had also deepened, but not so much as the others: they were now practically mature. No note as to the 9 dark ones, which were probably unchanged.	*June* 1.—*Lot of* 9: 2 light ones spinning; another matured June 2. *First lot of* 3.—Becoming light; 2 very light, like the lightest of the lot of 9. *Second lot of* 3.—Becoming lighter. *Lot of* 2.—Very light, as light as any in Experiment II.	*June* 1.— The larvæ were now becoming darker rather suddenly; they were considerably smaller than those of I. and II.
June 4.—2 of the darker lot of 9 and 2 of the less dark lot of 7 were preserved. The former were not the blackest individuals.	*June* 4.—*Lot of* 9: 2 light ones spun up, and 1 drowned accidentally; the large darker one preserved: it remained much darker than the others to the end. *First lot of* 3. — 1 dead (probably the least light larva); 1 spun and 1 preserved. *Second lot of* 3.—Had become still lighter, especially the 2 larger, which were preserved. No further notes of the remaining larva.	*June* 4.—11 larvæ, a good deal darker than II., but not dark like I., being much nearer to the former; 4 preserved, 1 of which was much lighter than others.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.	Experiment III. Green Surroundings in the dark.
June 6.—*The lot of* 9: 2 had been sent away June 4; the remaining 7 were spinning or just about to spin. They remained extremely dark to the end. *The lot of* 7.—2 had been sent away June 4; 2 were spinning; the remaining 3 were quite dark, like the lot of 9. *June* 10.—Of those left, 1 spun and the remainder were preserved.	*June* 6.—*Lot of* 9: 1 of the darker larvæ spun up; no further notes of the other. They remained comparatively dark to the end, but not like the larvæ of Experiment I. *Lot of* 2.—These very light larvæ were both spinning up.	*June* 8.—2 spun np; now that the larvæ were mature their tint was unchanged. They all remained much darker than II., but far nearer these than the larvæ of I.

These results confirm those of the previous year, and show the great susceptibility of the larvæ. The effects seem to have become prominent somewhat suddenly after about 12 days' exposure to the conditions of experiment.

Experiment III. proved that the larvæ are far more strongly affected by dark surroundings in a strong light than by darkness. This result has been confirmed in other species, and may be considered as established (see especially experiments on *Amphidasis betularia* in 1892).

By far the most important result, however, is found in the fact that the susceptibility to green surroundings was not diminished by the fact that the parent larvæ had been made dark by dark surroundings in the previous year. The comparison between I. and II. leaves no doubt on this point. The rather less complete results in the lot of 9 in II. were probably due to the effect of these large larvæ upon one another. When less crowded the effects were more marked.

There is evidence, then, so far as it can be relied on in one generation, that these marked characters, acquired in a normal manner, and very early in the life of the parents, are not transmitted to their offspring, even in the form of a tendency or bias in one direction rather than another.

15. Experiments in 1889 upon the larvæ and cocoons of Hemerophylla abruptaria.

A captured female laid the eggs from which were obtained the larvæ employed in the following experiments. The great majority of the eggs hatched June 5, a single larva appearing on the 4th. They were fed together until June 17, when the experiment was begun.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.
June 17.—26 larvæ of an average length of 7·4 mm., and most of them 12 days old, were introduced; many very dark twigs (of *Quercus cerris*, &c.) being intermixed with the food-plant.	June 17.—25 similar larvæ surrounded by leaves and green shoots of lilac. Leaves of similar age and from the same plant were supplied to I. Up to this date the 51 larvæ had been fed under the conditions of II., *viz.*, among leaves and shoots, without the intermixture of any dark sticks.
June 30.—Larvæ compared. There was a most remarkable difference between them, these being very dark, almost black. The effect had thus become marked in 13 days or under. The larvæ were of an average length of 15·0 mm.	June 30.—The darkest of these larvæ were probably lighter than the lightest of the others.
July 14.—All the 26 were alive, and very uniformly dark. Their size was about the same as those of Experiment II.	July 14.—The largest larvæ were 31·0 mm. long, and were nearly full-grown. The most usual length was 25·0 mm., some 3 or 4 being much shorter (about 18·0 mm.). All 25 were alive. The colour was extremely uniform, being a pale brown with a greenish tinge in the lightest individuals.
July 25.—2 larvæ had spun up. The 24 remaining larvæ were compared for the last time with those of II. The difference was wonderful, and there was no exception on either side.	July 25.—24 larvæ still feeding, and compared. Both lots were photographed at this date.
July 26.—1 larva had spun up.	July 26.—6 of the largest larvæ were put under the conditions of I., but there was no change.

These larvæ are thus seen to be extremely sensitive.

I was kindly helped by Mr. G. J. Burch in photographing the larvæ. Isochromatic plates were used, and the most favourable results were obtained when the larvæ were exposed for 30 seconds to the light from a small magic lantern (with a paraffin lamp), after passing through a sheet of yellow glass. The larvæ were resting on a piece of black net, and the dark and light varieties were intermixed, so that examples of both were in areas of all degrees of illumination (which differed greatly on the two sides of the net). A collotype of the negative is shown on Plate XV., fig. 3.

The larvæ were painted by Miss Cundell on July 27, and reproductions of the drawings are shown on Plate XIV., figs. 1 and 2. The larvæ are represented of the natural size, and the colour-difference is very well shown, although the attitudes of the resting larvæ are not quite natural. They were probably temporary attitudes assumed after disturbance.

The colours of the cocoons were also tested in these experiments. At first sight the power of adjustment to the surface of attachment seemed to be undoubtedly present, but when I examined the cocoons in 1889, I soon found that the appearance was due to adventitious material being woven into the fabric. The resemblance to surroundings is extremely perfect, and so well packed and so small are the foreign particles that the light brown silk does not in the least interfere with concealment on a dark surface. This is shown in Plate XIV., fig. 2, where a cocoon is represented on the right side of the base of the twig of *Quercus cerris*. When the cocoons were spun on muslin, the larvæ had but little power of gnawing off fragments, and these being few and thinly scattered, the appearance of the cocoon was made up by the light brown silk. Their power of dealing with paper was superior to that of dealing with muslin, but far less than when supplied with bark, which is probably the natural surface on which they spin.

16. Experiments in 1886, 1887, and 1888 upon Rumia cratægata.

1886.

These experiments have a personal interest to me, inasmuch as they first indicated that the power of individual colour-adaptation was widely present among lepidopterous larvæ, and was best studied among the most perfectly concealed forms, rather than among the *Sphingidæ*. I have already said that I owe the suggestion to test this species to Lord Walsingham.

A captured female laid the eggs which furnished the material for this experiment.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.
June 26. — 9 larvæ introduced; dark twigs mixed with the food-plant (hawthorn), black paper floor and roof to cylinder.	June 25.—29 larvæ introduced; leaves only, with green paper floor and roof to cylinder.
June 27.—13 more larvæ added.	
July 14. — Only 4 now alive; small and brown.	July 14.—Only 5 now alive; quite small, and various shades of brown.
July 24.—All but 1 *much* darker than other lot; that 1 about the same as the 3 in the green cylinder.	July 24.—Only three now alive.
Aug. 12.—3 alive; 1 so dark as to be almost black; another larger one was dark brown, mottled with grey; 3rd small and dark brown.	Aug. 12.—Not so large as in I.; the largest was light brown mottled with grey, and with green apparently showing through in many places; the next in size was a little darker brown, with a distinct squarish green patch on each side of the humps on the 3rd abdominal. There was also green in other parts, especially on sides of 6th, 7th and 8th abdominals. The 3rd and smallest was darkish brown.
Aug. 13.—The largest larva was painted (see Plate XIV., fig. 3).	Aug. 13.—A most striking change had taken place in the last 24 hours in the clearing up of the opaque brown pigment, and the consequent appearance of the underlying green. The whole effect was now as much green as brown. This chiefly applied to the 2 larger larvæ; on the 12th they had been brown mottled with green (as the smallest was now); on the 13th they were as much green as brown.
Aug. 28.—The very dark larva continued almost black. There was no trace of green in any of the three.	Aug. 28.—The smaller larva remained the same; the others were not quite so green as on the 13th, but still a distinct greenish brown, a bluish grey "bloom" having appeared on the larger one.
Sept. 5.—The largest had spun up a few days before.	
Sept. 17.—The less dark of the 2 remaining larvæ was painted (see Plate XIV., fig. 4), but both were now very dark, and no trace of green was seen on the darker one, except on using a lens. A little green was present on that which was drawn.	Sept. 17.—The largest, with the "bloom" on it, nearly full-fed, was painted (see Plate XIV., fig. 6); the next in size was much lighter in colour, and a yellowish brown with green appearing through in various parts. The smallest was a dark brownish green, but still much of the latter colour present on it.
Sept. 28.—The 2nd larva painted had spun up.	Sept. 23.—One of the larger ones had spun up a day or two. The lighter large one was painted about this time (see Plate XIV., fig. 7).
Oct. 4.—The darkest larva had just spun up. It had previously been painted (see Plate XIV., fig. 5).	Sept. 26.—The smallest had died; it was lighter than any in I., but not light like the two larger in this experiment.

These results show that the larvæ are very sensitive to the colours of their normal surroundings. This was the first species in which green and brown environments had respectively produced green and brown larvæ. In others the former had merely produced very light brown larvæ, and this is still true of the great majority of species as yet tested. The results determined me to conduct the same experiment more carefully and on a larger scale in the succeeding year.

It is interesting to observe that, although there was so marked a difference between the larvæ in I. and II., considerable individual differences were noticeable in each set. The sets varied in the amount or distribution of darkness and greenness respectively, and in the amount and distribution of "bloom." Although the conditions were the same for each set, the larvæ reacted rather differently, according to their individual predispositions. I find this to be the case in many species, but the results become more and more uniform as the conditions are applied earlier, and as care is taken that they shall be as extreme as possible throughout. But when every precaution is taken, occasional exceptions show that there are sometimes strong individual differences of predisposition. This will appear in some of the experiments on *Amphidasis betularia*.

1887.

(*See Table, pages* 320, 321.)

These larvæ were shown at the British Association at Manchester, and a brief summary of the result is printed in the Report of the Meeting (see Report, 1887, p. 756; also 'Nature,' vol. 36, p. 594). Professor Weismann, who was staying with me before the meeting, compared them carefully; he subsequently alluded to them in his essay, "On the Supposed Botanical Proofs of the Transmission of Acquired Characters" (1888). See Weismann, "On Heredity," Oxford, vol. i., 2nd edition, pp. 406, 407.

One of the chief interests is, however, due to the fact that the moths produced by the larvæ of Experiments II. and III. paired and laid eggs, providing the material for the next year. As the larvæ of II. had been made dark by their surroundings, and the larvæ of III. green, and as the offspring of both were subjected to both these conditions, the test of any hereditary result was unusually complete.

1887.

A captured female *R. cratægata* laid a large number of eggs which afforded the material for the following experiments. The larvæ began to hatch in large numbers on June 24. The experiments began rather over a fortnight later, on July 11, when the larvæ were arranged as follows:—

Dates.	Experiment I. Dark Surroundings: Dark twigs intermixed with food-plant (hawthorn).	Experiment II. Dark Surroundings: As in I., only experiment begun about a fortnight later than in other lots.	Experiment III. Green Surroundings: Leaves and young shoots of hawthorn alone made use of. The leaves became brown on one occasion.	Experiment IV. Green Surroundings: As in III., except that leaves never became brown.	Experiment V. Green Surroundings: As in III., but leaves became brown more than in latter.
July 11 July 26 or 30	About 30 larvæ introduced. July 30.—25 alive.	25 larvæ introduced. July 26.—15 larvæ alive; hardly half-grown; 1 appears to be green, but all others various shades of brown. *Dark sticks added, and experiment begun.*	13 larvæ introduced. July 30. — 9 alive; the leaves had unfortunately become brown. This was not repeated afterwards.	About 20 larvæ introduced. July 30.—Only 7 alive.	17 larvæ introduced. July 26.—12 alive, of various shades of brown. Some leaves had become brown the last few days.
Aug. 8	Refed.	All 15 seem to be getting dark.			12 alive; leaves again allowed to become brown, and remained so a few days.
Aug. 16	3 or 4 advanced in last stage.	1 nearly mature, 1 somewhat smaller, but no others in last stage. Although many were partially green, they are losing it; the older ones especially are brown.	9 alive; mostly in last stage but one, and becoming *very* green in most cases.	7 alive; 2 small in last stage, others smaller still; they were becoming very green indeed; 1 small one was the greenest in any lot.	1 nearly mature and greenish brown; no others in last stage. All but 4 were green rather than brown, although some brown in all. There was a great change towards green since the last examination (Aug. 8). The larvæ were for the most part greener than any obtained in 1886.

Aug. 29 or 30	Aug. 30.—25 alive, very dark.	Aug. 29.—14 alive; 7 large, all brownish and mostly deep brown, although with a greenish tinge in 2 or 3. A most remarkable difference between these and the larvæ in III., IV. and V. Not quite so dark as I.	Aug. 29.—The 9 larvæ compared with II.; a most striking difference between them. All were green but 1, which was brownish. 4 were large.	Aug. 30.—Greener than V., and about the same as III. 1 larva mature.	Aug. 30.—12 alive; 1 at least pupating. Leaves had again become brown for some little time. These larvæ were not so green as III. or IV.
Sept. 12	24 alive; 2 pupating.	11 feeding, 2 ready for pupation.	1 had spun.	5 feeding, 1 spun up.	1 died; 9 still feeding.
Sept. 15		3 pupating and removed.			
Sept. 22	19 still feeding.	8 larvæ, and 2 spun up.	5 still feeding; all *very* green, except 1, which is darker, but greenish; 2 pupating, 2 pupæ.	5 larvæ, 2 of which are apparently mature. All were distinct green forms, 4 of them being extreme.	9 still feeding. The grey "bloom" was marked in these green ones, and about half had a more or less distinct brownish tinge, especially pronounced in 1.
RESULTS.	The darkest larvæ of all these experiments, but not extreme dark varieties like the darkest obtained in 1886. They were nevertheless distinct dark forms, without any but the faintest trace of green. There was, however, a considerable amount of greyish "bloom" on many of them.	The larvæ of II. never became quite so dark as I., the grey being more predominant. They were *very* different from III., IV. and V.	These results were very characteristic of green surroundings, and contrasted most strongly with the effects produced in II., and especially in I.	Results as in III.	These were not nearly such extreme results as those obtained in III. and IV., but they were *far* nearer to the latter than to those of I. and II. The divergence from III. and IV. is easily explained by the longer time during which these larvæ were exposed to brown leaves, and because they were, up to Aug. 30, crowded in a very small cylinder, so that each was much affected by the colour of the others; the larger number of larvæ also contributed to the result.

1888.

The larvæ hatched from eggs laid by moths from Experiment II. (1887) will first be considered. The pupæ of this experiment were kept in one receptacle, and the moths emerged together, so it is impossible to decide upon the number of moths which laid eggs; but the small batch obtained favours the conclusion that only one did so.

The experiments on this lot of larvæ are given below in a tabular form.

Experiment I. Dark Surroundings.	Experiment II. Green Surroundings.
July 1.—12 larvæ introduced, still quite young.	July 1.—12 similar larvæ introduced.
Aug. 5.—10 alive; larvæ were still small and not very dark yet.	Aug. 5.—8 alive; still small. Compared with I., these were decidedly lighter and somewhat greener; they were not as yet very light and green.
Aug. 19.—10 alive; much darker than II., but not so dark as might be expected from the dark surroundings. Most were nearly mature.	Aug. 19.—8 alive; these were clearly greener and lighter, and good examples of the effect of green surroundings.
Sept. 3.—9 alive; 1 spun. The results were not nearly so marked as in II., but they were much darker than these; 3 of them were grey rather than dark, the remainder being darker, but only one very dark, and this with some green on it.	Sept. 3.—8 alive, 3 having spun up; 2 full-fed and green-grey in colour: the results very characteristic of green surroundings. 3 smaller and not quite so green, but still light varieties.
Sept. 12.—1 more had spun and 7 left.	Sept. 12.—2 more had spun and 3 left.
Sept. 14.—Still 7 left, and not very dark considering the conditions; 3 were greyish and 1 of the darkest was still greenish. Compared with the larvæ descended from moths of Experiment III., 1887, those in I. (of which only 5 could now be compared safely, because the others had undergone changes preparatory to pupation) were rather darker than these 7, but not much. On the other hand, these 7 were rather darker than the 4 II., and much more so than the 5 IV. There was only 1 III. left for the purposes of comparison, and this seemed to be about the same as these 7.	Sept. 14.—Still 3 left; they were very pale greenish grey, showing distinctly the effects of the experiment, far more than in I. Compared with larvæ from moths of Experiment III., 1887, these 3 were certainly lighter than the 5 IV. now left, much lighter than the 1 III. and 4 II., and far more so than the I.

Conclusions are best deferred until the description of experiments upon moths produced by the larvæ of Experiment III., 1887.

As in the last experiments, it is impossible to decide the number of moths which laid the eggs. The larvæ of these experiments were hatched on June 16th, 1888, and other days not far removed. The young larvæ were kept together until July 3rd, when many were arranged in Experiments I., II., and III. On July 7th a further number were divided between II. and IV.

Dates.	Experiment I. Dark Surroundings (dark twigs).	Experiment II. Dark Surroundings (dark twigs covered with black paper).	Experiment III. Green Surroundings.	Experiment IV. Green Surroundings.
July 3	23 larvæ introduced.	12 larvæ introduced; 8 more added July 7.	36 larvæ introduced.	July 7.—8 larvæ introduced.
July 20	More dark twigs added, although many were present already. Marked effects had been produced.	At this date twigs covered with black paper were substituted for the ordinary dark ones. Their number was gradually increased for about a week.	Examined; much effect was seen to have been produced. 13 larvæ removed from here and introduced into IV.	13 larvæ introduced from III.
Aug. 6	22 larvæ living: compared with others these were considerably darker than any of the others, including II. Only 1 or 2 larvæ were greenish brown, like many of II., and these less distinctly so.	20 larvæ living; many of these larvæ were greenish brown. The slight effect of the black twigs here was one of the most interesting things in this comparison.	21 larvæ living. These larvæ were much greener than I. and II.; only two of them were dark and brownish rather than green, and these not very dark. 1 larva had spun at this date, and 1 previously.	21 larvæ living. These were like III., except that none were very brown. The marked greenness of III. and IV. is remarkable as compared with the less marked darkness of the other 2 lots, even I.
Aug. 19	3 had spun.	3 had spun.	Many had now spun, for the most part a few days previously.	Many had now spun.
Sept. 4	....	Only 8 remained, the rest having spun. The 8 are full-fed and darkish, although by no means extremely dark.	Only 2 remained; both greenish larvæ	
Sept. 14	Only five larvæ could be relied on (the others having spun or changed colour before pupation). They were dark, but not extremely dark forms, but considerably darker than the 7 of Experiment I. descended from moths of II., 1887.	4 larvæ could be relied on. They are of a rather dark greenish brown, certainly darker than IV., but not greatly so.	1 larva only could be compared: it resembled those of II.	5 larvæ could be compared; 4 were of a light greenish brown, and much the lightest coloured larvæ at this date in this set of experiments, 1 resembled II. and III.

Experiment II. is interesting, in showing that black paper-covered sticks are not nearly so effective in producing dark larvæ as dark twigs, although the latter are less black. At the same time it must be remembered that the former tend to become grey from the growth of mould.

The comparison between these and the former larvæ of this year certainly shows that the results produced in the parent larvæ in 1887 were not hereditary. A careful comparison was made on Sept. 14th (see both sets of tables), showing that the larvæ descended from those which had been made green (III. in 1887) were not only darker than those descended from larvæ which had been made dark (II. in 1887), when both were exposed to conditions which tended towards darkness, but the converse was also true, *viz.*, the larvæ of the former set became less green than those of the latter, when both had been subjected to green surroundings. In other words, the tendencies exhibited were rather the reverse of those to be expected by the operation of heredity, and it seems clear that no bias whatever was imparted to the offspring by the conditions to which the parents had been exposed.

In addition to these two sets of experiments, another set was conducted in the same year (1888) upon larvæ hatched from eggs laid by a captured female. These eggs hatched June 18th and 19th. Thus all the larvæ in this set of experiments came from the same parents.

Dates.	Experiment I. Dark Surroundings.	Experiment II. Green Surroundings in dark.	Experiment III. Green Surroundings.
July 1	45 larvæ introduced when quite small.	45 similar larvæ introduced.	45 similar larvæ introduced.
July 21	All had escaped except 3 by gnawing holes in the black tissue-paper roof to cylinder. Black net substituted, and 12 larvæ introduced from II. and III., making 27 here.	34 or 35 larvæ alive. The leaves found to be withered and brown when examined Aug. 19.	39 larvæ alive. Leaves had become very brown. Larvæ had not become green.

<table>
<tr><th>Dates.</th><th>Experiment I.
Dark Surroundings.</th><th>Experiment II.
Green Surroundings in dark.</th><th>Experiment III.
Green Surroundings.</th></tr>
<tr><td>Sept. 4</td><td>12 larvæ alive. They were carefully compared, and no effects were to be seen, all the larvæ of I., II., and III. being darkish. The larvæ in the latter were evidently affected by the frequency with which the leaves had become brown.</td><td>12 larvæ alive; 2 had spun up.</td><td>17 larvæ alive; 1 had spun up.</td></tr>
<tr><td rowspan="2">Sept. 14</td><td rowspan="2">9 alive. Many were now spinning, and the rest nearly mature. This lot is but slightly different from the others, which are practically the same; these are no darker, but exhibit rather less of a greenish tinge than the others.</td><td>10 larvæ alive.</td><td>13 larvæ alive.</td></tr>
<tr><td colspan="2">These larvæ were somewhat greener than in I., but it was a very brownish green; a colour which, however, concealed them very effectually among the greenish brown leaves which surrounded them.</td></tr>
</table>

It is evident that these experiments were treated with some neglect, and the food not changed sufficiently often, so that the leaves became brown, and remained so for some time. The results are, however, interesting, showing that such surroundings produce a powerful influence, no less than those provided by dark twigs; and in the case of Experiment I., it is clear that the effects of the latter were mitigated by those of the former. The results of Experiment II. harmonise with those of other experiments in which darkness produces darkish larvæ intermediate between the effects of dark surroundings and of green surroundings in the light. For this would have been the position of the larvæ in II. had the experiments upon I. and III. been carried out with care.

After the experience I have now had with *Amphidasis betularia*, I should be glad for the experiments on *R. cratægata* to be repeated with the use of other greener food-plants, such as *Populus nigra* (if, indeed, the larvæ would eat this plant). I anticipate that bright green larvæ might be produced in this way without any of the brownish shade or "bloom," either or both of which are usually found when the green surroundings are contributed by hawthorn. It would also be interesting to test the effect of dark lichen-covered twigs on this very sensitive species.

While larva-beating during the past autumn (1892), I have noted the colours of the larvæ of this species beaten from various bushes of hawthorn and blackthorn, and I always found a most marked correspondence between the appearance of the larva and the particular bush on which it had lived. The bushes, even when belonging to the same species, differ greatly in the darkness of their twigs, and the amount of bloom-like superficial colouring. These individual differences were faithfully reproduced, showing the efficiency of the power of colour-relation to surroundings in promoting concealment under normal conditions.

Some of the cocoons produced in these experiments are described in Proc. Ent. Soc. Lond., 1888, p. xxviii, as illustrations of the power of individual colour adaptation, being brown when spun upon green paper and green leaves, but white when spun upon white muslin. I should not now advance these cocoons as examples of the power until after renewed experiments have been made, guarding against the sources of error pointed out by Mr. Bateson.

17. Experiments in 1886, 1889, and 1892 upon Amphidasis betularia.

1886.

A single captured female laid the eggs which produced the larvæ described in the tables below.

When examined and compared Aug. 17th or 18th the sizes of the larvæ were found to vary very greatly, but none had entered the last stage. The following letters were therefore used to express the sizes:—

A.—Changing last skin.
B.—Large in last stage but one; over 30·0 mm. long when extended at rest.
C.—Medium size in last stage but one; over 24·0 mm. long when extended at rest.
D.—Very small in last stage but one, or changing last skin but one.
E.—Earlier stages.

(*See Table, pages* 328, 329.)

In working at experiments such as these, I often note the results in each set of larvæ, without paying attention to the conditions (which are generally indicated by a number or letter). Hence the observations are entirely unbiassed, for I do not know the past history of each set. Subsequently the notes are written out and the conditions described, and then only can the value of the experiment be estimated properly. In the case of the experiments just recorded, this has only just been done, more than six years after the experiments were conducted. Had I written out the results earlier, I should have seen what admirable material was afforded by the larvæ of this species, and should have sought them for more detailed and careful investigation. My general impression at the time the notes were taken was, as is often the case, the reverse of that now gained by a careful study and comparison of the whole course of the experiments. At the time I thought that the larvæ were not susceptible, or but slightly so. I had even less time than usual to do more than take the necessary notes, being exceptionally hurried while this work was progressing.

1889.

The next investigation of this species took place three years later, in 1889, and was the outcome of the accidental capture of a female moth which laid large numbers of eggs. I remembered the tendency of the birch leaves to become brown, and determined chiefly to make use of *Populus nigra*, the large bright green leaves of which will keep fresh for a very long time if the twigs are placed in water.

Most of the experiments were begun July 15, a few days after hatching, when the larvæ were still quite small. The results can be given most concisely in a tabular form.

(*See Table, page* 330.)

I. Ordinary food-plant.	I. A. Dark twigs.	I. B. Blinding Experiment.	II. Green and brown leaves.
Upon birch leaves and twigs (including dark ones) for the whole larval life up to Aug. 18, and retained to the end in many cases.	In I. up to Aug. 18, then dark hawthorn twigs intermixed with food.	In I. up to Aug. 18, then surrounded by green twigs and leaves of birch, 3 out of 5 larvæ being blinded.	Surrounded for about a fortnight with the leaves alone of birch, but these had become old and brown towards end of time.
Aug. 18.—Compared. A. Greyish brown . 1 Greenish brown . 1 Reddish brown . 3 B. Reddish brown 4 Greenish brown . 1 Greyish brown . 2 Greenish . . . 1 C. Light greenish brown . . . 1 Brown . . . . 4 D. Reddish brown 1 Greenish brown . 2 — 21 Many removed for other experiments.	*Aug.* 18.—4 of the B larvæ (2 reddish brown, 1 greenish, and 1 greyish brown, the lighter of the 2), 3 of the C (2 brown and the lighter one), and 1 of the D (the lighter of the 2 greenish brown ones) were introduced from I. at this date.	*Aug.* 18.—The A lot from I. introduced at this date. By Aug. 21 they had changed their last skins, and some were blinded, as follows:— 1 light reddish brown (*blinded*). 1 light reddish brown (*unblinded*). 1 dark reddish brown (*unblinded*). 1 greenish brown (*blinded*). 1 greyish brown (*blinded*).	*Aug.* 18.—Compared. A. . . . . . . 0 B. Greenish . . 1 Light greenish brown . . . 2 Dark reddish brown 2 C. Reddish brown 3 D. Reddish brown 5 — 13 3 of the B (1 of each colour), 1 of the C, and 2 D (changing last skin but one) removed to dark surroundings (II. A). Fresh green leaves added and brown removed. On Aug. 21 an escaped reddish brown larva (D) was added.
Sept. 3.—All the 8 remaining larvæ in last stage, most being nearly mature, the smallest about half through the stage; 4 green, although not very bright, brown dorsal line present; 1 dull greenish brown; 3 dull reddish brown. The last 4 were not very dark.	*Sept.* 3.—1 a decided green, much brighter than any in I.; 4 very dark smoky brown, much darker than the reddish brown ones in I.; 1 greyish brown, much darker than the greenish brown larva in I. 1 of the dark larvæ pupating.	*Sept.* 3.—The larvæ had a very smoky appearance, especially the blinded ones; the others redder and not so dark as those in I. A.	*Sept.* 15.—1 pupa, 3 nearly mature green larvæ with brown dorsal line.
In feeding the larvæ it is probable that twigs with a great profusion of leaves were employed; hence the absence of very dark forms and the prevalence of green.	The effect of the dark twigs present between Aug. 18 and Sept. 3 is very clear on all the larvæ, except the single bright green one, which seems to have been especially predisposed towards this variety, or more probably may have been older than the others and its colour already determined.	The results are not convincing, because the larvæ were only subjected to these conditions during the last stage; and more careful recent work (1892) shows that they are but little sensitive during this period. Nevertheless, the results are such as to suggest further blinding experiments in the future, and for longer periods of larval life.	The effect of green surroundings predominated in spite of the leaves becoming brown part of the time. This result and that of I. perhaps indicates that the larvæ may have been somewhat predisposed towards the green forms.

II. A. Black paper leaves, &c.	III. Darkness.	IV. Green leaves.	V. Orange paper leaves.
Up to Aug. 18 same surroundings as II.; then brown birch twigs introduced with food, and also pieces of black paper roughly cut into the form of leaves; also black floor and roof.	For about a fortnight, ending Aug. 18, enclosed in a darkened cylinder (covered with one thickness of black tissue paper). Dark twigs of birch not excluded.	Kept for last fortnight on birch leaves and green twigs under a shade of one thickness of faded yellowish green tissue paper.	Kept for about a fortnight on birch leaves and twigs (brown ones included), intermixed with pieces of orange paper cut roughly into the form of leaves.
Aug. 18.—The 6 larvæ which had been removed at this date from II. were now placed in dark surroundings.	*Aug.* 18.—Compared. A. . . . . 0 B. Dark reddish brown . . . 4 C. . . . . 0 D. Reddish brown 2 Light greenish brown . . . 1 — 7 Placed at this date in a larger cylinder covered with 2 thicknesses of black paper and black floor.	*Aug.* 17.—Examined and compared. A. Dark reddish brown . . . 1 B. Dark reddish brown . . . 1 Green . . . . 1 Greenish brown . 3 C. Reddish brown. 3 Light greenish brown . . . 1 D. Reddish brown 3 Light reddish brown . . . 2 — 15 Put in a larger cylinder; tissue paper changed.	*Aug.* 18.—Examined and compared. A. . . . . 0 B. . . . . 0 C. Greenish brown 3 Tending in different degrees towards reddish brown, two being the typical colour 6 D. Reddish brown 1 E. Reddish brown, varying . . . 4 Light greenish brown . . . 1 — 15
Sept. 15.—5 larvæ in last stage, 3 being dark brown and 1 greenish brown; 1 small and reddish brown; 1 pupa.	*Sept.* 15.—Only one larva left; greenish brown.	*Sept.* 15.—1 pupa; 1 nearly mature green larva, with brown along back. Others escaped.	*Sept.* 15.—Only 2 remaining; both distinctly green, with a brown line down back.
The effect of dark surroundings added Aug. 18 is clear when these larvæ are compared with those of II.	Insufficient to draw conclusions, but so far as it goes, the evidence corresponds with later experiments in showing that darkness is not so effective as dark surroundings in a strong light.	Insufficient evidence, but corresponds with II. in showing susceptibility to green surroundings.	Results correspond with those obtained in 1892, showing the power of orange surroundings in producing green larvæ.

A. Dark Surroundings.

I. Cylinder with abundant dark twigs intermixed with food.	II. Same as I.
July 15.—31 young larvæ introduced.	July 15.—30 introduced.
July 24.—Compared on this and following dates. Resting (by day) on the dark twigs were 16 dark, 1 green, and 2 intermediate larvæ. Resting on leaves and green shoots were 3 dark, 3 green, and 6 intermediate larvæ.	July 23.—Compared. Nearly all dark brown; at later dates this tendency became more marked, and finally only 2 exceptions remained, 1 being bright green, and 1 intermediate.
Aug. 5.—3 dark larvæ on leaves; 25 dark larvæ on dark twigs; 1 intermediate larva on dark twigs; 2 brownish intermediate larvæ on dark twigs.	
Aug. 10 and onwards.—The larvæ sought pupation without further change of colour.	Aug. 11.—At this date and onwards the larvæ began to seek pupation.

The extreme susceptibility to dark surroundings is clear from these results. The fact that green surroundings cannot be excluded is no doubt the explanation of the few exceptions. In the converse experiments with green surroundings everything dark can be excluded, and hence exceptions did not occur. The exceptions undoubtedly show individual differences in the degree of susceptibility to green and brown surroundings respectively, although the final result—1 marked exception (the single green larva)—out of 61 individuals shows that such differences are of no great numerical importance in determining the colours of this species. The proportions of light and dark larvæ found July 24, in I., on dark and green surfaces respectively, seem at first sight to suggest the existence of a tendency to seek an environment with the corresponding colour. On Aug. 5, however, nearly all were on the dark twigs; and in 1892 very inappropriate situations were often observed (Experiment XXVI.).

It is also seen that a period of 8 days (July 15 to 23) is sufficient to produce marked effects on the majority of the larvæ.

B. Artificial Dark Surroundings.

A single experiment was made with sticks covered with black tissue paper taking the place of twigs which were naturally dark, like those of I. and II. This and some of the other experiments were begun rather later than those just described; for the whole stock of larvæ was not exhausted on July 15th.

Experiment III.

Black-paper-covered sticks intermixed with food-plant.

July 20	9 larvæ introduced.
Aug. 17	The larvæ were very large. All 9 were very black, at least as dark as those of I. and II.
Aug. 30	4 ceased feeding.
Sept. 4	2 ceased feeding. They remained as dark as ever to the end; 1 was dead by Sept. 5.

This experiment shows that artificial may be as effective as natural surfaces. It is probable that the comparative failure in the case of *R. cratægata* (see p. 324) was due to the growth of mould upon the black paper, making it much lighter in appearance.

C. Very small proportion of dark twigs in surroundings, and comparison experiment with green alone.

Two experiments were then made with the object of testing the susceptibility of the larvæ to a very small proportion of dark material in the environment. Incidentally the effect of green surroundings produced by another food-plant (nut) was also tested, and found to be as effective as that due to *Populus nigra*.

The experiments were arranged as follows:—25 young larvæ were introduced July 20 into a large glass lamp-shade (about 165 mm. high, and the approximate capacity of 1300 cc.). On Aug. 21 they were removed to a larger lamp-shade (204 mm. high, and the approximate capacity of 1900 cc.). These relatively large areas were kept filled with green leaves and shoots of nut, intermixed with which were 5 small dark pieces of dead twig. Three of these were about 40, 65, and 75 mm. long respectively, while 2 of them were about 80 mm. in length; the diameters varied from 3 to 5 mm. They were unbranched, but mostly very rough; 1 was curved, the rest straight. The relation between the sizes of twigs and the smaller glass cylinder first used is shown about $\frac{1}{4}$ the real size in Plate XV., fig. 4.

In the comparison experiment, 25 larvæ were introduced July 20 into a glass cylinder (about 185 mm. high, 82 mm. internal diameter, and 1000 cc. capacity); and on Aug. 21 they were transferred into two lamp-shades (about 165 mm. high, and the approximate capacity of 1300 cc.). These larvæ were treated exactly as in the former experiment, except that their surroundings were uniformly green, no dark twigs being at any time admitted. The results of the experiments are given below.

Experiment IV. Green Surroundings, with very small proportion of dark material.	Experiment V. Green Surroundings alone.
July 20.—25 larvæ introduced.	July 20.—25 larvæ introduced.
Aug. 12.—8 larvæ were resting on the pieces of dark stick, and 1 was holding a piece by its thoracic legs.	
Aug. 21.—23 larvæ alive; shifted to larger lamp-shade.	Aug. 21.—22 larvæ alive; shifted to two lamp-shades, between which they were equally divided.
Aug. 24.—The larvæ compared (1 unnoted):— *Intermediate* . . 6 *Green* . . . . 4 *Dark* . . . . 12 — 22	
Aug. 26.—1 dark larva dead (about half-grown in last stage).	
Aug. 30.—6 larvæ dead:—4 *dark* (1 large, 3 small in last stage); 2 *green* (small in last stage). The rest carefully compared:— *Green* . . . . 3 *Greenish intermediate* . 2 *Intermediate* . . . . 1 *Brownish intermediate* . 2 *Dark* . . . . 8 — 16	
Sept. 2. — The larvæ were now mostly pupating; 1 had died, and 1 was lost. No further change in the colours.	Sept. 2. — Many were now pupating; all the 22 were alive, and all bright green.

These results are very interesting and remarkable. They show that the susceptibility to dark surroundings is far keener than to green, and this corresponds with the fact that the dark larvæ are much more perfectly concealed than the green. Although the proportion of brown to green in the surroundings may be very small, it is still to the advantage of the average larva of this species to resemble the former, and the average larva does so.

The green larvæ are of a yellower shade than that which appears when they are fed upon *Populus nigra*. This corresponds to the difference between the leaves themselves.

D. Dark Surroundings near the larva, but not actually in contact, and comparison experiment with green alone.

The details of the experiment are described below:—

VI. On green leaves alone, with dark twigs *outside* cylinder.	VII. On green leaves alone, for comparison with VI.
July 23. — 21 larvæ, previously surrounded by green leaves alone, were carefully divided into two lots as much alike as possible; when any difference was unavoidable, the darker larvæ were put in VI., the greener here, in a small cylinder containing green leaves alone, but surrounded by a large cylinder with dark twigs packed between the two.	July 23.—The 21 larvæ divided at this date between VI. and VII. were small and nearly all greenish, except one, which was large and green. The latter was placed here with 10 of the small ones, on the whole *slightly* darker than those in VI.
Aug. 2. — 1 is certainly brown, though not a very dark one; the rest green.	Aug. 2. — All green, or evidently rapidly becoming so.
....	Aug. 4. — 6 are still in last stage but one, 4 in last stage, 1 changing last skin; all bright green, except the smallest, which is changing in that direction.
Aug. 13. — The dark twigs were absent Aug. 6—12. The first became mature. The single larva still remained brown; all others green.	Aug. 13. — The first became mature. From this date onwards the larvæ gradually sought pupation, all being bright green.
Sept. 2. — The dark larva was nearly mature (quite so Sept. 6), and was a brownish intermediate larva. All the others remained bright green, and matured at a rather earlier date.	

Conclusions. — The fact that one larva became brown in VI. is not sufficient evidence that any results were produced, except by the light being somewhat dimmed by the surrounding twigs, and especially by the effects of crowding in a small cylinder. The experiments of 1892 show that both these causes are effective in producing dark larvæ. It is probable that the dark larva is to be accounted for in one of these ways, inasmuch as green surroundings in which such causes did not operate never produced a single dark larva (see below).

E. Green Surroundings.

(*See Table, page* 335.)

The strong susceptibility to green surroundings when nothing brown or dark is present is extremely clear in these results, as well as in the comparison experiments of C and D (V. and VII.). Among the 105 larvæ which matured in these 7 experiments not a single exception occurs.

A very characteristic green larva with a brownish shade along the dorsal area was painted by Miss Cundell, and is represented in Plate XIV., fig. 8. It is shown in a very common attitude, resting on a green twig of *Populus nigra.*

Many of the green and dark larvæ from one of these experiments, and either I. or II., were interchanged for a few days during the last stage. No effects were produced, and it was clear that the larvæ are not susceptible to a short exposure during this period of life.

F. White Surroundings.

Nine larvæ were fed upon *Populus nigra*, the surroundings being green, except for the presence of many white paper spills. The experiment was arranged July 20, and the larvæ were compared with the others Aug. 17. Some of them tended towards green, and some towards light brown, but in both, these colours were, without exception, almost hidden under the predominant whiteness which gave the larvæ a very remarkable appearance, utterly unlike that in any of the other experiments. They were again examined Aug. 24, when the whiteness of the larger larvæ was even more pronounced. They were carefully compared Sept. 2 with 12 of the green larvæ upon nut (Experiment V.); 3 remained small in

E. Green Surroundings.

Leaves and green shoots of the food-plant were alone made use of.

VIII.	IX.	X.	XI.	XII.
July 15.—16 young larvæ introduced. July 23. — 4 largest all bright green, others brownish green. Aug. 5.—15 larvæ found, and all bright green. Aug. 8.—From this date onwards the larvæ matured, remaining bright green to the end.	July 15.—14 introduced. July 24. — All green or greenish. July 28.—All green. Aug. 4.—1 large, 3 moderate-sized, 8 small, 2 changing last skin. Aug. 10.—From this date the larvæ matured, all remaining bright green; 1 died.	July 15.—15 introduced. July 25. — All green or greenish. .... Aug. 9.—From this date the larvæ matured, and all remained bright green; 1 died. At this date a chocolate-brown larva found wild upon apple was added to this cylinder to see whether it could change its colour. It was small in the last stage, or at the end of the last but one. It remained dark until mature, when it was eaten by a lizard.	July 15.—16 introduced. July 21. — Mostly about 11·0 mm. long. All greenish, with brown shade on back, and dark beneath. July 28. — All green but one, which is brownish green. The largest is 34·0 mm. long, and bright green. Aug. 4.—10 small in last stage, 1 large, 2 moderate-sized, 3 changing last skin. All now bright green. Aug. 8.—From this date the larvæ matured, remaining bright green.	July 15.—12 introduced. July 23.—All larger ones bright green, and all others changing in that direction. Aug. 4. — 4 small in last stage, 4 large, 2 moderate-sized, 2 changing last skin. All bright green. Aug. 8.—From this date the larvæ matured, remaining bright green.

the last stage, while 6 were nearly full-fed, and these latter were chiefly compared. The white points on the skin appeared to be far more abundant in these 6, and, so far as any green tint appeared, it was of a whitish bluish shade, instead of bright and yellowish, as in all the larvæ upon nut.

The green blood from 2 white and 3 bright green larvæ was then compared, to see whether any difference in the shade of green was due to its colour. There was some individual difference in the tint of the blood, but this was true of both sets of larvæ. It was clear that no explanation was thus to be found, and that the seat of effective colour was in the skin and the structures immediately below it.

The three smaller larvæ were also white; and although 1 tended towards a dark variety, the tendency was obscured by the whiteness.

These results were so remarkable that, although there was no exception, I did not venture to publish them until I had obtained confirmation. This, however, has been forthcoming in the experiments of the past summer (1892), and the results have now been seen by many naturalists.

G. Effect of unsuitable food upon colour-relation.

On July 20, 21 young larvæ were introduced into a cylinder, and supplied with lilac-leaves, dark twigs being abundantly intermixed with the food-plant. The larvæ were observed as follows:—

July 20.—21 young larvæ introduced.

Aug. 9.—11 alive, but small for age.

Sept. 4.—5 alive, but quite small for age; reddish brown in colour.

Sept. 25.—3 still alive, although these subsequently died.

It is therefore probable that the unsuitable food, which prevented the larvæ from attaining maturity, did not interfere with their susceptibility to the colours of the environment. The results observed on Sept. 4 show that all the 5 surviving larvæ harmonized with the dark surroundings. In order to furnish conclusive proof that this result was due to true susceptibility, and not to pathological change, it will be necessary to repeat the experiment, employing green surroundings alone. Such an experiment was attempted as a comparison with the above, but the 21 larvæ had all died by Sept. 4.

The chief results of these experiments, as regards green and dark surroundings, have been briefly mentioned in 'Colours of Animals,' pp. 152, 153, where a dark and light form are represented by uncoloured illustrations.

These experiments at once proved that *A. betularia* was by far the most suitable species for the purposes of this investigation; and I tried to obtain eggs in the succeeding years. In this I was unsuccessful until the present year, in which a much larger series of more careful experiments have been conducted.

The pupæ obtained from these experiments were carefully separated, and the attempt was made to breed from the imagos which emerged. The great majority, however, died in the pupal state, and those which emerged did not pair.

As the moths are well known to vary in darkness, I noted the colours of those few which emerged, but found that there was no relation between the larva and imago in this respect.

1892.

This is by far the most extensive series of experiments upon the modification of the colours of larvæ by the environment that I have ever undertaken. The results obtained in 1889 not only proved that this is the most sensitive larva as yet subjected to experiment, but also that it is most satisfactory to breed, and in every way the most suitable for the purposes of this investigation. I was therefore very anxious to repeat the experiment on a larger scale, and especially to test again the effects of white surroundings, which had produced such remarkable results on the previous occasion; also to make use of other artificial colours, as well as the natural tints of twigs of various kinds and conditions.

A captured female laid a very large number of eggs, of which probably about 200 were sent to Mr. Bateson; these unfortunately hatched during his absence from home, and the larvæ died. The remaining eggs began to hatch in large numbers on June 29th, and all the larvæ appeared in a few days. The majority of these were at once placed in a cylinder, and fed upon the leaves and green shoots of *Populus nigra*, being thus kept in green surroundings, although just before they were re-arranged many of the leaves had become withered and brown. The susceptibility of larvæ during these early stages, if any exists, has been shown not to interfere with such experiments. These larvæ formed the stock from which, when they were rather older, the majority of the experiments were supplied. They will be alluded to below as "the first stock."

As soon as the larvæ began to hatch, a mass of the eggs was separated, and placed (June 29th) in green surroundings in complete darkness until 11 p.m., when it was exposed to the light of a paraffin lamp until 9.10 a.m. the following morning, when it was again placed in darkness. Under these conditions the larvæ hatched, and they constitute "the second stock," from which several experiments were supplied. This alternation of darkness and lamp-light was continued in some of the experiments until the evening of August 2nd. The changes were made every day, and the fixed times were never departed from by so much as an hour.

All the larvæ which hatched from the eggs were made use of in the experiments, except 30, which were sent to Mr. Bateson, and were experimented upon by him with results published in this volume (p. 213), and 80, which were placed on a tree (*Populus nigra*) in muslin bags. These last were intended for experiments, which, however, I was unable to undertake.

The sizes of the glass vessels in which the larvæ were kept are given, because the amount of crowding is shown to exercise a considerable influence on the colour.

When measurements are stated, it must be understood that they were taken when the larvæ were at rest in the rigidly straight position which is characteristic of *Geometræ*.

The experiments are so numerous that it has been necessary to classify them, and treat the various classes separately. The following table indicates the arrangement pursued, and serves as a guide to any particular experiment :—

	Experiments.
A. Dark Surroundings (in addition to the necessary green leaves of the food-plant):—	1. *Natural*:—I. Black twigs; II., brown twigs; III., IV. and V., reddish twigs or stalks, becoming blackish; VI., brown leaves; VII., red leaves, becoming blackish. 2. *Artificial*:— VIII. Black enamelled smooth twigs; IX., black enamelled rough twigs. 3. *Dark Surroundings near the larvæ, but not actually in contact*:—X. Dark twigs.
B. Green Surroundings:—	1. *Natural*:—XI., XII. and XIII. Green leaves and shoots of food-plant (*Populus nigra*); XIV., leaves and shoots of food-plant, with golden-green twigs intermixed. 2. *Artificial*:—XV. Green paper spills; XVI., dark green enamelled rough twigs; XVII., dark green enamelled smooth twigs; XVIII., light green enamelled twigs.
C. Similar Surroundings in dim Light:—	XIX. Dark twigs; XX., red stalks, becoming blackish; XXI., green leaves and shoots of food-plant; XXII., dark twigs; XXIII., green leaves and shoots.
D. Similar Surroundings in Darkness:—	XXIV. Dark twigs; XXV., green leaves and shoots of food-plant.
E. Transference Experiments:—	XXVI. Transferred from green to dark surroundings; XXVII., transferred from dark to green surroundings.
F. White Surroundings:—	XXVIII. White paper spills; XXIX. and XXX., white enamelled twigs.
G. Surroundings of other Colours:—	XXXI. Dark blue paper spills; XXXII., blue spills; XXXIII., orange spills and pieces of paper; XXXIV., orange enamelled twigs.

During the critical period of all these 34 experiments the same food was made use of—the leaves of the black poplar (*Populus nigra*). Great care was taken to ensure that the larvæ were supplied with leaves of the same age, and it may be safely concluded that no effects were produced by the different condition of the food-plant in the various experiments.

The conditions described above were kept up in all cases until August 3rd, when the larvæ were packed for removal to Edinburgh, in order that they might be exhibited at the British Association. After this date they were fed irregularly, and sometimes upon other food-plants, while the conditions of some of the experiments were relaxed; but only in the case of larvæ which were advanced in the last stage, and long past the period at which change of colour is possible. Whenever there was any possibility of further change, the conditions were carefully adhered to.

The majority of the larvæ were also arranged in cases more suitable for travelling than those in which they had been previously kept. During the susceptible stages clear glass vessels were always employed; some of these were cylindrical, others of the shape shown in Plate XV., fig. 4, bulging in part of the length and contracted at both ends, although often to an unequal extent, while the bulging was nearly always closer to one end than the other. These will be called *lamp-shades* in the description of the experiments, and their heights and approximate capacities will also be given. The former will be called *cylinders*, and their heights, internal diameters, and approximate capacities will also be furnished. Each glass receptacle was placed on a plate perforated by a hole, through which the stalks of the food-plant passed into water below. The food-plant was invariably represented by green leaves and shoots alone, whether other surroundings were made use of or not.

The details of the experiments will now be given in order.

A. Dark Surroundings.

(In addition to the necessary green leaves of the food-plant).

1. *Dark Objects which are natural to the Larvæ.*

(*See Table, pages* 342, 343, *and* 344.)

The results of these experiments are a great advance upon those of 1889. Instead of merely proving that dark larvæ are produced by dark surroundings, we now know that each of certain varied tints which are liable to occur in a dark environment produces its appropriate effect.

Thus black twigs produce black larvæ (I. and fig. 10); brown twigs produce brown larvæ (II. and figs. 11 and 12); light brown mottled leaves produce larvæ which harmonise with them (VI. and fig. 14).

I omit Experiments III., IV., V., and VII., because the results were complicated by the environments altering during the course of the experiment. But the results in reality harmonise with those given above, for the dark larvæ were never like those of I., but tended more in the direction of the mouldy, dark grey, or blackish appearance of the twigs or leaves. Sometimes, however, the larvæ were evidently affected to the end by the earlier appearance of their environment.

Some conclusions as to the period of greatest susceptibility may also be drawn from these results. The facts that the single exception in I. was older than the other larvæ,—that the larvæ transferred from II. to XXVII. for nearly the whole of the two last stages could change so little,—that the larvæ of IV. were considerably darker than III., in which the environment changed more slowly, —and that the earlier colour of the surroundings produced its full effect long after its change, in certain mature larvæ of III., IV., and VII.,—clearly indicate that the time of chief susceptibility has been passed when the last stage but one has been reached. It is equally clear, however, that there is some susceptibility in certain larvæ during the last two stages. On the other hand, the condition of the larvæ during the earliest period of growth does not seem to produce any effect, or at any rate does not interfere in the least with the full power of the surroundings which are subsequently applied. Thus the larvæ of these experiments began to hatch on June 29th, and were kept in green surroundings until July 9th or 10th, when the dark environments were substituted. But the earlier green surroundings probably did not diminish the influence of the later environment in any instance, except perhaps the single green larva in I. The same conclusions are to be gained by a study of nearly all the species experimented with, for the environments were very rarely applied immediately after hatching.

And this is what we should expect from the habits of the larvæ, which always rest on the leaves during the earliest stages. It is probable that the colours of the mature larvæ are decided when they abandon this habit, and first come to rest on the twigs. Too early susceptibility would render all larvæ green.

We may therefore conclude that the time of effective susceptibility lies somewhere within the second and third stages of larval life, and perhaps in the third rather than the second.

II. Dark Surroundings (in addition to the necessary green leaves of the food-plant).

1. *Dark Objects which are natural to the Larvæ.*

Experiments I.—VII.

I.	II.	III.	IV.	V.	VI.	VII.
Lamp-shade. *Height*, 204 mm.; *approximate capacity*, 1900 cc.	Cylinder. *Height*, 175 mm.; *internal diameter*, 82 mm.; *approximate capacity*, 900 cc.	Lamp-shade. *Height*, 168 mm.; *approximate capacity*, 1000 cc.	Cylinder. *Height*, 176 mm.; *internal diameter*, 79·5 mm.; *approximate capacity*, 950 cc. The cylinder bulged slightly, thus increasing capacity.	Cylinder. *Height*, 185 mm.; *internal diameter*, 82 mm.; *approximate capacity*, 1000 cc.	Lamp-shade. *Height*, 127 mm.; *approximate capacity*, 750 cc.	Cylinder. *Height*, 176 mm.; *internal diameter*, 84 mm.; *approximate capacity*, 1000 cc.
Large numbers of very black rough twigs, chiefly of *Quercus cerris*, were intermixed with and heaped round the leaves.	Large numbers of lightish brown dead twigs of some species of *Salix* intermixed as in I.: the twigs were smooth.	Large numbers of reddish brown fresh twigs of *Salix rubra*, stripped of their leaves, were similarly intermixed. In a short time they became blackish.	Similar to III., except that the twigs became blackish even sooner.	Large numbers of the red-and-green stalks and stems of *Spiræa ulmaria*, stripped of their leaves, were similarly intermixed. These also soon became blackish and mouldy	Many light brown, dead ivy leaves similarly intermixed. The stalks of these leaves had been removed.	Many red leaves of *Mahonia aquifolia* were similarly intermixed. The brown spots and edges were cut off when present, but the leaves soon became blackish and mouldy.
July 9.—35 young larvæ introduced from "first stock," having been in green surroundings previously, although the leaves had lately become somewhat withered.	*July* 10.—11 young larvæ introduced, as in I.	*July* 9.—17 young larvæ introduced, as in I.	*July* 10.—18 young larvæ introduced, as in I.	*July* 10.—17 young larvæ introduced, as in I.	*July* 10.—12 young larvæ introduced, as in I.	*July* 10.—20 young larvæ introduced, as in I.
	July 17.—Mostly brown.	*July* 17.—Most of the twigs were becoming black.	*July* 17.—Twigs beginning to turn black.	*July* 17.—Mostly brown.	*July* 17.—Mostly green.	
		July 19.—17 larvæ living. The usual length was 17·0 mm. 12 green or greenish, 5 brown. The larvæ afforded a curious contrast with IV. The twigs were becoming black, but not quite so much so as in IV.	*July* 19.—18 alive: 13 brown, many darkish, 5 green or greenish. Only 1 large larva (about 17·0 mm.) was bright green. The twigs were becoming very black.			

July 27.—34 alive: 32 brown, 1 intermediate, 1 bright green. The latter was the largest, and changing last skin; the others small in last stage but one.	*July* 27.—11 alive; all small in last stage but one, and all brown, of a shade which matches the twigs, except that it is rather darker. 3 removed to XXVII., being placed on green leaves to test whether a further change is now possible.	*July* 27.—16 alive: 7 green, 4 brown, 5 intermediate. Many of the larvæ were changing the last skin; they nearly always rested on twigs. The latter were now very dark.	*July* 27.— 11 brown, 5 intermediate, 2 green. The largest were changing the last skin, but they were mostly much smaller.	*July* 26.— 12 brown, 2 green, 3 intermediate.	*July* 23.— 6 brown, 6 green.	*July* 23.— 18 Brown and brownish, 2 greenish.
Aug. 3.—32 alive: 1 changing last skin and chocolate-brown, the others in last stage, 1 bright green, 1 dark grey, 29 intensely black, exactly like the black twigs. The green larva was the only one nearly mature; the others small in the last stage. The green larva and a black one selected for painting.	*August* 3—13.—Frequently examined; all remained the same rich brown, almost exactly matching the brown twigs, 2 selected for figuring.	*Aug.* 5.— 5 distinct green (rather dullish, with pronounced dorsal line, tending in some to spread downwards on the anterior part of each segment. 3 greenish intermediate, 2 brownish ditto, 5 deep brown, 1 blackish.	*Aug.* 1.—*In last stage:* 12 dark brown. *Changing last skin:* 1 green, 1 greenish intermediate. *Last stage but one:* 1 chocolate-brown, 1 light brown, 1 greenish brown, 1 intermediate. *Aug.* 13.—Mostly pupating. 1 green, 1 intermediate, 1 dark. Others had died.	*Aug.* 13.— 3 intermediate, 8 dark greyish forms (not very dark).	*July* 30.—All in last stage. 9 brown, 1 green, 2 intermediate. *Aug.* 5.—Nearly mature. 1 bright green (brown dorsal line) 1 brownish intermediate, 10 light brown, and harmonising well with ivy leaves, being marked by a network of dark and light greys; 1 was rather a rich brown, a colour also present on some of the leaves. 1 of the former was selected for painting.	*Aug.* 1.— *Last stage:* 14 brown, 1 intermediate. *Changing last skin:* 3 brown. *Last stage but one:* 1 brown. *Changing last skin but one:* 1 brown. *Aug.* 13.—Many pupating. 2 greenish intermediate 2 intermediate, 3 brownish intermediate, 13 dark, These results were approximate, because of the changes of colour before pupation. The larvæ had been probably somewhat darker.

RESULTS (A. DARK SURROUNDINGS, &c.).

The green larva is represented Pl. XIV., fig. 9, and the dark one fig. 10. Both are shown upon the dark twigs of *Quercus cerris*, chiefly made use of in this experiment. The fact that the one exception was the largest larva on July 27, and also when painted about Aug. 5 (compare sizes of figs. 9 and 10), seems to indicate that the period of keenest susceptibility had been already passed through in its case on July 9, although not in that of the remaining larvæ. But this larva was also probably especially predisposed towards the influence of green in the surroundings, like the single green larva in Experiment II., 1889.	These results were as marked as those of I., and there was no exception here. The two larvæ figured about August 5 are shown in Pl. XIV., figs. 11 and 12. One (fig. 11) is a somewhat darker brown, and the other (fig. 12) rather lighter and greyer; but the difference is small, and represented the most extreme divergence met with in this experiment. The colour of the twigs used in the surroundings is shown in these two figures. Compare fig. 13, which shows the effect of removing 3 of the larvæ into green surroundings from July 27 until Aug. 10, when one was painted. It is rather lighter in tint, but the effect of green surroundings during the last stage, and most of the last but one, is very insignificant.	The comparison between III. and IV. is very interesting. It is evident that the change in colour of the twigs was taking place about the critical period in larval life, when susceptibility is keenest, and hence the twigs darkening rather more rapidly in IV. its larvæ are much darker as a whole, especially at first (July 19). Afterwards the gradual influence of the darkened twigs acting over a period of less susceptibility, brought the two results a little nearer together, but they remained very different at the end. The dark larvæ were not like those of I. or II., but more resembled their own peculiar environment.	These larvæ harmonised very well with the dark grey mouldy stems which formed their environment.	It has been pointed out above that these larvæ harmonised very well with the brown ivy leaves. A typical specimen was figured about Aug. 5, and is shown in Pl. XIV., fig. 14, where the appearance of the ivy leaves is indicated by one example.	These larvæ were not black, like those in I., but were dark forms, resembling the blackish mouldy leaves. The normal dark surroundings of this species are made up by twigs and not leaves, and hence we find that in this experiment, and in VI., that exceptions occur in greater proportion than when the more normal dark environment is supplied. This is probably due to the larvæ chiefly resting on dark twigs when they are present, but not seeking the dark leaves so exclusively.

2. *Artificial Dark Surroundings.*

Experiments VIII. and IX.

VIII.	IX.
Cylinder. *Height* . . . . 182 mm. *Interm. diam.* . . 83 mm. *Approx. capacity* . 1000 cc.	Lamp-shade. *Height* . . . . 164 mm. *Approx. capacity* . 1300 cc.
Smooth stripped twigs of *Salix rubra* and other species of *Salix* were enamelled black, and intermixed with and placed round the food-plant.	Rough twigs chiefly of *Quercus cerris* and elm were enamelled with black, and intermixed with and placed round the food-plant.
July 16.—10 introduced from the "second stock," having been previously in green surroundings, in darkness by day, and illuminated by a lamp at night. July 25.—Length about 24·0 mm. 7 brown, 3 green, but the latter not bright. Aug. 1. — 10 all brown, although some of them not very dark. Aug. 13.—1 had pupated, and 1 was missing. 5 *intermediate* or *lightish brown* (they had changed in colour before pupating). 3 *dark*.	July 14. — 10 young larvæ introduced from "first stock" (green leaves and shoots, which became brown towards the end). Aug. 12. — 1 *green* (pupating), 1 *intermediate*, 1 *light chocolate-brown*, 7 *dark brown* (5 pupating).

These results harmonize with those of black-paper covered sticks in the case of *R. cratægata* (see p. 324), although probably for a different reason. The artificially darkened surroundings did not seem to produce nearly so strong an effect as those which are natural to the larvæ. At the same time, the larvæ were subject to different conditions for a considerable part of their earlier life, and these probably produced effects which endured till maturity in several instances, especially in IX. It would be well to repeat these experiments, employing similar environments for the whole larval life, and again to make use of black-paper covered sticks, which were found to exercise a very strong influence on this species in 1889 (see p. 331).

3. *Dark Surroundings near the Larvæ, but not actually in contact.*

EXPERIMENT X.

X.

Cylinder: *Height*, 190 mm.; *interm. diam.*, 26·5 mm.; *approx. capacity*, 110 cc.

In this tall narrow cylinder only green leaves and shoots of food-plant were present, but outside it many twigs, as in I., were placed.

July 10. — 12 young larvæ introduced from the "first stock."

July 25.—Length about 24·0 mm. 4 *green*, 2 *intermediate*, 6 *brown*.

Aug. 1. — All but 1 in last stage; 3 *green* (1 changing last skin), 2 *greenish intermediate*, 2 *light brown*, 5 *dark brown*.

Aug. 5.—All in last stage; 3 *green* (rather dull), 2 *greenish intermediate*, 1 *very light brown*, 1 *very light grey*, 4 *deep brown* (1 very dark, 1 dead), 1 *very dark blackish grey*.

The criticism made on the analogous experiment with the 1889 larvæ (see p. 334) holds in this case. The effect of crowding comes out so clearly in some of the green surroundings (see Experiments XII. and XIII.), that it will be necessary to repeat this experiment, including very few larvæ in each cylinder, and making comparison experiments with the light dimmed by objects other than dark twigs. Until this is done, there will be no reason for believing that a larva is affected by any twigs except those with which it is in contact, or at any rate immediately surrounded. It would be interesting also to make use of dark cylinders enclosed in glass tubes of varying thickness.

B. GREEN SURROUNDINGS.

1. *Green Surroundings which are natural to the Larvæ.*

(*See Table, page* 347.)

The strong susceptibility to green surroundings in the absence of darker colours is very clearly brought out in these experiments, but also the much greater susceptibility to brown, so that when the larvæ were crowded, as they were in XII. and XIII., in cases with only half the capacity of XI. and XIV., they were strongly affected by one another's colours, which are always brown in the earlier stages. The light brown larvæ thus produced much resembled those from Experiment VI., one of which is shown in Plate XIV., fig. 14.

XI. Lamp-shade. *Height* . . 165 mm. *Approx. cap.* 1350 cc.	XII. Lamp-shade. *Height* . . 131 mm. *Approx. cap.* 650 cc.	XIII. Lamp-shade. *Height* . . 130 mm. *Approx. cap.* 800 cc.	XIV. Lamp-shade. *Height* . . 163 mm. *Approx. cap.* 1300 cc.
Green leaves and shoots of *Populus nigra* alone.	As in XI.	As in XI.	As in XI., except that abundant golden green, smooth, stripped twigs of *Salix viminalis* were intermixed. These retained their colour a long time, and only became a light greenish brown when a change eventually occurred, but the larvæ had then ceased to be sensitive.
July 9. — 20 young larvæ introduced from the "first stock," having been on the same surroundings with many others since hatching, & the leaves having become rather withered.	*July* 10.—20 young larvæ introduced; hitherto as in XI. *July* 17. — 18 alive; for the most part they remained brown.	*July* 10.—20 young larvæ introduced as in XI.	*July* 10.— 40 young larvæ introduced as in XI. *July* 16. — 6 larvæ removed to put in XXXIV. *July* 19.—33 counted, of which 30 green or greenish (mostly former), & 3 brownish (not dark), & of these 1 quite small. Usual length 17·0 mm.
July 21. — Length from 15·0 to 20·0 mm. 12 larvæ green, 1 ,, greenish, 7 ,, brown, but only 1 of them darkish brown.	*July* 23.— 17 alive; 14 brown, 3 green.	July 23.—20 alive: 8 brown, 12 green or greenish.	*July* 26. — 33 alive; all bright green except 1 small larva, which is intermediate. 4 just before changing last skin were removed to XXVI. to test whether any further change is now possible.
July 30.—20 alive. *Bright green:* 11 in last stage, 6 changing last skin 1 last stage but one. *Intermediate*, perhaps greenish: 1 changing last skin. *Very light brown*, perhaps intermediate: 1 (stage unnoted, probably young).	*July* 30. *Bright green:* 1 in last stage but one *Greenish:* 1 in last stage, 1 changing last skin. *Light brown:* 11 in last stage, 2 ,, but one 1 changing last skin.	*Aug.* 1. *Bright green:* 3 in last stage. *Greenish:* 6 in last stage, 1 changing last skin *Brownish intermediate:* 1 in last stage but one *Light brown:* 8 in last stage, 1 changing last skin	*July* 31.—All bright green: *Last stage* . . . 24 *Changing last skin* 3 *Last stage but one* 2 1 of the 2 last was removed to XXVI., being added to the 4 removed July 26.
Aug. 7.—All in last stage, and many pupating. All bright green, 11 without the brown dorsal stripe, or with it very faint, 8 with it distinct, the latter being generally the smaller larvæ.	*Aug.* 7. — All in last stage: 2 *bright green* (1 with and 1 without dorsal stripe). 2 *greyish intermediate* 13 *light brown*, like the 7 of XIII. and the 10 of VI.	*Aug.* 5.—In last stage. 3 *bright green* (1 small), 6 *dull but distinct green* (marked brown dorsal line), 1 *greenish intermediate*, 1 *brownish intermediate*, 7 *light brown* (1 rather darker than others), 1 *rich brown* (small), changing last skin 1 *intermediate.* The 7 light brown much resembled the 10 of VI.	*Aug.* 7.—All in last stage: 24 *bright green*, without brown dorsal stripe or with it very faint (most pupating); 4 *light green*, with dorsal line distinct (all these small in stage).

The larvæ of XIV. were much more crowded than those of XI., but became equally green, or perhaps even brighter. I attribute this to the presence of the golden-green twigs of *Salix viminalis* upon which the larvæ rested, and which influenced them strongly. We see this when we compare the rates at which the effects were manifested in XI. and XIV. Thus XIV. were far more strongly influenced by July 19 and 26 than XI. by July 21 and 30 respectively. The larvæ manifest a strong tendency to rest by day on anything twig-like, greatly preferring it to the leaves. When the latter are offered alone they frequently rest on each other, and hence their progress towards greenness is retarded or even arrested if they are sufficiently crowded.

The result of the transference of green larvæ from XIV. to dark surroundings (XXVI.) for the whole of the last stage, and in one case for most of the last stage but one also, showed that there was no power of further change. No effects at all were produced by the transference. This supports the result of the converse experiment already described (see p. 344, Expt. II.). And yet the dark surroundings to which these larvæ were removed had every opportunity of influencing them, if this were possible; for the larvæ almost invariably rested on the dark twigs with which their colours were in such marked contrast.

2. *Artificial Green Surroundings.*

(*See Table, page* 349.)

Omitting XV., the larvæ of which may have been affected pathologically by the green pigment, the other experiments show that the larvæ are affected in the direction of green, but not nearly so strongly as when the natural green surroundings are employed. The effects of the dark green enamel were very similar to those of the green leaves and shoots when the larvæ are crowded (Experiments XII. and XIII.). It is probable that the quality of the green light was less effective than that reflected from leaves and shoots: this will be considered later on (see Conclusions). The lighter green enamel (XVIII.) produced much stronger effects in the direction of green, but not equal to those of natural surroundings when the larvæ are uncrowded (XI. and XIV.). It would, however, be well to repeat the experiment over a longer period of larval life. Stronger effects would probably be witnessed, especially under the conditions of XVIII.

2. *Artificial Green Surroundings.*

EXPERIMENTS XV.—XVIII.

XV.	XVI.	XVII.	XVIII.
Cylinder. *Height* . . 179 mm. *Internal diam.* 71 mm. *Approx. cap.* 700 cc. Bright green paper spills intermixed with food-plant.	Lamp-shade. *Height* . . 166 mm. *Approx. cap.* 1200 cc. Rough twigs, chiefly of *Quercus cerris* and elm, enamelled dark green, were intermixed.	Lamp-shade. *Height* . . 109 mm. *Approx. cap.* 700 cc. Smooth twigs of *Salix* enamelled dark green, as in XVI., were intermixed.	Lamp-shade. *Height* . . 133 mm. *Approx. cap.* 700 cc. Twigs, chiefly rough, were enamelled light green and intermixed.
July 9.—8 young larvæ introduced from "first stock," having been in green surroundings, the leaves becoming rather brown shortly before this date.	*July* 14.—10 young larvæ introduced as in XV.	*July* 16.—8 introduced from "second stock," having been previously in green surroundings, in darkness by day, and illuminated by a lamp at night.	*July* 16.—10 introduced as in XVII.
July 23.—More green spills added; only 4 larvæ alive; all light brown.	....	*July* 25. 1 green, 1 greenish, 1 intermediate, 5 brown.	*July* 25. 3 green, 2 intermediate, 5 brown (not dark).
July 31.—All large in last stage but one; 3 greenish, 1 light brown. 2 were resting on spills, 2 on leaves.	*July* 30. 6 *dark brown*, all at beginning of last stage, 3 *green* (not very bright), 2 at beginning of last stage, 1 changing last skin. 1 *intermediate*, changing last skin.	....	*July* 31. *Last stage:* 2 bright green, 4 dull green, 2 darkish brown. *Last stage but one:* 1 dull green, 1 intermediate.
Aug. 5.—All 4 rather small in last stage: 2 *brownish green.* 1 *intermediate.* 1 *light grey.*	*Aug.* 5.—All in last stage: 2 *bright green* (dorsal band distinct, & in 1 tending to spread downwards), 2 *intermediate,* 3 *greyish brown* (1 light), 3 *deep brown.* Not a great difference between the dark forms; none of them very dark.	*Aug.* 7.—All in last stage: 1 *bright green* (faint dorsal line), 1 *greenish intermediate,* 6 *grey,* like the 10 in VI., only darker as a whole, although with much individual difference.	*Aug.* 5.—3 larvæ had ceased feeding—2 green and 1 brown. 7 in last stage: 5 *green* (1 small), 1 *intermediate,* 1 *light brown.* All the green larvæ wer rather dull, with pronounced brown dorsal line.
Aug. 12.—All dead.	*Aug.* 12. 2 *green,* 3 *intermediate,* 5 *dark* (although not very dark).		

C. Dark and Green Surroundings in Dim Light.

Experiments XIX.—XXIII.

XIX.	XX.	XXI.	XXII.	XXIII.
Lamp-shade. *Height* . . . 163 mm. *Approx. cap.* . 1000 cc. Kept in darkness by day, and illuminated by small paraffin lamp at night (until Aug. 3rd, when exposed to ordinary conditions). Dark twigs were added July 16.	Lamp-shade. *Height* . . . 166 mm. *Approx. cap.* . 1350 cc. Similar to XIX., except that red-and-green stripped stems of dock or sorrel were added July 16. These became darker, but not blackish, like the *Spiræa*, &c.	Lamp-shade. *Height* . . . 131 mm. *Approx. cap.* . 800 cc. Similar conditions of illumination, but surroundings green (leaves & shoots alone of *Populus nigra*).	Lamp-shade. *Height* . . . 129 mm. *Approx. cap.* . 650 cc. Similar to XIX., except that the larvæ were separated from the "second stock" at a later date (July 16). Dark twigs added July 16.	Cylinder. *Height* . . . 124 mm. *Internal diam.* 67 mm. *Approx. cap.* . 450 cc. Similar to XXII., except that the surroundings remained green, as in XXI.
July 8. — 26 introduced from "second stock," having been subject to the conditions described above from the time of hatching. *July* 19. — Many were green and greenish. *July* 26.—Many of them 32·0 mm. long, others smaller: 6 green (dull), 1 intermediate, 19 brown.	*July* 8. — 25 introduced, as in XIX. *July* 19.—25 alive. *July* 26. — 24 alive; the largest about 32·0 mm. long, 2 just entered last stage: 1 green, 4 intermediate, 19 brown.	*July* 8. — 25 introduced, as in XIX. *July* 26.—Many of them 32·0 mm. long, others smaller: 6 green (dull), 2 intermediate, 16 brown. Hence 24 alive.	*July* 16. — 9 introduced, as in XIX.	*July* 16. — 9 introduced, as in XIX.
. . . .	*July* 30.—*Last stage:* 2 rather light brown, 21 dark brown. *Last stage but one:* 1 intermediate.	. . . .	*July* 30.—All dark brown: 6 in last stage, 2 ,, but one, 1 changing last skin.	*July* 30.— 8 *brown:* 4 in last stage, 1 ,, but one, 3 changing last skin. 1 *intermediate*, changing last skin.
Aug. 7.—All in last stage, and all dark blackish forms, darker than XX., and much darker than XXI., although not nearly attaining the deep blackness of I. Many were pupating.	*Aug.* 7.—All in last stage, and all dark forms, distinctly darker than XXI., with a deep brown tinge about all of them. Many were pupating.	*Aug.* 7.—All in last stage: 2 *greenish intermediate*, 22 *brown*, not very dark forms, various shades of brown and grey. Many were pupating.	*Aug.* 7.—All in last stage, and resembling XIX., being dark blackish forms, darker than XX. and much darker than XXI., although not nearly attaining the deep blackness of I. Many were pupating.	*Aug.* 5.—All mature and very uniform, being darkish grey forms,—not very dark. One larva was rich brown, intermixed with grey. Distinctly lighter than XXII. *Aug.* 13.—All 9 still dark, only 2 remained feeding.

C. Dark and Green Surroundings in Dim Light.

(*See Table, page* 350.)

These experiments were conducted with the object of investigating the relation between the habits of the larvæ as regards resting and feeding, and the external conditions as regards light. In this respect I did not come to a conclusion; but the experiments have proved very valuable in another way,—in testing the effect of dim light upon the colour-relation between larvæ and their surroundings. The effect is very clear, and conclusively proves that light is the agency which influences the larvæ. For, with this dim illumination, neither green nor (probably) even dark surroundings produce their full effect, the influence of the former naturally being diminished far more than that of the latter. Thus green surroundings continued, in this case, for the whole of larval life (XXI. and XXIII.) failed to produce a single green larva, only 2 out of 33 being greenish intermediate. It must be remembered, however, that XXI. was much crowded, as were the larvæ of XXIII. previous to July 16. On the other hand, the dark twigs in XIX. and XXII. produced very different effects from those of I., where, however, they were added 7 days earlier. Although the effects are diminished, they are not altogether absent even in the case of the green surroundings, for we find that the larvæ exposed to the latter (XXI. and XXIII.) are the lightest, those exposed to dark twigs (XIX. and XXII.) are the darkest, and those exposed to the stems of dock which became dark brownish (XX.) are intermediate. When we compare these results with those of the next experiments, in which dark and green surroundings in darkness produced the same effect on the larvæ, it becomes clear that light is the agency by which the colour-changes are directly, or more probably indirectly, brought about.

D. Dark and Green Surroundings in Darkness.

Experiments XXIV. and XXV.

XXIV. Lamp-shade. *Height*, 132 mm.; *approximate capacity*, 8[illegible]0 cc.	XXV. Lamp-shade. *Height*, 129·5 mm.; *approximate capacity*, 750 cc.
Kept in same illumination as XIX.—XXIII. from hatching until July 9. From July 9 to Aug. 3 kept in total darkness, except when fed and when XIX.—XXIII. were being shifted from light to darkness, and *vice versâ*, every 24 hours. Green surroundings as in XXIII., &c.	As in XXIV., except that abundant dark twigs were added July 16.
July 9.—25 larvæ arranged in is cylinder.	*July* 9.—25 larvæ introduced, as in XXIV.

XXIV.	XXV.
Lamp-shade. *Height*, 132 mm.; *approximate capacity*, 800 cc.	Lamp-shade. *Height*, 129·5 mm.; *approximate capacity*, 750 cc.
July 20.—Many about 20·0 mm. long; others smaller. 2 green, 7 greenish, 16 brown. *July* 26.—The largest about 32·0 mm. long. 4 green, 2 intermediate, 19 brown. *Aug.* 7.—All in last stage, and all dark,—grey, brown, and blackish larvæ being intermixed. Although dark, none of them approached the results of I.	*July* 20.—Same size as XXIV. 6 green, 7 greenish, 12 brown. *July* 26.— 2 green, 7 intermediate, 16 brown. *Aug.* 7.—All in last stage, and similar to XXIV. It was impossible to assert that these were any darker than the latter; the two lots were as nearly as possible the same.

The significance of these results has been pointed out already (see p. 351).

It is interesting to note that the larvæ varied greatly; this was also the case in some of the larvæ exposed to dim light (XXI.), while others were very uniform (XX., XXIII.).

E. Transference Experiments.

Experiments XXVI. and XXVII.

XXVI.	XXVII.
First contained in XIV.; then in cylinder. *Height*, 176 mm. *Internal diameter*, 71 mm. *Approximate capacity*, 700 cc. Transferred from green to dark surroundings for the last stage.	First contained in II.; then in cylinder. *Height*, 86 mm. *Internal diameter*, 61 mm. *Approximate capacity*, 250 cc. Transferred from dark to green surroundings for last stage, and part of last but one.
July 26.—4 green larvæ about 32·0 mm. long, just before changing their last skins, transferred from XIV. to another cylinder with abundant dark twigs intermixed. *July* 27.—All but 1 were changing skins, and all were resting on the dark twigs. *July* 30.—Same; all on brown twigs, and as bright green as ever. *July* 31.—Same; still resting on brown twigs. A fifth bright green larva, small in last stage but one, transferred from XIV. to this cylinder. *Aug.* 1.—All resting on brown twigs, and all bright green. *Aug.* 5.—The 4 larvæ transferred July 26 had ceased feeding, remaining bright green, with a faint dorsal line. The 1 small larva transferred July 31 was changing last skin, and was bright green, with distinct dorsal line. There was no further change.	*July* 27.—3 brown larvæ, about 24·0 mm. long, transferred from II., where they had been subjected to brown surroundings, to green leaves and twigs alone of food-plant. *July* 31.—2 changing last skin, 1 at beginning of last stage; still brown. *Aug.* 5.—The 3 larvæ were now more than half-grown in last stage, and had become rather lighter than those remaining in II. The most changed was painted.

The results of these experiments have been described under II. and XIV. respectively (see pp. 344 and 348).

It is interesting to note that the darkening of a larva which has become green appears to be more difficult than the converse change. Thus the effects, if any, in XXVI. were confined to the dorsal area (even in the larva transferred on July 31), whereas the pigment in XXVII. had become somewhat lighter over the whole surface.

F. White Surroundings.

(See Table, page 354.)

The faintly greenish white larva is shown in Plate XIV., fig. 15; the faintly brownish in fig. 16. Reference to these figures will show how completely the white dominates the tendency to other colours; and, as shown above, there was no such tendency in most of the larvæ in XXVIII.

The less marked effects witnessed in XXIX. and XXX. were probably due to the facts that the experiments began later, and that the enamelled surface was less congenial to the larvæ than the paper. But it would be well to repeat these experiments. It must be remembered, too, that the sticks in XXX. were not so white as the others.

G. Surroundings of other Colours.

(See Table, page 355.)

The influence of blue (XXXI. and XXXII.) is evidently strongly in the direction of dark forms. The uniform purplish brown colour of all the larvæ in XXXI. must be something more than a coincidence. It is clear that the blue not only tended to produce dark larvæ, but dark larvæ of a certain kind. At the same time the larvæ did not resemble the blue spills, but were such as would have been protected on dark purplish brown twigs. Some quality in the light reflected from such twigs would cause the larval adjustment, and this experiment suggests that the proportion of blue rays may be the effective stimulus which causes the larvæ to assume the appropriate shade of brown. The appearance of these larvæ is well shown in Plate XIV., fig. 17, where the

F. White Surroundings.

Experiments XXVIII.—XXX.

XXVIII.	XXIX.	XXX.
Cylinder. *Height* . . 149 mm. *Intern. diam.* 71 mm. *Approx. cap.* 600 cc. Many white paper spills intermixed with and surrounding food-plant.	Lamp-shade. *Height* . . 165 mm. *Approx. cap.* 1300 cc. Many rough twigs, chiefly of *Quercus cerris* and elm, were enamelled twice with white, and intermixed.	Lamp-shade. *Height* . . 147 mm. *Approx. cap.* 550 cc. Similar to XXIX., except that twigs were only enamelled once, & hence were not so brilliantly white.
July 11. — 10 young larvæ introduced from "first stock," having been previously on green leaves and twigs alone, which had become somewhat brown by July 11. *July* 21. — Larvæ 22·0 mm. long: 3 bright green, 6 greenish, 1 light brown. Some of the larvæ had a very whitish appearance; this was noticed some days previously. *July* 23. — More spills added. *July* 30. — All in last stage; all resting on the spills: 8 *very whitish* & opaque-looking, 1 *green*, 1 *brownish* (small in last stage). *Aug.* 3.—Carefully compared; all 10 nearly mature, and extremely white and opaque. The results were very uniform, although 2 were faintly greenish and 1 faintly brownish, but these tints were nearly hidden in the predominant tendency towards white. One of each was selected for painting.	*July* 14. — 10 young larvæ introduced, as in XXVIII. *July* 25.— 5 green, 1 greenish, 4 brown (not dark). *Aug.* 7.—All last stage: 4 *bright green* (dorsal line very distinct on 1, faint on 2, overspread with grey on 1), 4 *whitish*, 2 *very light grey*, inclining to whitish. The whitish larvæ were duller and more inclining to other colours (greenish, brownish or yellowish) than those of XXVIII. They were, however, quite distinct opaque whitish forms.	*July* 16.—9 introduced from the "second stock," having been on green surroundings, in darkness by day, and lamp-light at night. *July* 25.—9 alive: 7 green, 2 greenish. *Aug.* 7. — All in last stage: 4 *bright green* (3 with distinct dorsal line, 1 tending to be overspread with grey), 4 *whitish* (duller than XXIX.), 1 *light brown*, like the 10 larvæ in VI.

G. Surroundings of other Colours.

Experiments XXXI.—XXXIV.

XXXI.	XXXII.	XXXIII.	XXXIV.
Lamp-shade. *Height* . . 131 mm. *Approx. cap.* 700 cc. Many dark blue paper spills intermixed with food-plant and surrounding it.	Cylinder. *Height* . . 158 mm. *Internal diam.* 71 mm. *Approx. cap.* 650 cc. Similar to XXXI., except that the blue, although pronounced, was not so deep in tint.	Lamp-shade. *Height* . . 133 mm. *Approx. cap.* 700 cc. Many deep orange paper spills and pieces of paper similarly intermixed.	Cylinder. *Height* . . 180 mm. *Internal diam.* 82 mm. *Approx. cap.* 1000 cc. Many smooth twigs of *Salix* enamelled deep orange were similarly intermixed.
July 10.—11 young larvæ introduced from the "first stock," having been previously in green surroundings, which had become somewhat dark towards this date.	*July* 10.—11 young larvæ introduced, as in XXXI.	*July* 9.—12 young larvæ introduced, as in XXXI.	*July* 14.—4 young larvæ introduced, as in XXXI.
July 21.—10 alive: 9 brown, many dark; 1 greenish, the largest. The general length was about 19·0 mm. *July* 23.—More spills added. *July* 31.—All 10 in last stage, and all very dark. They nearly always rest on the spills.	*July* 21.—10 alive: 9 brown, many dark; 1 green (the largest larva). About 19·0 mm. is the usual length. *July* 23.—More blue spills added. *July* 31.— 9 small in last stage; all dark, but not so dark as in XXXI. 1 green, not bright, but with much brown on back, and yellow spots distinct on side and beneath. This is the largest, and almost mature. The larvæ nearly always rest on the spills.	*July* 19.—Larger larvæ about 17·0 mm. long. 1 darkish brown, 11 varying from greenish to brownish green. No bright green larvæ. *July* 23.—More orange spills added. 1 brown, 11 green, some of them greenish. *July* 31.—12 all green, although many were not the brightest green. They were nearly always found resting on the orange paper.	*July* 16.—6 more added from XIV. *July* 25.— 7 green, 1 greenish, 1 intermediate, 1 brown.
Aug. 3.—Uniformly very dark purplish brown, with hardly any individual differences. The 10 larvæ were nearly mature. A larva was selected for painting. *Aug.* 12.—Only one feeding. All remained very dark, as before.	*Aug.* 5.—All in last stage, and about mature. 1 *greenish intermediate*, 1 *lightish grey*, 4 *deep rich brown*, } about equally dark. 4 *blackish*. } These larvæ were very dark, although not nearly so much so as those of XXXI. *Aug.* 13.—All pupating.	*Aug.* 12.—Many pupating, and all 12 mature. All bright green, generally with but slight dorsal line.	*Aug.* 5.—All last stage, nearly mature. 7 *bright green* (only 1 with dorsal line distinct), 2 *intermediate*, 1 *light brown*.

purplish larva is represented on a spill of the dark blue colour employed. The effects of lighter blue (XXXII.) were far less uniform. It may be that the blue rays must come from a surface of a certain depth of colour in order to produce the effect seen in XXXI.

Orange surroundings, on the other hand (XXXIII. and XXXIV.), tend to produce typical green larvæ, although the effect of orange paper was much stronger than that of orange enamel. The larvæ were, however, exposed to the latter for a shorter time, and probably found it a less congenial surface to rest upon.

Here, too, when an artificial colour entirely different from anything in the normal surroundings of the species produces exactly the same effect as a totally different appearance in the natural environment, the most probable view is that there is some common quality in the reflected light, and that this is the effective stimulus. If there were any evidence for pathological change or abnormal development of any kind, the argument would not hold; but the larvæ reared among orange spills and sticks appeared to be as healthy, and in every way as normal, as those reared among the green leaves and shoots, which produce the same result. Nor is it at all probable that the results are merely due to the quantity of reflected light rather than its quality. Thus the greater amount of light reflected from white paper does not make the larvæ greener than orange paper, but utterly different in appearance.

These considerations will be brought side by side with those derived from the experiments on pupæ in the Conclusions at the end of the paper, where the spectroscopic composition of the light reflected from the backgrounds will be described, together with its effect upon the various species employed.

Comparison with the earlier experiments on the pupæ of *Pieris rapæ* and *P. brassicæ* strengthens this conclusion; for I have shown (Phil. Trans. Roy. Soc., vol. 178 (1887), B, pp. 429—432) that in both these species the same orange paper employed in XXXIII. and the same blue employed in XXXI., produced green and dark pupæ respectively. On p. 431 the extent in the spectrum of the rays which were chiefly reflected from these colours is represented in a diagram, and it is shown to be probable that the rays which check the formation of true pigment, and so reveal the more deeply placed green, lie between a wave-length of $\frac{57}{100000}$ and $\frac{60}{100000}$ mm.; in other words, about the D line of the solar spectrum.

It will be of the greatest value to now test these conclusions by the use of coloured glass or gelatine screens. White spills or painted sticks might be employed in a large number of experiments with screens of various colours. This method has been already tried to some extent with the pupæ (see *Vanessa io* and the *Pieridæ*), but the larvæ of *A. betularia* are far more suited for the investigation, being so highly sensitive, and possessing such a wide range of possible colours and combinations of colours.

The fact that each of these artificial colours produces nothing peculiar, but only some one out of the well-known appearances which are liable to occur in the surroundings, is strongly in favour of the essentially protective significance of the change, which is thus only possible when it leads to harmony with some natural environment. The same fact holds universally throughout the species which have been proved to be susceptible, unless an exception is to be made in favour of the golden pupæ of *Vanessa urticæ*. These, however, are discussed in a later part of the paper (see Conclusions).

The Structural Cause of the varied Colours of the Larvæ of Amphidasis betularia.

This was partially investigated in 1889 (see p. 336), and was proved to be due to colour in the skin or just below it. In the present year the following method was adopted, and found to work well. The larva was stretched with its ventral line uppermost across a glass slide covering a window cut in a sheet of cork. The anterior and posterior ends of the larva extended beyond the glass, and were pinned to the cork. The body walls were then divided along the median ventral line and pinned out flat at each end, so that the section of the body passing across the glass was flat also. The latter part could be examined from above or below with the lens or a compound microscope, and the effect of removing any coloured layer was at once seen.

In such stretched and flattened larvæ the loss of the green blood made the colour rather less deep, and the same effect followed the removal of a section of the digestive tract. But I do not think any effect is produced in the normal state when the larva is less stretched, and the superficial coloured layers are therefore thicker, and when the light has to penetrate the larval skin before reaching the blood and internal organs; so that the latter cannot be highly illuminated as they were in the dissection.

In all larvæ the layer of fat between the superficial muscles and the epidermis (hypodermis) was more or less green. In green varieties it is bright green, and causes the colour of the larva, as is at once seen if a small area be removed. In some brown larvæ it is quite as green as in the green ones, but is concealed by dark pigment in the epidermis, which acts as a screen. In others the colour is developed but little, and in one dark larva examined this fat was pale yellowish green, except in the first abdominal segment, where it was as strongly coloured as in a green larva. If a little of the green fat be removed and examined under the microscope, it is seen to be opaque and bright green. It can be made thinner by pressure, and thus rendered transparent, when it appears as a pale yellowish green. High powers show that the green colouring matter (probably some derivative of chlorophyll) is contained in the oil-globules within the cells. Alcohol instantly turns the fat deep yellow, and causes the oil-globules to be compressed out of the cells, and to cohere in large yellow drops, gradually decolorised by the alcohol, which becomes itself tinged with the same colour.

The dark pigment is contained, as I have said, in the epidermis cells, which lie over this layer of fat, thus concealing the latter. In green larvæ the epidermal layer covering the green fat contains a light yellow transparent colour, appearing greenish yellow under the microscope. It dissolves out in alcohol, and is probably some chlorophyll derivative. The cuticle is colourless, except for certain small brown spots.

Intermediate larvæ are well suited for displaying both these causes of colour. These are commonly green, with a distinct wide brown dorsal stripe, which, anteriorly in each segment, passes downwards, and forms a girdle round the larva; while posteriorly the green colour forms a broader girdle, interrupted in the dorsal region by the brown stripe. If such a larva be pinned out in the manner previously described, the appearance, as seen from the internal surface, after removing the digestive tract and most of the deep part of the fat-body, is shown in Plate XIV., fig. 18, where abdominal segments 1 to 4 are represented. The tracheal system is only indicated on the left side. The anterior direction is shown by the arrow. In each segment the anterior brown band prolonged from the dorsal stripe is well shown, and here the epidermis is not underlaid by green fat, although this effect is probably in part due to the stretching. A mass of bright yellow fat lies on each side of the dorsal stripe anteriorly in each segment. This belongs to a deeper part of the fat-body *below* the muscles of the body-walls. Over the green fat which forms the posterior band in each segment, it has been already stated that the epidermis is not brown but pale yellowish in tint, and quite transparent.

It is therefore clear that the surroundings determine not only the presence or absence of true pigment in the epidermic cells, but also its constitution and therefore colour when present. And the range of possible tints and combinations is very wide, including all shades of brown and grey, passing into black on the one side and white on the other, and comprising uniform tints as well as the most complex combinations, as when these larvæ resemble the appearance of lichen. But the surroundings also determine the presence of the green colour in the superficial layer of fat. These are the results, and some quality in the light reflected from surrounding objects forms the cause, but the physiological chain which connects the two has yet to be discovered.

Direct Evidence of a Colour-relation between the Larvæ of A. betularia and their Natural Surroundings.

Nearly all the colours obtained in these experiments are well known in the field, and the others will doubtless be found if looked for on plants of the appropriate colour. Thus the white varieties, the only ones I have not seen wild, would probably be found upon food-plants with white pubescent or glaucous shoots. Such a wide power of colour-adaptation is especially necessary for a larva which feeds, like *A. betularia,* on almost any shrub or tree. For several years I have observed the correspondence between wild larvæ and their food-plants. Thus they are especially common in gardens feeding on rose, and, so far as I have observed, these are invariably green and well concealed among the abundant green shoots on which, and not on the older brown wood, they are found. I have found the same to be true of larvæ found on the green shoots of sallow and *Ribes americana*, while larvæ found on the brown branches of cherry were brown, and the same was the case with one found on apple. Two green varieties found feeding on broom were brought me by Miss Gould during the past autumn. The larvæ are very commonly beaten from birch and oak, and these are, so far as my experience goes, always dark varieties. Mr. Arthur Sidgwick, who has had a wider experience of the wild larvæ, not only agrees with this, but tells me that he always notices a difference between the dark larvæ beaten from the two trees, corresponding to the difference between the twigs on which the larvæ rest in the two cases.

The most interesting example, however, was told me by Dr. Stacey Wilson, of Birmingham, who beat the larva from a lichen-covered food-plant, and found it so exactly resembled the lichen that he thought it could not be this species at all, and was only convinced when the moth appeared. Had I known this earlier in the summer, I should have tried the effect of lichen-covered sticks. In a complex result of this kind it would be especially interesting to attempt to determine the peculiar quality in the reflected light which acts as the stimulus.

There is thus a considerable body of evidence to prove that the results obtained by breeding in confinement under certain conditions, point to the existence of a power of individual colour-adaptation which is possessed and is widely used by the wild larvæ in their natural surroundings.

C. Experiments on the Colours of Pupæ, 1887—1892.

These experiments were partly undertaken in order to confirm the results of my previous work (Phil. Trans., B., 1887, p. 311), and partly to make out further details. Professor Weismann had suggested to me that confirmation was desirable, inasmuch as the results of experiment were not uniform, but depended upon averages. I was also very anxious to investigate the pupa of *Vanessa io* as completely as that of *V. urticæ*. Considering the importance of the conclusions which seem legitimately to follow from the results of conflicting colour experiments, I was desirous of repeating these, and of devising some improved method by which the larvæ could be subjected to the conditions for the whole of the sensitive period. Coloured glass screens have also been employed in many of the experiments, especially with the *Pieridæ*. Attention was also directed to other special points, some of which came out in the course of the enquiry.

Crowding the larvæ affects the colour, and therefore the size of the receptacles becomes a matter of importance. These are described in detail at the end of the paper, and will be referred to by numbers, accompanied by a very brief description, under the experiments themselves.

Experiments upon Vanessa urticæ.

1887.

In working at these pupæ in the preceding year, I gained a very strong impression that the pupæ in darkness were, other things being equal, formed later than those in the light. If this were the case, it appeared possible that time might be an element in the production of the dark superficial pigment which prevents the golden appearance. I had concluded that this protraction of the period before pupation occurs, from the experiments on *Pieridæ*, as well as those on *Vanessidæ* (Phil. Trans., 1887, B., pp. 339 and 432), and my friend Mr. G. C. Griffiths had independently noticed the same thing with the *Pieridæ* (Trans. Ent. Soc. Lond., 1888, pp. 256, 257). I was therefore anxious to make some experiments with this special end in view, the impression I had gained being merely the incidental result of experiments intended for other purposes.

I made three such sets of experiments upon *V. urticæ* in 1887, and a brief summary of the first is given in a footnote to the paper referred to above (Phil. Trans., *l. c.*, p. 339).

Before detailing these experiments, it will be necessary to quote the description of the varieties of this pupa from my earlier paper:—

"(1) Very unusually dark, almost black; very little gold, or none.

(2) Dark normal form; dark grey, often with a slight pinkish tinge, with very little gold, or none.

(3) Light normal form; light grey, often with a pronounced pinkish tinge; more gold than (2), occasionally none.

(4) Lighter than (3); the pinkish tinge often very pronounced, and usually a large amount of gold.

(5) Very light forms; generally completely covered with gold" (Phil. Trans., B., 1887, p. 320).

It was also found convenient to subdivide the (3)s still further into dark (3)s, (3)s, and light (3)s. This arrangement will be adopted in the present paper.

Experiments 1 and 1*a*.

A small company of 44 larvæ of *Vanessa urticæ* were found at Oxford, at 7.30 p.m., July 11, 1887. They were so obviously mature that it was probable that some had already left the food-plant, and that the shock of capture would cause these remaining larvæ also to seek pupation. Their size being very uniform, they were well suited for the purposes of this enquiry.

About 10 p.m. they were offered food; the majority refused it, and wandered. These were separated, and again offered food; and it was assumed that the 29 larvæ which again refused it, had entered Stage I. of the period before pupation. They were therefore divided between the 3 receptacles described below, while the 15 which remained on the food were placed with leaves in 3 similar receptacles. The arrangements were complete about 10.45 p.m.

(*See Table, pages* 363, 364.)

Several very interesting conclusions can be derived from this table.

Bearing upon the duration of the stages before pupation:—

The observations were repeated so frequently that the beginnings of the stages can be fixed with a very small margin of error.

Dates.	Experiment 1.—Without food.			Experiment 1. a.—With food.		
	These numbers refer to detailed description of receptacles (see G, Appendix).					
	XXXI. or XLVI. Dutch leaf. Gilt box in strong light.	Similar to XLIX. Bright tin box in strong light.	I., II., or III. Black cylinder in darkness.	XXXI. or XLVI. Dutch leaf. Gilt box in strong light.	Similar to XLIX. Bright tin box in strong light.	I., II., or III. Black cylinder in darkness.
July 11, 10.45 p.m.	9 larvæ introduced.	6 larvæ introduced.	14 larvæ introduced.	2 larvæ introduced.	6 larvæ introduced.	7 larvæ introduced.
July 12, 9.15 a.m.	1 suspended, rest on roof.	All on the roof.	All on the roof.	All on food.	2 on roof, rest on food.	1 on roof, rest on food.
,, 10.30 a.m.	2 suspended (say 9.50 for 2nd larva).	Ditto.	Ditto.	Ditto.	5 have now left food (say 9.50 for 3rd, 4th, and 5th larvæ).	4 have left food (say 9.50 for 2nd, 3rd and 4th larvæ).
,, 12.20 p.m.	Ditto.	Ditto.	Ditto.	1 has left food (say 11.30).	Ditto.	5 have left food (say 11.30 for 5th larva).
,, 3. 0 p.m.	6 suspended (say 1.40 for 3rd, 4th, 5th, and 6th larvæ).	2 suspended (say 1.40 for 1st and 2nd larvæ).	2 suspended (say 1.40 for 1st and 2nd larvæ).	Both have left food (say 1.40 for 2nd larva).	2 suspended (say 1.40 for 1st and 2nd larvæ).	1 suspended (say 1.40). 5 on roof (say 1.40 for 6th larva).
,, 5. 7 p.m.	8 suspended (say 4 p.m. for 7th & 8th larvæ).	3 suspended (say 4 p.m. for 3rd larva).	4 suspended (say 4 p.m. for 3rd & 4th larvæ).	1 suspended (say 4 p.m.).	4 suspended (say 4 p.m. for 3rd & 4th larvæ).	2 suspended (say 4 p.m. for 2nd larva); all have left food (say 4 p.m. for 7th larva).
,, 8.30 p.m.	2 pupated, 1 about an hour (say 7.30), 1 a few minutes (say 8.20). Both moderately isolated on roof, and both moderately golden (5)s, the latter one being rather the more brilliant.	5 suspended (say 6.50 for 4th and 5th larvæ).	10 suspended (say 6.50 for 5th to 10th larvæ).	2 suspended (say 6.50 for 2nd larva).	5 suspended (say 6.50 for 5th larva).	4 suspended (say 6.50 for 3rd and 4th larvæ).
,, 10. 0 p.m.	Ditto.	Ditto.	11 suspended (say 9.15 for 11th larva).	Ditto.	6 suspended (say 9.15 for 6th larva).	5 suspended (say 9.15 for 5th larva).
,, 11.15 p.m.	Ditto.	Ditto.	Ditto.	Ditto.	Ditto.	Ditto.
,, 12 midnght.	Another pupated (say 11.40), one of a group of 6 suspended larvæ on the roof, a very light (3) brilliant.	Ditto.	12 suspended (say 11.40 for 12th larva).	Ditto.	Ditto.	Ditto.

July 13, 8. 0 a.m.	5 pupated; the others of the group of 6 on the roof mentioned above. 3 some few hours (say 4 a.m.); all (3)s with very little gilt, 2 recently (say 7.30) both normally golden (5)s.	3 pupated some few hours (say 4 a.m.), moderately crowded on roof. 2 (3)s and 1 (4) with normal gilt.	3 pupated, 2 some few hours (say 4 a.m.): a very black (1) and a very dark (3); 1 only just pupated (say 8 a.m.), and a very dark (3). All the larvæ suspended.	1 pupated recently (say 7.30), isolated on the roof; an extremely brilliant (5).	4 pupated, 2 some few hours (say 4 a.m.), 1 on roof (not crowded), a (4) with moderate gilt: 1 suspended on back, but fell to floor, a very dark (3). 1 pupated recently (say 7.30) on roof (not crowded), a (4) as above. 1 only just pupated (8 a.m.) on roof (not crowded), a (4) more silvery than golden.	2 pupated, 1 some few hours (say 4 a.m.), and a light (3), exceptionally golden: 1 recently (say 7.30), and a very light (3), exceptionally golden. All the larvæ suspended.
„ 10. 6 a.m.	The last larva is now suspended (say 9 a.m. for 9th larva).	1 pupated on roof (say 9 a.m.), moderately crowded: a (4) moderate gilt.	3 pupated: 2 only just completed change (10 a.m.), and are a very dark (3) and a (4). The 3rd pupa (say 9 a.m.) is a (3).	1 pupated (say 9 a.m.) on a leaf of food-plant; an extremely brilliant (5).	1 pupated (say 9 a.m.) on roof, not crowded, a (4) with moderate gilt.	2 pupated (say 9 a.m. for 3rd and 4th larvæ), a (1) and a (3).
„ 11.35 a.m.	Ditto.	1 pupated as above (say 10.50): a (4) little gilt.	4 pupated: 3 recently (say 11 a.m.), 2 very light (3) and 1 light (3). 1 earlier (say 10.30), and a very dark (3).		1 pupated on food-plant, probably some few hours (say 4 a.m., but very uncertain), and not noticed before: a (5), very brilliant.	No further change.
„ 12.40 p.m.	Ditto.	Ditto.	1 has pupated quite recently (say 12 noon), a (3).			1 has just pupated (12.40), a (1).
„ 1.35 p.m.	Ditto.	Ditto.	Ditto.			Ditto.
„ 2.40 p.m.	Ditto.	Ditto.	Ditto.			Ditto.
„ 3.40 p.m.	Ditto.	Ditto.	1 has pupated nearly an hour (say 3 p.m.) a (5), brilliantly golden			1 has just pupated (3.40), a very dark (3).
„ 8.30 p.m.	Ditto.	1 pupated some few hours (say 6 p.m.), as above: a light (3).	2 pupated: 1 some hours (say 6 p.m.), a light (3), & 1 quite recently (say 8 p.m.), a (2).			1 has just pupated (8.30), a dark (3).
„ 11.30 p.m.	The last larva has just (11.30) pupated, isolated on roof; a (4) with unusual gilt.					

I have previously spoken of the period before pupation as the "preparatory period," and have pointed out that it consists of three stages :—

"Stage I., in which the larva quits its food plant and hurries about, seeking for some place upon which to pupate.

Stage II., in which the larva rests motionless upon the selected surface, and towards the end of the stage spins the boss of silk for its subsequent suspension.

Stage III., in which the larva hangs suspended by its posterior claspers from a boss of silk" (Phil. Trans., 1887, B., pp. 327, 328).

If we assume that Stage I. began with the shock of capture in the case of the first three larvæ to pupate in each of the three receptacles without food, the following table indicates the beginnings and ends of all the stages and preparatory periods which could be safely fixed.

(*See Table, pages* 366, 367.)

The first point brought out by these figures is the great difference between the lengths of the stages, according as the larvæ remained upon the food-plant, or were wandering at the time the experiment began. Stating the results approximately, this difference is more clearly shown by the following arrangement :—

(*See Table* 1, *page* 370.)

It is here seen that the great difference between the length of the period before pupation in A, C, E, and B, D, F, is almost entirely due to the immensely greater duration of Stages I. and II. in the former, Stage III. being approximately the same throughout.

My former conclusions as to the lengths of the stages before pupation were chiefly founded upon experiments which resembled A, C, E, rather than the others, and hence this comparison has an important bearing on the recorded results, which were summarized as follows :— "The larvæ wander for a variable time, then rest for about 15 hours upon the surface selected for pupation, and finally hang suspended, head downwards, for about 18 hours, after which time pupation takes place" (Phil. Trans., *l.c.*, p. 438). The estimates arrived at above are much smaller, especially in the larvæ provided with food,

Gilt boxes in strong light.

	Without food.									With food.	
	1st larva	2nd "	3rd "	4th "	5th "	6th "	7th "	8th "	9th "	1st larva	2nd "
Length of Stages I. & II. ...	..	14 h 20 m	18 h 10 m	..	..	..	..	..	..	4 h 30 m	5 h 10 m
Length of Stage III.	..	10 h 30 m	10 h	14 h 20 m	14 h 20 m	14 h 20 m	15 h 30 m	15 h 30 m	14 h 30 m	15 h 30 m	14 h 10 m
Length of whole period before pupation	24 h	24 h 50 m	28 h 10 m	32 h 30 m ?	32 h 30 m ?	32 h 30 m ?	..	..	..	20 h	19 h 20 m
Pupal colours	(5)	(5)	Very light (3), brilliant.	(3)	(3)	(3)	(5)	(5)	(4)	(5)	(5)
Average length of Stages I. and II.	Average of 2 cases, 16 h. 15 m.									Average of 2 cases, 4 h. 50 m.	
Average length of Stage III.	" 8 " 13 h. 37½ m.									" " 14 h. 50 m.	
Average length of whole period before pupation	" 3 " 25 h. 23⅓ m.									" " 19 h. 40 m.	

Tin boxes in strong light.

	Without food.						With food.					
	1st larva	2nd "	3rd "	4th "	5th "	6th "	1st larva	2nd "	3rd "	4th "	5th "	6th "
Length of Stages I. & II. ...	18 h 10 m	18 h 10 m	20 h 10 m	..	..	..	..	..	6 h 10 m	6 h 10 m	9 h	..
Length of Stage III.	14 h 20 m	14 h 20 m	12 h	14 h 10 m	16 h	..	14 h 20 m	14 h 20 m	15 h 30 m	16 h	14 h 10 m	..
Length of whole period before pupation	32 h 30 m	32 h 30 m	32 h 30 m	..	..	..	..	..	21 h 40 m	22 h 10 m	23 h 10 m	..
Pupal colours	2 (3)s 1 (4)			(4)	(4)	light (3)	1 (4) 1 very dark (3)		(4)	(4)	(4)	(5)
Average length of Stages I. and II.	Average of 3 cases, 18 h. 50 m.						Average of 3 cases, 7 h. 6⅔ m.					
Average length of Stage III.	" 5 " 14 h. 10 m.						" 5 " 14 h. 52 m.					
Average length of whole period before pupation	" 3 " 32 h. 30 m.						" 3 " 22 h. 20 m.					

	Black cylinders in darkness.																				
	Without food.														With food.						
	1st larva	2nd ,,	3rd ,,	4th ,,	5th ,,	6th ,,	7th ,,	8th ,,	9th ,,	10th ,,	11th ,,	12th ,,	13th ,,	14th ,,	1st larva	2nd ,,	3rd ,,	4th ,,	5th ,,	6th ,,	7th ,,
Length of Stages I. & II...	18 h 10 m	18 h 10 m	20 h 30 m	..	..	..	..	..	..	..	..	..	..	..	..	6 h 10 m	9 h	9 h	9 h 45 m	..	..
Length of Stage III.......	14 h 20 m	14 h 20 m	16 h	17 h	15 h 10 m	15 h 10 m	16 h 10 m	16 h 10 m	16 h 10 m	16 h 10 m	14 h 45 m	15 h 20 m	..	..	14 h 20 m	15 h 30 m	14 h 10 m	14 h 10 m	15 h 25 m	..	..
Length of whole period before pupation	32 h 30 m	32 h 30 m	36 h 30 m	..	..	..	..	..	..	..	..	..	..	..	..	21 h 40 m	23 h 10 m	23 h 10 m	25 h 10 m	26 h	28 h 30 m
Pupal colours	1 (1) and 1 very dark (3)		Very dark (3)	(3)	1 (4) and 1 very dark (3)		Very dark (3)	1 light (3) 2 very light (3)			(3)	(5)	light (3)	(2)	Light (3) Very golden	Very light (3)	1 (1) and 1 (3)		(1)	Very dark (3)	Dark (3)
Average length of Stages I. and III.	Average of 3 cases, 18 h. 56$\frac{2}{3}$ m.														Average of 4 cases, 8 h. 28$\frac{3}{4}$ m.						
Average length of Stage III.	,, 12 ,, 15 h. 33$\frac{3}{4}$ m.														,, 5 ,, 14 h. 43 m.						
Average length of whole period before pupation	,, 3 ,, 33 h. 50 m.														,, 6 ,, 24 h. 36$\frac{2}{3}$ m.						

and the question arises as to whether these or the larvæ without food gave the more normal results.

Assuming that the power of resembling surrounding surfaces is normal to the species (and we are justified in assuming this), the extent of resemblance becomes some test of the normal condition, including duration of the preparatory stages, in which the resemblance is brought about. The pupal colours are tabulated at the end of the last analysis (pp. 366, 367), which distinctly shows that the number of exceptions is far greater among the pupæ in the receptacles without food, the larvæ of which passed through the longer preparatory stages. It becomes probable that some of the more irritable larvæ, which are so disturbed by the shock of capture that they refuse to feed, do not pass into a normal preparatory period, so far as Stages I. and II. are concerned, and, inasmuch as Stage II. is in this species the chief time of susceptibility, frequently produce pupæ which are abnormal in that they are exceptions to the usual resemblance to surroundings. If this be so, the normal susceptibility of the species must be far higher than that indicated by the results of my previous paper, in which the larvæ were generally treated as in the receptacles without food; and Stages I. and II. must be far shorter.

On the other hand, it must be remembered that the batch of 44 larvæ were probably the last of a large company, while the 15 provided with food were the last of the batch. If there is any tendency towards the shortening of the stages in the latest larvæ, these 15 would exhibit the tendency. There is, however, no evidence for the existence of such a tendency, and the fact that pupation occurred far later in certain larvæ without food than in any of those provided with it, seems to indicate that we are dealing with an abnormal protraction of the preparatory period,—the larvæ which were the first to leave the food being much the last to pupate.

Upon the whole, it is probable that the preparatory stages of the 15 larvæ are about normal, and that Stages I. and II. are made too long in my previous paper. It is true that the early stages are hurried on by the shock of capture, but they appear to be far from hurried through.

Stage III. does not seem to be affected by disturbance of the larvæ. The estimate of 18 hours must be reduced to about 15, but this latter duration was commonly noticed in the previous observations (*l. c.*, pp. 342, 347, 351, &c.).

At the same time, I should be glad for these conclusions to be tested by the observation of larger numbers, and of many companies. My previous results depended on such varied material, which, upon the whole, gave such distinct testimony in favour of longer stages, that it is possible that some of the difference may be due to the hereditary individual predispositions of the 44 larvæ observed in 1887.

Relying on the latter observations alone, we should conclude that the preparatory period varies from 20 to 24 hours, Stages I. and II. together from 5 to 9; while Stage III. has a nearly constant duration of 15 hours.

Bearing upon the lengths of preparatory stages in different conditions:—

Under any circumstances the observation has a clear bearing upon the conclusion I had previously arrived at,—that darkness protracts the stages. Whether we consider the larvæ with or without food, the results are the same: Stages I. and II. are longer in the tin box than in the gilt box, in the dark cylinder than in the tin box, and the pupal colours become darker in the same order (see preceding table, pp. 366, 367). And the difference is much clearer in the larvæ with food, which have been shown above to be, in all probability, in a more normal state. The conclusion previously arrived at was capable of two explanations: darkness might directly protract the stages, or its action might be indirect, tending towards the production of dark pupæ, and time being an element in the formation of the superficial pigment, or rather of some colourless precursor. The latter view is strongly supported by the observations here recorded; for the difference in duration is true of the tin- as compared with the gilt-box, in which, although both were in light, there was a corresponding difference in the pupal colours. Furthermore, the more marked difference, in the case of the larvæ with food, corresponded to a more marked difference of pupal colours, although unattended by any difference of illumination, as compared with the larvæ without food. All these statements will be found

TABLE 1.

	Length of Stages I. & II.	Length of Stage III.	Length of whole period before pupation.	Degrees of Pupal Colour. (1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)	
Gilt box, without food...... A	16¼ hours.	13½ hours.	25½ hours.				3	1	1	4	= 9
Gilt box, with food .... B	4¾ ,,	14¾ ,,	19¾ ,,							2	= 2
Tin box, without food C	18¾ ,,	14¼ ,,	32½ ,,				2	1	3		= 6
Tin box, with food .... D	7 ,,	14¾ ,,	22¼ ,,			1			4	1	= 6
Black cylinder, without food E	19 ,,	15½ ,,	33¾ ,,	1	1	4	2	4	1	1	=14
Black cylinder, with food .. F	8½ ,,	14¾ ,,	24½ ,,	2		2	1	2			= 7
											44

TABLE 1A.

Pupal Colours.	Food.	Length of Stages I. and II.	Numbers from which averages taken.	Length of Stage III.	Numbers from which averages taken.	Length of whole period before pupation.	Numbers from which averages taken.
(1)	Absent	18 hours 10 minutes.	1	14 hours 20 minutes.	1	32 hours 30 minutes.	1
	Present	9 ,, 22½ ,,	2	14 ,, 47½ ,,	2	24 ,, 10 ,,	2
(2)	Absent						
	Present						
Dark (3)	Absent	19 ,, 20 ,,	2	15 ,, 25 ,,	4	34 ,, 30 ,,	2
	Present			14 ,, 20 ,,	1	27 ,, 15 ,,	2
(3)	Absent			14 ,, 57 ,,	5	32 ,, 30 ,,	2
	Present	9 ,, 0 ,,	1	14 ,, 10 ,,	1	23 ,, 10 ,,	1
Light (3)	Absent	18 ,, 10 ,,	1	14 ,, 37½ ,,	4	28 ,, 10 ,,	1
	Present	6 ,, 10 ,,	1	14 ,, 55 ,,	2	21 ,, 40 ,,	1
(4)	Absent			14 ,, 57½ ,,	4	32 ,, 30 ,,	1
	Present	7 ,, 6⅔ ,,	3	15 ,, 0 ,,	4	22 ,, 20 ,,	3
(5)	Absent	14 ,, 20 ,,	1	14 ,, 12½ ,,	4	24 ,, 25 ,,	2
	Present	4 ,, 50 ,,	2	14 ,, 50 ,,	2	19 ,, 40 ,,	2

to be amply supported by the last table. In order to test this conclusion more fully, I have constructed another table, in which the lengths of the periods and stages are shown in the pupæ of the various degrees of colour, without taking into account the conditions to which they had been subjected, except as regards the presence or absence of food.

(*See Table* 1 *a*, *page* 370.)

This table shows a remarkable uniformity in the length of Stage III. in pupæ of all degrees of colour, just as the preceding table showed it in all conditions of illumination, &c. On the other hand, Stages I. and II., upon the whole, exhibit a marked tendency to become longer as the pupæ become darker. There are exceptions, but the general tendency is clear, and especially so in the case of larvæ with food. Besides, the history of the exceptions lends no support to the theory that the protraction is determined by darkness, apart from any influence on the pupal colours. The table suffers from the small numbers employed in taking the averages. The careful study of these observations, made in 1887, convinces me that I was mistaken in maintaining, as the result of a far more superficial examination of the figures, that "there did not appear to be any evidence for the supposition that the gilded pupæ pass through a shorter preparatory period than those which are less brilliant, when both are equally exposed to light" (Note added Sept. 10th, 1887, to p. 339 of Phil. Trans., 1887, B.).

I believe, on the other hand, that we are warranted in the conclusion *that dark surroundings tend to prolong Stages I. and II. (taken together) of the preparatory period, and that this protraction is associated with the production of the colourless precursor of the dark superficial pigment.*

I have hitherto treated Stages I. and II. together, but, if the above conclusion be valid, it is clear that Stage II. is alone concerned; for in the earlier wandering stage the larva has not yet reached the surface by which it is to be affected, and, as soon as it reaches it, Stage II. begins.

The question as to whether darkness acts, except by promoting the formation of dark pupæ, was most easily answered by observing whether dark surfaces in strong light produce the same effect. This test was applied in the same year as follows:—

Experiments 2 and 2a.

A company of 29 mature larvæ (probably the last remaining ones) was found 1 p.m., July 30. By 3.30 it became evident that the shock had caused 16 of them to cease feeding, and enter Stage I. These were placed in two receptacles, a box lined with gilt, and a cylinder lined with black paper, with the open end closed by a sheet of clear glass, and turned to a strong east light. Others were subsequently added as they entered Stage I.

Dates.	Experiment 2. XXXI. or XLVI. Gilt (Dutch-leaf) Surroundings in strong east light.	Experiment 2a. I., II., or III. Black Surroundings in strong east light.
July 30. 3.30 p.m.	8 larvæ introduced.	8 larvæ introduced.
7.30 p.m.	3 larvæ introduced.	3 larvæ introduced.
10. 0 p.m.	3 larvæ introduced.	4 larvæ introduced.
July 31, 10. 0 a.m.	5 suspended.	4 suspended.
2.25 p.m.	13 suspended.	10 suspended.
4.50 p.m.	All 14 suspended.	All 15 suspended.
9.30 p.m.	3 pupated (1 some hours, 2 recently).	1 pupated.
10.10 p.m.	1 pupated.	3 pupated.
10.54 p.m.	1 pupated.	
12.40 midnight.	1 pupated.	
Aug. 1, 10.30 a.m.	All pupated a long time.	All pupated except 1, but 3 evidently quite recently.

No notes were taken as to the colours of the pupæ, but it may be safely assumed that those in black were far darker than the others; and it is also clear that, although the larvæ were treated in exactly the same way (except as regards their surroundings), those in black pupated rather later than the others. Although all were suspended by 4.50 p.m. on July 31 in both sets, all but one had been suspended more than 2 hours earlier in the gilt, a time at which only two-thirds of those in the black had entered Stage III. These are less satisfactory than Experiments 1 and 1a, in the fact that probably all the larvæ were disturbed by capture, but they undoubtedly support the conclusions previously arrived at.

Experiments 3 and 3 a.

Another small batch, also found July 30, continued feeding for a day or two, and were then subjected to similar conditions. They were in fact probably placed in the same receptacles with the same conditions of illumination, but I have no note upon the latter point.

Dates.	Experiment 3. Gilt Surroundings.	Experiment 3 a. Black Surroundings.
Aug. 1, 10.45 a.m.	12 larvæ introduced.	11 larvæ introduced.
,, 12.40 p.m.	1 larva introduced.	3 larvæ introduced.
Aug. 2, 11.40 a.m.	12 pupated.	5 pupated, 6 suspended.
,, 3 p.m.	Unchanged.	7 pupated (rather recently).
	Last 1 unnoted.	Last 2 unnoted.

These brief notes show the same prolongation of the preparatory period in dark surroundings even more clearly than in Experiment 2 and 2 a. We may conclude that dark surroundings in light produce the same effect in this respect as darkness.

Other conclusions as to the effect upon pupal colours of different metallic surfaces, and of darkness as opposed to black surroundings in light, are to be gained from Experiment 1; but they are better deferred until after the examination of the experiments made in 1888.

1888.

The object of the numerous experiments made during this year was to obtain abundant confirmation of the influence of surroundings upon the pupal colours, and also to test the effect of various metallic surfaces, &c. It will be most convenient first to tabulate the whole of the experiments, briefly indicating the results of each, and then to analyse the tables in such a manner as to show the chief conclusions.

Dates of Capture and Exa-nation of Colonies.	Number and brief description of receptacles. (Roman numerals refer to detailed description at end of paper, see G. Appendix).	Position of the pupæ.	Degrees of pupal colours. (1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)	Further remarks on the pupal colours, &c.	Results.
A. Three or four mixed colonies found at Malvern June 29, and Worcester June 25. Compared July 12, 13, and 16.	VII. (see description of receptacles at end of paper). Black compartment of wooden box in strong light. Experiment 4.	Crowded on roof. ..	4	14	16	6	3	2		The 16 dark (3)s were very dark for this degree. The 2 (4)s were nearly light (3)s. Very little gold throughout, except in (4)s and the 1 light (3), and these with little, considering the degrees to which they belonged.	Effects of black well shown.
		On food-plant and floor	4	5	2	3	1	1			
	III. Black cylinder, probably in darkness. Experiment 5.	On black paper roof, not very crowded.	2	1	6	1		1		All very black, somewhat relieved by light pink. The (4) almost a light (3).	
		On black paper floor. ..					1				
	6. VIII. All black cylinders in darkness.	On black paper roof ..	4	2	3	1	2			Dark (3)s with very black pigment, somewhat neutralised by a very distinct pink tint.	
		On floor.			1						
	7. ,, IX.	All on black paper roof.	3	4	2	2				Only the (3)s were at all glittering.	
	8. ,, X.	On black paper roof. ..	1		2						
		On black paper floor (may have passed Stage II., or part of it, before introduced).				1			1		
	9. ,, XI.	On black paper roof and domed glass top.		2	5	4	2			Somewhat dullish pupæ.	
	10. ,, XII.	On domed glass top.	1	2	8	1					
	11. ,, XIII.	On black paper roof and domed glass top.	1		2	2		1			

A. Three or four mixed colonies found at Malvern June 29, and Worcester June 25. Compared July 12, 13, and 16.

XV. Black wooden box in darkness. Experiment 12.	On black paper roof	10	13	7	5	3	1		Pigment very black in all.	Effects of black well shown.
	On floor		1	1						
XVI. Gold-lined and roofed cylinder in total darkness.* Embossed Dutch metal. Experiment 13.	All on roof, not crowded	2		3	1		1		2 dark (3)s very dark and nearly (2)s; (4) rather golden.	Practically the same results as black surfaces in darkness.
XXXI. Gilt compartment of wooden box in strong light. Polished Dutch metal. Experiment 14.	Group crowded on roof				2	4	3	5	(4)s and (5)s and light (3) on floor, golden all over, but not very brilliant for their degrees.	Characteristic effects of gilt surfaces. A curious exception in 17 was doubtless due to crowding. Those in 16 (the (1) and (2)) are less noteworthy, not being on the gilt surface.
	Isolated on roof ..							1		
	On food-plant						1			
	On floor					1				
XXXII. Compartment arranged like 14. Embossed Dutch metal. Experiment 15.	Crowded in one recess of roof					6			Most pupæ dully golden over much of dorsal area.	
	Not crowded on roof and upper shelves					4	2	5	Light (3)s as above; others not specially bright, except 1 (4) and 1 (5).	
	On lower shelves (5 pupæ crowded)					2	3	3	(5)s very bright.	
	Food-plant and floor ..				1	3	7	4	(5)s very bright.	
XXXIII. Similar to 15. Polished Dutch metal. Experiment 16.	Not crowded on roof and all shelves..			2	5	3	3	1	Dullish except the (5).	
	Food-plant and floor ..	1	1	6	5	6	2		About normal, except the (4)s, which are dull.	
XXX. Gilt wooden box in strong light. Polished Dutch metal. Experiment 17.	Crowded in corner of roof				1	4	1		Put in late, and probably already advanced in Stage II.	
	Crowded in another corner of roof	1			4	1	1			
	On side below gold ..					1				

* The larvæ were shut up in a black box, which was placed under the cylinder, the latter being covered with rugs and mats. The box was then opened by strings without interfering with the darkness, so that the larvæ cannot have seen the gilt surface at any time.

XVII. Gilt cylinder. Placed on side with clear glass front, in strong light. Polished Dutch metal. Experiment 18.	Towards back of roof, and so near the gilt back as well						1	4	A dullish lot of pupæ in most cases, considering the degrees.	Characteristic effects of gilt surfaces. A curious exception in 17 was doubtless due to crowding. Those in 16 (the (1) and (2)) are less noteworthy, not being on the gilt surface.
	Not crowded on rest of roof				3	6	8	1		
	On floor					1				
XLVI. Silver paper lined compartment of wooden box in strong light. Experiment 19.	Isolated on back ..					2			Shaded by food-plant (especially the 3 light (3s).	Influence of silver not so strong as gilt, in the direction of brilliant pupæ: light (3)s greatly preponderate.
	Crowded on back ..					3				
	Not crowded on roof ..				1	5	1		Light (3)s dull, (4) golden.	
	Crowded on roof (but in position of strong illumination)					3	2	2	Light (3)s dull, (5)s brilliant, 1 (4) very white, and yet with golden spots.	
	On floor or on food-plant					1	1		Both golden.	
XLVII. Silver paper lined cylinder with domed roof, white paper floor. In light. Experiment 20.	Crowded on roof (apex of silver dome)			5	10	8		1	All dull.	
	Somewhat isolated on roof						1		Light, but not golden.	
	On white paper floor ..						1		Golden.	
LXXVII. Wooden box with green glass windows, dull green paper lining. Experiment 21.	All on roof		5	7	6	2		1	Dullish, especially the (5).	The tendency was towards darkish forms.
White muslin bag containing food-plant, fæces, &c. Experiment 22.	On white muslin ..			4	4	11	3	1	All bright for their degrees, except (4)s and (5). These were the first larvæ to pupate, before the stock had been removed to 23.	Tendency towards lightish forms.
	On food-plant			1	1	1	1			
Plain wooden box with clear glass top, in which stock of larvæ were kept. Experiment 23.	Crowded on glass top ..	1	4	21	10	3	4	3	(4)s and (5)s bright, light (3)s fairly so, rest dull. The 4 lightest of the (5)s kept to see whether they were healthy: all emerged normally, July 24.	A very mixed result, as might be expected from the character of the environment.
	Not crowded on glass top			5	3	3	2		As above.	
	On food-plant at various levels and amounts of shade	2	3	12	11	5		3	2 (5)s very bright. Some of the other pupæ, except (1)s and (2)s, brightish.	
	On floor under piles of food and fæces	1	1	1	1	1	1		All except (1) and (2) fairly bright.	

A. Three or four mixed colonies found at Malvern June 29, and Worcester June 25. Compared July 12, 13, and 16.

B. A colony found at Oxford June 30: the larvæ were mostly mature. Pupæ compared July 12 and 20.	I. Black surroundings in strong light. Experiment 24.	Large group on roof .. On floor (deformed) ..	4 1	11	24	4				All dull.	
	II. Black surroundings in darkness. Experiment 25.	All crowded on roof ..	4	3	13	8				Not at all dull. Very difficult to classify with others, because the (3)s and the 9 lightest dark (3)s, and some of the darker pupæ, had a brilliancy and a development of light pink about the anterior dorsal region quite unlike the others (except in V.); and yet the dark pigment was blacker, and so compensated.	Very similar results from darkness and black surroundings in strong light.
	XXXI. Gold surroundings in strong light. Compartment of wooden box. Polished Dutch metal. Experiment 26.	On roof, not crowded ..		1			2	2		The light (3)s and (4)s were bright. The others pupated very soon, and had probably been influenced before.	The more powerful effects of gold are very clear. The effect of crowding very obvious in 27. This colony seems to exhibit a strong tendency towards the production of dark varieties, and the pupæ are not easily made golden. Only 2 (4)s obtained from the whole.
		On floor			2	1					
	XLVIII. Silver surroundings in light. Cylinder placed on open end, so the crumpled tin paper covering the other end formed the roof. Tin paper. Experiment 27.	Very large crowded group on roof	1	4	20	4				All very dull looking; very little gold.	
		Outlying members of same			2	1					
		Isolated on roof.. ..					2				
		Small group on roof ..			2		2				
		Small scattered group on roof			2	1	1				
C. Small company (or part of one) found July 5 at Northampton. Compared July 20.	VII. Black lined compartment in strong light. Experiment 28.	All on roof, not very crowded		1	11	1				All very dull.	This colony does not tend towards the black varieties.

C. Small company (or part of one) found July 5 at Northampton. Compared July 20.	XXXII. Gold lined compartment of same box in strong light. Embossed Dutch metal. Experiment 29.	Crowded in one coffer of roof			1	4	3			Light (3)s normal, others dull.	Effects of crowding are seen in 29.
		Isolated on roof					1	2		Normally brilliant.	
	XXXIII. Gold lined compartment like XXXII. Polished Dutch metal. Experiment 30.	On roof; 2 or 3 in some of the coffers				3	5	1		The (4) not bright.	This colony does not tend towards the black varieties.
		On floor					1			Normally bright, like the light (3)s above.	
D. Company found at Northampton July 5. Compared July 20.	Black lined cylinders in darkness; black paper floors. Expt. 31. II.	All on roof	2	7	25	1				Dark (3)s mostly very black, but with small spots of gold on some.	Characteristic results.
	,, 32. III.	All on roof	1	5	11	1				All dull, except for small spots of gold. Dark (3s) as above in II.	
	XVII. Gold lined cylinder, placed on its side. Polished Dutch metal. Experiment 33.	Not very crowded on roof				6	6	6		(4)s not brilliant, but nearly normal.	Gold as before produces more effect than silver or tin.
		On gilt back				1					
	XLVIII. Silver lined cylinder, placed on its side. Tin paper. Experiment 34.	Crowded group on high part of roof			3	9	2	1		The (4) bright and normal; the rest dullish.	Silver and tin produce almost the same effects.
		Isolated on silver paper sides				2					
	XLVII. Silver lined cylinder with domed roof; white paper floor. Silver paper. Experiment 35.	All on roof, somewhat crowded				10	4	1			
E. Small company found at Oxford July 9. Compared July 20 & 21.	XIII. Black covered cylinder in darkness; black paper floor. Experiment 36.	Near top of cylinder ..		1	6	2	3	1		A dull lot, including the (4).	Not a great effect, as compared with other experiments (24, 25, 31, 32).
		On floor				1					

E. Small company found at Oxford July 9. Compared July 20 and 31.	XXVI. Transferred July 20 in Stage III. (suspended) from XIII. to small gold lined cylinder in strong light. Polished Dutch metal. Expt. 37.	On gilt paper floor ..				2					No effect produced by transference: the pupal colours previously determined.
	XXIX. Tin box lined with gold paper, in strong light. Embossed Dutch metal. Experiment 38.	Crowded on roof ..				1	5		1		Characteristic.
		On top of glass front, near gold, and 2 on the latter, near glass			1		1	2		The (4) brilliant.	
		On floor					1				
	White muslin, probably in strong light. Experiment 39.	Muslin top of cylinder in which stock of larvæ had been kept			3						
F. Small company found at Oxford July 9. Compared July 20 and 31.	Black lined cylinders in darkness, black paper floors. Experiment 40. I.	On roof, except 1 on side and 1 on floor		5	11					All dark (3)s, except 3 very black, and nearly (2)s.	As in 36.
	„ 41. VIII.	On top of side or roof ..			10	1				As above, except 2.	
	„ 42. X.	All on roof		4	1						
	XVI. Gold lined cylinder in strong light; placed on side. Embossed Dutch metal. Experiment 43.	All on roof, not very crowded.			1	9	7			A dullish lot.	Small effect of gold.
	White muslin, probably in dim light. Experiment 44.	Muslin top of box in which stock of larvæ was kept				2	1				
G. Small company found at Oxford July 9. Compared July 20.	XLVI. Silver lined compartment in strong light. Silver paper. Experiment 45.	Not crowded on roof ..				1	5	1		The (4) silvery and light; others normal.	Characteristic.

H. Company found at Oxford July 16. Compared July 30.

VIII. Black covered cylinder in darkness. Without rugs, mats, &c. Experiment 46.	On roof or sides near it	1	1	6	4	1			All dull; the light (3) very dull.	Much like 36. The comparison of these two experiments shows that the rugs, &c., are not necessary, 46 being the darker lot.
	On floor					1				
XII. Black covered cylinder in darkness. Covered with rugs, mats, &c. Experiment 47.	On sides and paper roof			9	4				Most of the dark (3)s very black and near (2)s.	
XVI. Gold lined cylinder on side in strong light. Embossed Dutch metal. Experiment 48.	On roof, not very crowded				2	2	3	3	2 (5)s very brilliant. 2 (4)s ,, ,, 1 (4) pale and silvery.	Characteristic.
XXIX. Gold lined tin box in strong light. Embossed Dutch metal. Experiment 49.	Crowded on gilt paper ..			3	3		1	1	(5) very bright, (4) dull, dark (3)s rather dark.	
	Isolated on gilt paper ..					1	1	2	The (4) and 1 (5) dull.	
XXXI. Gold lined compartment of box, in strong light. Polished Dutch metal. Experiment 50.	On roof, rather near together						1	1	The (4) not golden, but *very* light and rather silvery.	
	On floor					1				
XLVI. Silver lined compartment of box, in strong light. Silver paper. Experiment 51.	Scattered over roof ..				2	2	2	2	(5)s normally golden, (4)s not golden, but very light and silvery.	Strong effect for silver.
XLVIII. Silver lined cylinder, placed on side. Tin paper. Experiment 52.	Crowded on roof ..			1	4	4			Light (3)s normal, rest dull.	Characteristic.
	On floor (clear glass, near silver back)						1		Dull for this degree.	

H. Company found at Oxford July 16. Compared July 30.	XLVII. Silver lined cylinder with domed roof. Silver paper. Experiment 53.	Small group on roof ..				2	1	2			Less effect than 51, due to less illumination and more crowding.
		Outlying member of group						1			
		Isolated on roof						1			
		On floor					1				
	Rectangular clear glass case with perforated zinc roof, in which stock of larvæ were kept. Experiment 54.	Fixed to zinc roof ..	1	2	11	9	2			The (3)s and most dark (3)s very much alike.	Clear difference between effects of zinc and those of food-plant.
		On clear glass sides ..				2					
		On food-plant at various depths			1	3	1	1		All but the dark (3) golden for their degrees.	
	Transferred, in Stage II. or III., from zinc roof of case, in which stock was kept, to small gold lined cylinder XXVI. in strong light. Polished Dutch metal. Experiment 55.	Not crowded on gilt sides and roof				1		2		The (4)s dull, although somewhat golden.	Here transference has produced a distinct effect on some of the pupæ. Compare 54.
		On gilt floor (evidently 2 larvæ which had been suspended, Stage III.).				1	1				
	Black lined or covered cylinders in darkness. All but II. covered with rugs, &c. But darkness almost complete without this. Experiment 56. XI.	On top of sides			2	1	1				Small effects.
	,, 57. XIV.	On sides and black paper top			4	1	1			The dark (3)s very black.	
	,, 58. II.	On roof		1	19	3	1				
		On floor			1	1					
	,, 59. III.	All on roof		1	9	4	4	1			
I. Company found at Oxford July 16. Compared July 31.	XXVII. Gold lined cylinder in strong light. Embossed Dutch metal. Experiment 60.	On roof, not crowded ..							3	Very brilliant.	This company compares with B in an interesting manner, the whole tendency being the exact opposite. Bright forms are produced easily, and the darkest not at all.
	XVII. Gold lined cylinder in strong light (placed on its open end). Polished Dutch metal. Experiment 61.	Not very crowded group on roof					1	1	2	The (4) dull; both (5)s very brilliant, but one silvery rather than golden.	Very strong effects.
		Not crowded group on roof					2	2	1	(5) very brilliant; (4)s not very golden, but very light.	
		Isolated on roof							1	Very light, but not very glittering.	
		Glass, side below gilt ..					1				

I. Company found at Oxford July 16. Compared July 31.

XXX. Gold lined box in strong light. Polished Dutch metal. Experiment 62.	Large group in one corner of roof		1	3	10	3	3	2		Influence of crowding well seen when this is compared with 60 and 61.
	In small separate groups on roof			1		6		2	1 (5) very brilliant.	
	On floor among food and fæces				1		1		Both dull.	
Food-plant in the field. Found as pupæ [3], or larvæ in Stage III. [3], or some earlier stage [6]. Experiment 63.	3 pupæ and 3 larvæ suspended to food-plant in the field, July 16							3	Brilliant. The 3 larvæ died.	This proves that healthy pupæ of the greatest brilliancy may occur in nature on the food-plant, although they are generally diseased.
	Larvæ pupating soon after capture, having passed some of their stages on the food-plant in the field..					1	2	3	(5)s brilliant, the (4)s unusually golden. The imagos emerged normally from all these.	
Rectangular glass box with perforated zinc top, in which stock of larvæ was kept. Angles bound with black, and a shallow box (black outside) placed in bottom. Experiment 64.	On zinc roof			7	2	1			A dipterous larva emerged from 1 of the (3)s.	As in 54.
	On glass sides (1 low down near angle bound with black, and a black wooden box for food) ..				2				The 1 low down, black, but relieved by gold.	
	On food-plant at various depths			1	1		1	1	(4) and (5) dull; dark (3) very dark.	
Transferred from stock (zinc roof in Stage III.), to embossed Dutch metal lined cylinder XXVII., in strong light. Experiment 65.	On floor				1	1	1			Some effect produced. Probably transferred at beginning of Stage III.
	Pupated on white and blue plate					1	1		The (4) somewhat dull.	

This company compares with B in an interesting manner, the whole tendency being the exact opposite. Bright forms are produced easily, and the darkest not at all.

I. Company found at Oxford July 16. Compared July 31.

Transferred in Stage II. from stock in rectangular glass case (probably on roof) to some of the gilt and silvered compartments (XXXIV. to XLV.) of wooden box: 1 larva in each compartment. Experiment 66.	On roof of polished Dutch metal lined compartments					2				Greatest effect when transferred for the longest time — the (4).
	On floor of polished Dutch metal lined compartment ..					1				
	On roof of embossed and polished Dutch metal lined compartment				1					
	On roof of tin paper lined compartments			1	2					
	On roof of tin paper lined compartment; pupated later than others						1			
	On roof of silver paper lined compartment (XLI.).				1					
2 larvæ transferred in Stage III. from III. (darkness) to strong light in XXXIX. (Polished and embossed Dutch metal), and XLV. (tin paper). Experiment 67.	On gilt floor			1						No effect. Interesting to compare with 66, in which transference took place earlier.
	On silver floor			1						
Transferred in Stage III. from stock to white paper. Experiment 68.	On food-plant in Stage III. to white paper ..					1				Very little effect.
	On zinc roof in Stage III. to white paper			1	1	1	1		The (4) dull.	

This company compares with B in an interesting manner, the whole tendency being the exact opposite. Bright forms are produced easily, and the darkest not at all.

		Pupal Colours.							
		(1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)	
Black Surroundings in Darkness. Pupæ found on floor included, except in Experiment 8 (see special note in description of experiment).	Experiment (1887) 1	1	1	4	2	4	1	1	=14
	,, (1887) 1 A	2		2	1	2			= 7
	,, 6	4	2	4	1	2			=13
	,, 7	3	4	2	2				=11
	,, 8	1		2					= 3
	,, 9		2	5	4	2			=13
	,, 10	1	2	8	1				=12
	,, 11	1		2	2		1		= 6
	,, 12	10	14	8	5	3	1		=41
	,, 25	4	3	13	8				=28
	,, 31	2	7	25	1				=35
	,, 32	1	5	11	1				=18
	,, 36		1	6	3	3	1		=14
	,, 40		5	11					=16
	,, 41			10	1				=11
	,, 42		4	1					= 5
	,, 46	1	1	6	4	2			=14
	,, 47			9	4				=13
	,, 56			2	1	1			= 4
	,, 57			4	1	1			= 6
	,, 58		1	20	4	1			=26
	,, 59		1	9	4	4	1		=19
	Totals..	31	53	164	50	25	5	1	329
	Results expressed as percentages of the total	9·4	16·1	50·0	15·2	7·6	1·5	·3	
Black Surroundings in Strong Light. Pupæ found on floor included, except in Experiment 4 (where they were not distinguished from those on food-plant).	Experiment 4	4	14	16	6	3	2		=45
	,, 24	5	11	24	4				=44
	,, 28		1	11	1				=13
	Totals..	9	26	51	11	3	2		102
	Results expressed as percentages of the total	8·8	25·5	50·0	10·8	2·9	2·0		
Perforated Zinc Roof in Light.	Experiment 54	1	2	11	9	2			=25
	,, 64			7	2	1			=10
	Totals..	1	2	18	11	3			35
	Results expressed as percentages of the total	2·9	5·7	51·4	31·4	8·6			

The influence of Dark Surroundings in light as contrasted with the effects of darkness.

In my previous paper (*l. c.*, pp. 364, 365) I had made a pair of experiments in order to test the relative efficiency of black surroundings in light and in darkness. The results favoured the latter, which, upon the whole, produced somewhat darker pupæ, although they also included some which were lighter than the others. The numbers were insufficient for any safe conclusion, and I was therefore anxious to repeat the experiments on a much larger scale, especially considering that *larvæ* brought up in darkness are as a rule much less dark than those brought up among dark surroundings in strong light (see the earlier part of this paper). Hence a far larger number of experiments were devoted to the solution of this question than of any other. The table at p. 384 shows the results of all such experiments upon this species in 1887 and 1888, omitting No. 5, the arrangement of which is uncertain, and including the pupæ formed upon a darkish surface of perforated zinc.

Below, the percentages are placed one under the other, and compared with the results obtained in 1886, and with the single experiment in which a gilt surface (embossed Dutch metal, Experiment 13) was used in complete darkness.

Degrees of Colour.	(1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)	Numbers of Pupæ.
α. Black surroundings in darkness, 1886	15·4	15·4	30·8	23·0	15·4			13
β. Black surroundings in darkness, 1887 & 1888	9·4	16·1	50·0	15·2	7·6	1·6	·3	329
γ. Gilt surroundings, in darkness, 1888	28·6		42·9	14·3		14·3		7
δ. Black surroundings in strong light, 1886 ..	9·8	29·3	25·0	20·7	13·0	2·2		92
ε. Black surroundings in strong light, 1888 ..	8·8	25·5	50·0	10·8	2·9	2·0		102
ζ. Zinc surroundings in strong light, 1888 ..	2·9	5·7	51·4	31·4	8·6			35

This table indicates that there is very little difference between the pupæ of α, β, as compared with δ, ε. α is not much to be relied on, because of the small numbers employed. As regards the darkest pupæ, β, δ, and ε are practically equal, but there is a much smaller proportion of (2)s in β. In other respects no great difference can be made out, for the percentages of β are either practically the same as either δ or ε, or intermediate between them. The wide difference between the (2)s in the averages of these large numbers justifies the conclusion that darkness tends rather less towards the appearance of dark pupæ, than dark surroundings in strong light.

So far as it is possible to judge from the small numbers, gilt surfaces in complete darkness (γ) produce, as we should expect, the same effect as black surfaces subjected to the same condition.

The larger numbers attached to a darkish surface of zinc (ζ) tend in the same direction as those exposed to black surfaces, but are, as might be anticipated, stronger in the intermediate forms, and weaker in the darkest.

The influence of various bright metallic surfaces.

The following is a summary of all experiments of this kind in 1887 and 1888. In those of the latter year the crowded are carefully separated from the uncrowded pupæ, and those which pupated on the food-plant or floor are excluded.

(*See Table, pages* 387, 388.)

The percentages are now placed under one another to facilitate comparison, the results obtained by "gilt" paper in 1886 being also added.

Degrees of Colour.	(1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)	Numbers of Pupæ.
α. Embossed Dutch metal, not crowded ..			2·9	5·7	25·7	28·6	37·1	35
β. Embossed Dutch metal, crowded			10·9	36·9	45·7	2·2	4·3	46
γ. Dutch leaf, 1886		1·5	3·0	10·4	23·9	40·3	20·9	67
δ. Dutch leaf, 1887				30·0	10·0	10·0	50·0	10
ε. Polished Dutch metal, not crowded ..		1·2	2·4	21·4	31·0	29·7	14·3	84
ζ. Polished Dutch metal, crowded	1·7	1·7	6·9	29·3	31·0	13·8	15·5	58
η. Silver paper (compartment), not crowded				16·6	58·3	16·6	8·3	24
θ. Silver paper (compartment), crowded ..					60·0	20·0	20·0	10
ι. Silver-paper (cylinder), not crowded ..						100		3
κ. Silver-paper (cylinder), crowded			11·4	50·0	29·5	6·8	2·3	44
λ. Tin-plate, 1887			8·3	16·7	8·3	58·3	8·3	12
μ. Tin-paper, not crowded			36·4	36·4	27·3			11
ν. Tin-paper, crowded	1·7	7·0	45·6	29·8	14·0	1·7		57

"Gilt" paper (covered with different forms of "Dutch metal,"—a variety of brass).

		Experiments.	Pupal Colours. (1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)	Totals
Bright Dutch metal with an embossed pattern on it.	Pupæ not crowded.	Experiment 15 ..					4	2	5	=11
		" 29 ..					1	2		= 3
		" 38 ..			1		1	2		= 4
		" 48 ..				2	2	3	3	=10
		" 49 ..					1	1	2	= 4
		" 60 ..							3	= 3
		Totals..			1	2	9	10	13	35
		Results expressed as percentages of the total			2·9	5·7	25·7	28·6	37·1	
	Pupæ crowded.	Experiment 15 ..					6			= 6
		" 29 ..			1	4	3			= 8
		" 38 ..				1	5		1	= 7
		" 43 ..			1	9	7			=17
		" 49 ..			3	3		1	1	= 8
		Totals..			5	17	21	1	2	46
		Results expressed as percentages of the total			10·9	36·9	45·7	2·2	4·3	
1887. Bright, but not highly polished Dutch metal applied to the paper in the form of "leaf."	No distinction made.	Experiment 1 ..				3	1	1	4	= 9
		" 1A ..							1	= 1
		Totals..				3	1	1	5	10
		Results expressed as percentages of the total				30·0	10·0	10·0	50·0	
Bright Dutch metal with a highly polished surface.	Pupæ not crowded.	Experiment 14 ..							1	= 1
		" 16 ..			2	5	3	3	1	=14
		" 17 ..					1			= 1
		" 18 ..				3	6	9	5	=23
		" 26 ..		1			2	2		= 5
		" 30 ..				3	5	1		= 9
		" 33 ..				7	6	6		=19
		" 50 ..						1	1	= 2
		" 61 ..					3	3	4	=10
		Totals..		1	2	18	26	25	12	84
		Results expressed as percentages of the total		1·2	2·4	21·4	31·0	29·7	14·3	
	Pupæ crowded.	Experiment 14 ..				2	4	3	5	=14
		" 17 ..	1			5	5	2		=13
		" 62 ..		1	4	10	9	3	4	=31
		Totals..	1	1	4	17	18	8	9	58
		Results expressed as percentages of the total	1·7	1·7	6·9	29·3	31·0	13·8	15·5	

Bright surface of metallic silver.	Silver paper, bright, but not highly polished, in strong light (compartment of wooden box).	Pupæ not crowded.	Experiment 19 ..				1	7	1		= 9
			,, 45 ..				1	5	1		= 7
			,, 51 ..				2	2	2	2	= 8
			Totals..				4	14	4	2	24
			Results expressed as percentages of the total				16·6	58·3	16·6	8·3	
		Pupæ crowded.	Experiment 19 ..					6	2	2	=10
			Results expressed as percentages of the total					60·0	20·0	20·0	
	Similar silver paper in less strong light (domed roof of cylinder).	Pupæ not crowded.	Experiment 20 ..						1		= 1
			,, 53 ..						2		= 2
			Totals..						3		3
			Results expressed as percentages of the total						100·		
		Pupæ crowded.	Experiment 20 ..			5	10	8		1	=24
			,, 35 ..				10	4	1		=15
			,, 53 ..				2	1	2		= 5
			Totals..			5	22	13	3	1	44
			Results expressed as percentages of the total			11·4	50·0	29·5	6·8	2·3	
Bright surface of metallic tin.	1887. Bright and highly polished tin-plate.	No distinction made.	Experiment 1 ..				2	1	3		= 6
			,, 1 A ..			1			4	1	= 6
			Totals..			1	2	1	7	1	12
			Results expressed as percentages of the total			8·3	16·7	8·3	58·3	8·3	
	Bright and polished surface of tin-paper (an artificial "silver paper"), greyer and less bright than tin-plate.	Pupæ not crowded.	Experiment 27 ..			4	2	3			= 9
			,, 34 ..				2				= 2
			Totals..			4	4	3			11
			Results expressed as percentages of the total			36·4	36·4	27·3			
		Pupæ crowded.	Experiment 27 ..	1	4	22	4	2			=33
			,, 34 ..			3	9	2	1		=15
			,, 52 ..			1	4	4			= 9
			Totals..	1	4	26	17	8	1		57
			Results expressed as percentages of the total	1·7	7·0	45·6	29·8	14·0	1·7		

The percentages of δ, θ, ι, λ, and μ depend on such small totals that they are not of much value. The remaining figures are mostly trustworthy, and lead to some interesting conclusions.

The comparison of α with β, and of ϵ with ζ, entirely confirm the conclusion at which I arrived in 1886,—that crowding the larvæ tends to produce dark pupæ, the effect being presumably due to the influence upon each larva of the dark skins of its neighbours.

Any supposed chemical influence of the surface is entirely dispelled by the comparison. When the same material is employed in different forms, different effects may be produced if the character of the reflected light is altered thereby. Thus Dutch metal produces least effect when it possesses a very highly polished surface (ϵ and ζ), most when it is broken up by a small raised pattern, as in α (β shows the effects of crowding to a remarkable extent), while the Dutch leaf, which is not highly polished, but of a very bright golden appearance, also produces powerful effects (γ). It is probable, indeed, that this latter is the most powerful form of the substance, for the averages of 1886 are brought down by the inclusion of pupæ which were excluded or separated in 1888 (pupæ on the floors or food-plant of cases, and crowded pupæ).

So, too, the silver paper produced far more effect when in strong light (η, θ) than when the light was somewhat dim (ι, κ), and bright tin-plate (λ), although the numbers were very small, is evidently far more powerful than the duller, greyer surface of tin-paper.

In 1886 I had sometimes thought that the pupæ produced on white opal glass tended to be silvery rather than golden, and one object I had in view was to test for any such susceptibility. This was the chief reason for employing the silver and tin surfaces. The results were entirely negative. Single pupæ belonging to (5)s or (4)s are occasionally met with having a silvery instead of a golden lustre, but there was no evidence that they were commoner on the surfaces with a corresponding colour. The tendency of silvery surfaces is in the same direction as that of golden ones, only it is not equally powerful.

Other Results.

The effects of a few other conditions not tested by large numbers of individuals are shown in the table below, the percentages from white surroundings in 1886 being also included for the purpose of comparison.

			(1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)	Numbers of Pupæ.
White surroundings (paper and opal glass), 1886 ..				4·8	14·5	25·5	30·3	17·2	7·6	145
White muslin.		Experiment 22 ..			4	4	11	3	1	= 23
		,, 39 ..			3					= 3
		,, 44 ..				2	1			= 3
		Totals..			7	6	12	3	1	29
		Results expressed as percentages of the total			24·1	20·7	41·4	10·3	3·4	
Clear glass.	Pupæ not crowded.	Experiment 23 ..			5	3	3	2		= 13
		,, 54 ..				2				= 2
		,, 64 ..				2				= 2
		Totals..			5	7	3	2		17
		Results expressed as percentages of the total			29·4	41·2	17·6	11·8		
	Pupæ crowded.	Experiment 23 ..	1	4	21	10	3	4	3	= 46
		Results expressed as percentages of the total	2·2	8·7	43·7	21·7	6·5	8·7	6·5	
Deep green glass in front of a dark green background.		Experiment 21 ..		5	7	6	2		1	= 21
		Results expressed as percentages of the total		23·8	33·3	28·6	9·5		4·8	

It is thus seen that white muslin was not nearly so powerful as the white paper and opal glass employed in 1886. The difference corresponds to the far smaller amount of light reflected from the former, and its feebler illumination under the conditions of the experiment.

Clear glass, when uncrowded, chiefly produced intermediate forms, while the crowded pupæ were considerably darker as a whole, although including 6·5 °/₀ of the lightest varieties. It will probably be found that larvæ suspended from threads at a distance from any background would tend, like the isolated ones on clear glass, to produce intermediate forms.

The effect of light transmitted through deep green glass was, with a single exception, to produce dark or intermediate pupæ. This will be alluded to further on in discussing the very different effect upon *V. io* of the same light reflected from a white background.

The few transference experiments need not be extracted from the descriptive table. They quite confirm, although they add nothing to, the results obtained with larger and more carefully conducted experiments in 1886.

The general result of the whole series of 68 experiments conducted, in 1888, upon many hundreds of pupæ is to afford abundant confirmation of the earlier work, at the same time extending it in many directions.

1892.

The only experiment upon *V. urticæ* in this year was one with conflicting colours. The results of such experiments have so important a bearing upon the physiology of the adjustment of pupal colours that I was anxious to repeat them, if possible, in a more searching manner.

In 1886 I devoted a great deal of time and attention to the subject (Phil. Trans. 1887, pp. 368—392), exposing the larvæ during Stage III. to gilt and black surroundings in compartmented tubes, and frames with perforated shelves between the contrasted colours.

The following questions as to the physiology of the process are answered by the results of these experiments:—(a) *The possible influence of colour upon the larval eyes.* Blinding the larvæ had failed to affect the power of adjustment, and this experiment would apply a valuable test to the conclusion that the eyes are of no importance in the matter. If the colour surrounding the anterior part of the larva had no more influence than that surrounding the posterior part, the conclusions from the blinding experiments receive strong confirmation. (b) *The direct photographic effect of light upon the skin.* Although the earlier view that the pupal tints are determined in this way *after* the last ecdysis, has been completely upset by the results of transference experiments, it still remained possible that the light directly influences the developing pupa beneath the larval cuticle, and thus determines the presence or absence of the colourless precursor of the pigment which subsequently appears. If two colours with opposite influences produced opposite effects on the two parts of the pupa to which they had been respectively applied, the suggestion made above would receive very strong support. If not, if some intermediate tint was common to the whole pupal surface, the above suggestion could only hold if we suppose that the superficial layer in which these changes take place is in a condition of such complete physiological unity that each local influence is just as powerful in another part of the layer where an opposite influence is at work as it is in the area directly exposed to its action. Although such a view is difficult to conceive, the tendency of recent research has certainly afforded proof of the organic continuity of tissues which such a hypothesis requires. Dr. Michael Foster tells me that he does not by any means consider this hypothesis to be essentially improbable as an explanation of the adjustment of colour. (c) *The influence of light through the nervous system.* If the nervous system receives the stimulus, and controls the result, a general effect from a local influence is to be expected. There is no difficulty whatever in the supposition that the impulses from conflicting stimuli applied to different areas of the body would become neutralized when they meet in some nervous centre or centres, and hence result in efferent impulses which produce a uniform intermediate effect. This conclusion is also supported by the power of adjusting the colours of the cocoon, which can still be maintained to exist in the genus *Halias*, and which receives its most probable explanation on the supposition that the nervous system is concerned.

In addition to its direct bearing on these important questions, the experiment also affords interesting information as to the relative strengths of stimuli opposed to each other, and (in the form in which it has been conducted in 1892) as to the possible exercise of choice by the larva.

The results obtained in 1886 are well known to be negative—a uniform result following the two opposed local influences. I was anxious to apply the experiment in such a form that the larvæ would be exposed to conflicting stimuli during the most sensitive stage (II.), as well as the last.

With this object in view, I constructed the case which is represented, about one-fifth of the true size, in Plate XV., fig. 5. It consisted of three rows of compartments, each row containing 14. The compartments were 8·1 cm. high in the two upper rows, rather higher in the lowest row. Their width varied from 1·5 to 5·0 cm.; their depth was 1·2 cm. at the bottom, while above it tapered away to a chink only 0·3 cm. wide. The front of each row was covered in by a strip of clear glass, which sloped gently backwards, resting upon the wedge-shaped divisions between the compartments. These divisions and the backs of the compartments were lined with alternating strips of gilt (polished Dutch metal) and black paper (black tissue paper). Those of the lowest row were crossed by two narrow gilt strips, 0·8 cm. broad, separated by black bands of three times the breadth, the uppermost being rather broader, and the narrow roof and floor (about 1·2 cm. wide) being gilt. The compartments of the two upper rows were crossed by strips of black and gilt, with an equal breadth of about 1·5 cm., except the uppermost (black in the top row, gilt in the middle one), which was rather broader. The narrow roof and floor were opposite in colour to the adjacent strips.

In use, the case was kept vertical in the position shown in fig. 5, and a single larva, having ceased to feed, was introduced into each compartment. Hence no allowance has to be made for crowding. The larvæ were left undisturbed in the compartments, and, after their first excitement, passed all the stages in a normal manner, and formed pupæ, suspended to either the back of the compartments or the glass front. It is clear that two or more parts of the larval body, succeeding each other antero-posteriorly, had been subjected to conflicting impulses during the whole of the sensitive period.

The last larvæ of a company found towards the end of August at Oxford, being mature, were at once placed in the case just described. The pupæ were compared August 28, with the following results:—

	Degrees of Colour of Pupæ.	(1)	(2)	Dark (3)	(3)	Light (3)	(4)	(5)
Fixed to vertical back of Rows I. and II., in which the black and gold bands are of equal width, or to the glass front.	3 fixed to junction of gold and black, the body on black, head in the middle of gold			1	1	1		
	3 fixed to junction of gold and black, the body on gold, head in the middle of black				2	1		
	2 fixed just above junction of gold and black, the body on gold, head and posterior end on black			1		1		
	4 fixed on the glass just opposite this level			2		2		
	3 fixed on middle of gold, head and anterior part on black					3		
	3 fixed below middle of gold, so that body lay upon black band, and the head just overlapped the next gold band			2		1		
	4 fixed on glass just opposite this level				2	1	1	
Fixed similarly to back (except one on side), or glass of Row III., in which the gold bands are only ⅓ the width of the black ones.	5 fixed on junction of gold and black, so that the whole pupa was on black, the head not reaching the next gold band	1		2	1	1		
	1 fixed on glass opposite this level			1				
	1 fixed just below junction of gold and black, so that head just overlapped next gold band					1		
	3 fixed just above the middle of gold, so that all the rest of the pupa was on the black band			3				
	1 fixed on the junction of gold and black, so that posterior end crossed the gold, and the rest of pupa was on black			1				
	1 fixed on side of compartment, the middle of the pupa crossing a gold band, the rest on black			1				

These pupæ were wonderfully uniform and transitional, so that their classification was a matter of great difficulty. It will be noted that there are only two out of the whole number which were other than intermediate [some form of (3)] varieties. There was remarkably little gold on the pupæ, the classification of the (3)s being entirely dependent on the amount and depth of the pigments present.

In order to test the results of this experiment still further, a different mode of comparison was adopted. Neglecting the pupæ fixed to the glass, all the others in Rows I. and II. were arranged according to the parts of the body which were exposed to black or gold. They fell into four classes:—

A. — 3 pupæ with head well in gold.
B. — 6 ,, ,, black.
C. — 3 ,, just in gold.
D. — 2 ,, ,, black.

But there was no tendency for the anterior part of pupæ A. and C. to be any lighter than the same part of B. and D. respectively.

Those fixed on Row III. were then similarly compared. They fell into two classes:—

E. — 10 pupæ with head in black.
F. — 1 pupa ,, gold.

The last was certainly lighter than any of E., but it was light altogether, and not specially about the head or anterior part.

It is thus clear that the colours did not produce localized effects. The anterior or posterior end of a pupa was often specially light, but this was quite irrespective of the colour of the band against which it had rested.

These comparisons were carried out with the greatest care, the pupæ being not only arranged side by side on a sheet of white paper, with the light falling on the same side of each of them (for this plan is always adopted in my comparison of pupæ), but the sheet was gradually turned round to permit their equal illumination on all parts of the body.

Although the results are entirely negative, thus confirming my earlier experiments in 1886, it is clear that the pupæ in Row III., with the broader black bands, were distinctly darker as a whole than those in Rows I. and II. Although no localised effects are produced, the gold and the black certainly influence the pupa, and when the relative extent of one of the areas is increased, its effect, as tested by the whole pupal surface, tends to preponderate over that of the other.

The bearing of this experiment upon the important physiological questions set forth at the beginning of this section is thus clear, and although nothing new is added to my earlier work, it is at any rate important to confirm by the use of an improved method an experiment upon which conclusions of so much interest depend.

Mr. Bateson (Trans. Ent. Soc. Lond., 1892, p. 212) states that he gleaned "no hint at all of the physiology of these phenomena," as indeed was to be expected from the class of my experiments of 1886, which he had selected for repetition. But although he failed to select experiments which would have yielded some information on the point, the experiments had nevertheless been made in 1886, and published with every detail in 1887. Other workers are likely to be discouraged rather than inspired by a statement which, although no doubt true of the writer himself, does not represent the knowledge of the time at which he wrote. For we do possess certain clear indications as to the physiology of these processes, even though they may not carry us very far.

I now turn to the bearing of the recent conflicting colour experiments upon the smaller points already alluded to (see page 392).

The larvæ, as a rule, tend to mount a vertical surface, and suspend themselves from the under side of any ledge projecting from it, but in the absence of the latter they will fix themselves to the vertical surface itself. Advantage of this habit was taken in compelling the larvæ to fix themselves to the vertical back of the conflicting colour case, where the conditions of the experiment could be carried out in the best manner. Reference to fig. 5 (Plate XV.) will show the positions selected by many of the larvæ; for the white bosses of silk from which the pupæ were suspended are clearly indicated as white spots in the collotype. It is thus seen that they did not mount to the highest points, but suspended themselves about half-way up or a little above this level; and this was true of all the rows, irrespective of the band of colour which happened to be at this horizon. There is no evidence that any selection was made, although there is no doubt that the resulting pupæ would have been less conspicuous on the black than on the gold.

We are forced to conclude that the larvæ ascended the lessening space, and stopped at the point where the narrow width of the chink would have endangered the success of the process of pupation which is so precarious in this group of Lepidoptera. Such an instinct would be extremely valuable to species pupating in cracks and chinks of stone or bark, and it certainly seems to exist. The evidence of it was equally clear in *V. io*, and was found in both kinds of case employed with this species (see the level of the bosses of silk on the black part of fig. 6 in Plate XV.).

As to the relative strength of black and gilt when equal in extent, the intermediate position of the pupæ indicates a tolerably equal balance, inclining rather to the side of the latter in the number of light (3)s and the (4). When the extent of the areas becomes relatively unequal, the balance of strength is of course upset, giving black by far the greater power under the particular conditions of the experiment as carried out in the lowest row of compartments.

2. Experiments on the pupa of Vanessa io, 1888, 1891, and 1892.

In working in 1886 I had experimented upon a very few individuals of this species, and had shown that they are highly susceptible. I was most anxious to investigate the species very fully, for it appeared to be even more suitable for the purposes of this enquiry than *Vanessa urticæ*. Although the number of individuals tested has been smaller than in the latter species, the results are more decisive, and I think we may consider that our knowledge of these two *Vanessidæ* is, in this respect, about on a level.

The first necessity was the construction of a scale of pupal colours in which each marked form is represented by a number. This was made in 1888, and found to work well in subsequent years. The divisions are made, as far as possible, equivalent to those of *V. urticæ*, and, indeed, the division into 5 classes was the one into which a large series of individuals of *V. io* most naturally falls. If we substitute green for gold, and remember that the intermediate forms are not so common and do not require subdivision into 3 classes, the criteria adopted in the two arrangements become almost identical, as will be seen below.

(1) (2) { The darkest forms; the underlying green is completely or very nearly [in some (2)s] concealed by the superficial pigment, which is blacker in (1), lighter in (2).

(3) { Intermediate forms, with a varying amount of pigment, although never sufficient to conceal the green colour, which is prominent on the pupa.

(4) (5) { Distinct green forms, very bright and glittering in (5), somewhat duller and with more pigment in (4). The small amount of pigment tends to exhibit a reddish tint.

The chief and obvious distinction is between (1) + (2) and (4) + (5). Completely transitional forms occur, especially among the (3)s, but these are not very common, and a large majority of the pupæ are classified with the greatest ease, far more so than in the case of *V. urticæ.*

A figure of the green and golden form (5) is shown in Phil. Trans., 1887, B, plate 26, fig. 7, and a representation of the cuticle of the wing of the same form in fig. 10 (magnified 7 diameters), showing the small amount of superficial pigment, some of which is reddish. In fig. 11 there is a similar representation of the pupal wing of a dark form, (1), showing the relative abundance and intensity of the cuticular pigment.

There is little doubt that the green forms of *V. io* truly represent the golden ones of *V. urticæ*, the former being also distinctly golden, although this appearance is rendered less prominent because of the green colouring. They are, furthermore, produced in almost every case by the same stimuli.

In the following account all the experiments which are intended to test the effects of various coloured backgrounds and screens will first be given, with their details. The results will be analysed at the end of the section concerned with this species, *after* the consideration of various other experiments, dealing with the length and susceptibility of the preparatory stages and the effects of conflicting colours. Thus the arrangement will not necessarily follow the order in which the experiments succeeded each other.

The effects of various colours will now be shown in the accompanying tables.

Companies of Larvæ made use of.	Receptacles employed.	Positions of pupæ.	Pupal Colours. (1)	(2)	(3)	(4)	(5)	Results.
A. Small lot of 9 found at Oxford, July 9, 1888, together with 1 larva taken previously; compared July 24. Larvæ fed for several days in the receptacles described.	IV. Black lined cylinder in strong light. Experiment 1.	4 larvæ introduced; 1 died; 3 pupæ suspended to roof, of which 1 died	2					The (5)s precisely alike, and bright green forms. Hence the green and gilt surroundings produced exactly the same effect. The results of black were very pronounced.
	XXVII. Gold lined cylinder in strong light. Embossed Dutch metal. Experiment 2.	4 introduced (all fixed to roof).					4	
	LXIX. Green tissue paper covered cylinder. Experiment 3.	1 introduced (on roof). ..					1	
	LXX. Green tissue paper covered cylinder. Experiment 4.	1 introduced (on roof). ..					1	
B. Company found at Chipping Norton towards the end of July, 1888; compared Aug. 9. It is possible that 2 or 3 larvæ from D. were accidentally introduced; and 3 from C. were intermixed with Experiment 6. It is probable that this and the next lot belong to one company, as they were of the same age, and found on the same bed of nettles.	I. Black lined cylinder in complete darkness (covered with rugs, &c.). Experiment 5.	5 on floor.	2	1	1		1	Effect of darkness was very irregular.
		4 on roof in group.	2		1	1		
		4 on roof in scattered group, the (5) outlying.	1	2			1	
		13 introduced.						
	VIII. Black lined cylinder in complete darkness (covered with rugs, &c.). Experiment 6.	3 of these larvæ were taken from C company. 6 introduced (all on roof).			2	3	1	
	XXV. Gold lined cylinder. Dutch leaf. Experiment 7.	1 introduced (on roof). ..					1	The gilt surroundings produced bright green pupæ almost uniformly.

XVI. Gold lined cylinder. Embossed Dutch metal. Experiment 8.	6 introduced; all in a somewhat scattered group on roof near background (gilt end). The (2) was in the middle of the group.		1		3	2	The gilt surroundings produced bright green pupæ almost uniformly.
XXIX. Gold lined tin box. Embossed Dutch metal. Experiment 9.	1 on floor (perhaps had been suspended). 1 dead larva on floor. 3 dead larvæ on roof. 1 pupa on roof, somewhat separated from these latter. — 6 introduced.					2	
XVII. Gold lined cylinder. Polished Dutch metal. Experiment 10.	7 in small group on roof (1 of them dead and discoloured). 1 on floor. — 8 introduced.					7	
XX. Gold lined cylinder. Polished Dutch metal. Experiment 11.	1 dead on floor. 1 deformed on floor, a (5). 4 close together on roof. — 6 introduced.			1		4	
XXVI. Gold lined cylinder. Polished Dutch metal. Experiment 12.	1 introduced (on roof). ..					1	
XXXI. Gold lined compartment. Polished Dutch metal. Experiment 13.	All on roof. 4 in group (1 (4)). 1 isolated. 2 in group (1 (4)). — 7 introduced.				2	5	

B. Company found at Chipping Norton towards the end of July, 1888; compared Aug. 9. It is possible that 2 or 3 larvæ from D. were accidentally introduced; and 3 from C. were intermixed with Experiment 6. It is probable that this and the next lot belong to one company, as they were of the same age, and found on the same bed of nettles.

XLVI. Silver paper lined compartment. Experiment 14.	5 crowded on roof. 1 dead larva. 1 dead pupa, discoloured. — 7 introduced.			1	1	3	Effects not equal to gilt.
LXIX. Green tissue paper covered cylinder. Experiment 15.	1 introduced (fixed to side near roof).					1	Effects like that of gilt.
LXXVII. White paper lined box with green glass windows. Experiment 16.	11 in a longish but crowded group on roof. 1 on floor. — 12 introduced.					12	
Found in stock of larvæ. Experiment 17.	2 pupæ low down on food-plant, and shaded; isolated.			1	1		These pupæ on leaves are usually bright green. Here they were probably affected by shade.
Black lined cylinders in complete darkness (rugs, &c.) Experiment 18. II.	Group of 10 on roof, including 1 dead larva		2	5	1	1	Irregular results, inclining on the whole towards dark pupæ.
	Small group of 2 on another part of roof. 12 introduced ..	1				1	
,, 19. X.	1 on floor (a (1)). 4 on roof. 1 larva dead. — 6 larvæ introduced.	2		1	2		
Gold lined compartments. Polished Dutch metal. Experiment 20. XXXIV.	On floor (fallen and injured). 1 larva introduced				1		Much greater effect of gold than silver in the direction of green forms.
,, 21. XXXV.	On floor. 1 larva introduced.					1	
,, 22. XXXVI.	Fixed to roof. 1 larva introduced					1	

B. Company found at Chipping Norton towards the end of July, 1888; compared Aug. 9. It is possible that 2 or 3 larvæ from D. were accidentally introduced; and 3 from C. were intermixed with Experiment 6. It is probable that this and the next lot belong to one company, as they were of the same age, and found on the same bed of nettles.

C. A company found at Chipping Norton towards the end of July, 1888; compared Aug. 9. Like the larvæ of B, they were changing their last skins when found, and were upon the same bed of nettles. It is probable that they belonged to the same company; 3 of these were intermixed with B in Expt. 6, and it is possible that larvæ of B may have been introduced into Expts. 31 and 32, although this is unlikely.

Gold lined compartments. Mixed polished and embossed Dutch metal.							
Experiment 23. XXXVII.	Fixed to roof. I larva introduced			1			Much greater effect of gold than silver in the direction of green forms.
,, 24. XXXVIII.	Fixed to back high up. 1 larva introduced					1	
,, 25. XXXIX.	Fixed to roof. 1 larva introduced					1	
Tin paper lined compartments in strong light.							
Experiment 26. XLI.	Fixed to roof. 1 larva introduced			1			Only 1 bright green pupa.
,, 27. XLII.	On floor. 1 larva introduced.				1		
,, 28. XLIII.	Fixed to roof. 1 larva introduced			1			
,, 29. XLIV.	On floor. 1 larva introduced.					1	
XLVIII. Tin paper lined cylinder, placed on its side, with clear glass front. Experiment 30.	All on roof. 1 isolated. 7 in somewhat scattered group. — 8 introduced.		8				Very different to the effects of gilt.
L. Opal glass gas-globe. Experiment 31.	3 on glass side near top, near together, but not crowded. 3 on floor (1 deformed, 1 fell off roof). 1 dead on floor. — 7 introduced.				3	3	Tends to produce green pupæ, although not to the same extent as gilt.
LI. Opal glass gas-globe. Experiment 32.	3 on floor (2 (5)). 4 small group high up on side (1 (2) and 1 (3)). — 7 introduced.		1	1	3	2	
LXVII. Compartment lined with orange paper; clear glass front. Experiment 33.	1 introduced (on roof) ..					1	Orange and yellow backgrounds produce bright green pupæ.

C. A company found at Chipping Norton towards the end of July, 1888; compared Aug. 9. Like the larvæ of B, they were changing their last skins when found, and were upon the same bed of nettles. It is probable that they belonged to the same company; 3 of these were intermixed with B in Expt. 6, and it is possible that larvæ of B may have been introduced into Expts. 31 and 32, although this is unlikely.

LXVIII. Compartment lined with yellow paper; clear glass front. Experiment 34.	1 introduced (on floor) ..					1	Orange and yellow backgrounds produce bright green pupæ.
LXXII. Plain wood compartment, with front of red gelatine. Experiment 35.	2 on roof near together. 1 floor. — 3 introduced.					3	Red glass and gelatine produce bright green pupæ when the background is light. (LXXII and LXXV)
LXXV. Plain wood compartment, with front of red glass. Experiment 36.	1 introduced (on roof) ..					1	
LXXVI. Plain wood compartment, with front of yellow glass. Experiment 37.	4 introduced (on roof near together)..				1	3	Same as 35 and 36, only not quite so strongly in the direction of green pupæ; but this was probably due to crowding. (LXXVI and LXXIII)
LXXIII. Plain wood compartment, with front of green gelatine. Experiment 38.	2 introduced (on roof close together)..				1	1	
LXX. Green tissue-paper covered cylinder. Experiment 39.	1 introduced (fixed to roof) ..					1	Same as 35 and 36.
LXXIV. Plain wood compartment, with a front of blue gelatine. Experiment 40.	3 introduced (on roof near together)..			3			Blue light tends to produce darkish pupæ.
On food-plant, on which stock of larvæ were kept. Experiment 41.	2 pupæ low down and shaded on food-plant. Isolated		1	1			The effect was due to shade, for the larvæ are bright green when found on the food-plant in nature.

C. A company found at Chipping Norton towards the end of July, 1888; compared Aug. 9. Like the larvæ of B, they were changing their last skins when found, and were upon the same bed of nettles. It is probable that they belonged to the same company; 3 of these were intermixed with B in Expt. 6, and it is possible that larvæ of B may have been introduced into Expts. 31 and 32, although this is unlikely.

C. A company found at Chipping Norton towards the end of July, 1888: &c.	3 larvæ suspended—mostly low down and in shadow—to food-plant, on which stock of larvæ were fed. These 3 were transferred in Stage III. to a surface of polished Dutch metal in strong light, being pinned up by the boss of silk. Experiment 42.	1 first to pupate				1		Transference in Stage III. apparently produced some effect on two of the pupæ.
		2 second to pupate		1		1		
	XXVII. Gilt cylinder. Embossed Dutch metal. Experiment 43.	Unnoted			1	2	1	The (3) was the first to pupate, and may have been affected before experiment.
	LVI. Bright yellow tissue-paper lined compartment. Experiment 44.	On roof; 2 together, 1 isolated					3	Characteristic.
	LXXI. Red glass front to white paper lined box. Experiment 45.	2 first to pupate and fell down	1		1			The first to pupate may have been affected before experiment.
		3 on roof				1	2	
	XIV. Black covered cylinder in complete darkness. Larvæ introduced July 29 (evening). Experiment 46.	Unnoted	1		2		1	Irregular results.
	Transferred for Stage III. from food-plant of stock, to black surface in light. Experiment 47.	....				1		Probably no effect produced.

D. Part of a company found at Oxford about July 22, 1888. Compared Aug. 11. The rest were used in Expts. 77—92.

II. Black paper lined cylinder, placed on its side in strong light. Experiment 48.	19 on upper part of side (roof in this position). 19 introduced	13	6				Strong effects of black surroundings.
I. Black paper lined cylinder, placed open end upwards (roof downwards), and covered with a clear glass sheet, on which the larvæ were densely crowded, with their ventral surfaces in strong light, dorsal in dim light and black surroundings. Experiment 49.	69 on clear glass.	27	14	5	13	10	Irregular results, tending strongly towards the dark forms.
	10 dead on clear glass.						
	7 on black paper sides.	6	1				
	1 dead on black paper sides.						
	— 87 introduced.						
III. Black paper lined cylinder in darkness. Experiment 50.	13 on black paper roof. 13 introduced	8	1	1	2	1	Irregular results, but tending most strongly towards dark pupæ.
XX. Polished Dutch metal. Experiment 51.	2 on gilt. 2 introduced ..	1				1	As above, but some effect appears to have been produced by the gilt surface during the short periods of illumination; as the proportion of green pupæ is much higher.
XXIII. Dutch leaf. Experiment 52.	2 on gilt. 2 introduced ..	1				1	
XXIV. Dutch leaf. Experiment 53.	1 on gilt.		1				
	1 on glass.	1					
	— 2 introduced.						
XXIX. Gilt tin box, embossed Dutch metal. Experiment 54.	9 crowded at top of gilt roof (1 dead).	1	3		2	2	
	5 scattered over middle and lower part of gilt.	1			2	2	
	— 14 introduced.						

3 small cylinders and box in complete darkness, except at 11 p.m. and 9 a.m., when the covering was removed to adjust some other experiments.

E. Two companies of nearly mature larvæ, taken early in July, 1892, near Oxford, and mixed together. The pupæ were compared July 16.

XXII. Small gilt cylinder in strong light. Polished Dutch metal. Experiment 55.	12 on gilt, very crowded. 12 introduced	1	7	1	1	2	Effect of crowding.
XXV. Small gilt cylinder in strong light. Dutch leaf. Experiment 56.	3 on gilt. 3 introduced ..					3	Characteristic effect of gilt. (XXV., XIX., XXI.)
XIX. Small gilt cylinder in strong light. Polished Dutch metal. Experiment 57.	2 on gilt. 1 dead (dipterous larva — emerged). 3 introduced.					2	
XXI. Small gilt cylinder in strong light. Polished Dutch metal. Experiment 58.	2 on gilt. 2 introduced ..				1	1	
XXVI. Similar cylinder, with the roof more in shadow. Polished Dutch metal. Experiment 59.	3 on gilt. 3 introduced ..		2		1		Some effect produced by the shade of roof.
XVI. Large gold lined cylinder in strong light. Embossed Dutch metal. Experiment 60.	Crowded on upper part of side (roof in this position). 16 introduced				3	13	Interesting to compare effects of crowding with those in a much smaller cylinder, XXII., Expt. 55:
XXXI. Gold lined compartment in strong light. Polished Dutch metal. Experiment 61.	11 crowded on one side of gilt roof.	1			2	8	Characteristic effects of gold somewhat modified by crowding.
	3 together on the other side. — 14 introduced.				1	2	
XLVI. Silver lined compartment. Silver paper. Experiment 62.	14 distributed over silver top. 14 introduced	8	2		3	1	Very different to gold. The pupæ crowded on the domed roof of XLVII. were especially dark.

E. Two companies of nearly mature larvæ, taken early in July, 1892, near Oxford, and mixed together. The pupæ were compared July 16.

E. Two companies of nearly mature larvæ, taken early in July, 1892, near Oxford, and mixed together. The pupæ were compared July 16.	XLVII. Silver lined cylinder with domed roof. Silver paper. Experiment 63.	17 crowded in silver top of dome.	7	6	2	2		Very different to gold. The pupæ crowded in the domed roof of XLVII. were especially dark.
		1 on white paper floor, with leaves and fæces.		1				
		18 introduced.						
	L. White opal globe. Experiment 64.	10 crowded near top of glass sides 10 introduced					10	Effects like those of gilt.
	LII. Rectangular clear glass box, with a clear glass roof. Experiment 65.	6 crowded in middle of one side.		5		1		Irregular results, inclining towards dark forms.
		4 dead in middle of one side.						
		2 together in one of the black-bound angles of side.	1	1				
		2 together in another of the black-bound angles of side.	2					
		4 on floor with leaves and fæces.	1	1	1	1		
		2 dead on floor with leaves and fæces.						
		1 dead on roof,						
		21 introduced.						
F. The last larvæ of a large company found at Oxford July 17, 1892. Compared Aug. 9.	V. Black paper covered cylinder in strong light, all the paper being *outside* glass. Experiment 66.	2 suspended to roof.	1				1	These experiments were to test whether the effects of gilt and black surfaces were the same when covered with glass. The results show that this is the case, although there was one curious exception in V.
		3 suspended to sides (1 just off the black background and 2 on it).	3					
		1 killed by *Tachina*.						
		6 introduced.						

F. The last larvæ of a large company found at Oxford July 17, 1892. Compared Aug. 9.	XXVIII. A similar cylinder, covered *outside* with polished Dutch metal. Experiment 67.	3 suspended to back (on gold background).			1	1	1	These experiments were to test whether the effects of gilt and black surfaces were the same when covered with glass. The results show that this is the case, although there was one curious exception in V.
		2 suspended to food-plant, close to gold background.					2	
		1 dead.						
		6 introduced.						
	Black covered cylinder, probably I., II., or III.; probably in complete darkness. Experiment 68.	Suspended, probably to roof.	4	4	3		1	Results not so irregular as usual, but conditions not quite certain.
		On floor		2	1			
	Shut up in an oval zinc (corked) pocket box, and therefore in darkness. Experiment 69.	....	3			1	3	Results irregular.
	Placed in 5 small gilt cylinders, XVIII. and others like it (2 in each). Experiment 70.	All suspended to gilt.					2	Some curious exceptions.
	,, 71.					1	1	
	,, 72.			2				
	,, 73.		1				1	
	,, 74.					1		
	In clear glass cylinder, almost filled with yellow spills. Experiment 75.	2 fixed to yellow spills. 2 introduced.					2	Results like those of gilt.
	L. White opal glass, with white paper roof and floor. Experiment 76.	7 fixed to top of globe (not paper).			2	1	4	Results less regular than those of Expts. 31, 32, and 64.
		3 on floor.	1		1		1	
		10 introduced.						

G. Two or three companies found at Oxford in July, 1892. Compared Aug. 9. The larvæ in each experiment were from the same company.

The lengths of the stages preparatory to pupation. 1888.
Experiments 77—92.

I was very desirous of ascertaining the duration of these stages, and of comparing them with *V. urticæ*. A series of experiments, with this object in view, were conducted in the summer of 1888 upon the larvæ of a single company (possibly a few from another company may have been intermixed, although I do not think it is likely), kindly brought me by Miss Bell, having been found near Oxford. Others were used in the experiments already tabulated (D. Experiments 43—47).

The results of frequent examination are shown below: the letter T indicating that the larvæ had sought the top of the case (Stage II.); S, that they had suspended (Stage III.); P, that pupation had occurred. The time beneath each such letter is either estimated or stated without comment; when stated, the change indicated had been actually observed. When no time is quoted, the data were not made use of in calculating the lengths of stages, as was the case when the limits of error were very wide as compared with the interval to be estimated.

(*See Table, pages* 410, 411, 412.)

The results of these observations are worked out below, where the colours of the receptacles and the pupæ are also shown, the latter being carefully compared, Aug. 11, 1888. Two additional experiments (91 and 92) are also included, the calculation being so simple that I did not think it necessary to give the data from which the lengths of the stages were arrived at, as I have in all the other experiments.

(*See Table, pages* 413, 414.)

The 3rd pupæ of Experiments 88 and 89 were transferred immediately after throwing off the larval skin to a white paper floor, close to a gilt back-ground in strong light. The results prove that they had ceased to be sensitive.

The lengths of the stages were subject to the most excessive fluctuation, suggesting that some of the larvæ had quitted their food-plant somewhat prematurely as the result of disturbance, while others left it in the normal manner. It has been already shown, in the case of

Larvæ introduced evening of July 29.	LIII.	LIV.	LV.	LVII.	LVIII.	LIX.	LX.	LXI.	LXII.	LXIII.	LXIV.	LXV.	LXVI.	XLVII.
July 30. 9. 0 a.m.				1 S (say 4 a.m.)					3 S (say 4 a.m.)					
12.15 noon												1 S (say 11 a.m.)		Not examined, 12.15. 1.30 p.m. 1 S 2 T (say 11 a.m.)
2.15 p.m.		1 S (say 1.15)							1 S (say 1 p.m.)					
6. 0 p.m.	1 T (say 4 p.m.)	2 T (say 4 p.m.), food removed before.	1 T (say 4 p.m.)	2 T (say 4 p.m.), food removed.	2 T 1 S (say 4 p.m.), food removed.	3 T (say 4 p.m.), food removed.	3 T (say 4 p.m.), food removed.		Food removed before.		1 T (say 4 p.m.)	2 T (say 4 p.m.), food removed.	2 T (say 4 p.m.)	Food removed.
10. 5 p.m.	1 S by 10.35	2 S (10.5)			1 S (say 8 p.m.)		1 S (say 8 p.m.)	1 T (say 8 p.m.)				1 S 1 T (say 8 p.m.)	2 S (say 8 p.m.)	1 S (say 8 p.m.)
July 31. 9. 0 a.m.				1 P (say 3.30 a.m.) 1 S		1 dead.	1 S (say 3.30 a.m.)		3 P (say 3.30 a.m.)		1 S (say 3.30 a.m.)		1 T (say 3.30 a.m.)	1 S (say 3.30 a.m.)
12.45 noon			1 T (say 11 a.m.)									1 P (1.15 p.m.)		1 P (12.45)

Larvæ introduced evening of July 29.	LIII.	LIV.	LV.	LVII.	LVIII.	LIX.	LX.	LXI.	LXII.	LXIII.	LXIV.	LXV.	LXVI.	XLVII.
July 31.														
2.15 p.m.														
3.49 p.m.	1 T (say 3 p.m.)	1 P (4.45)						2 T (say 3 p.m.)	1 P (4.15)	3 T (say 3 p.m.)	1 T (say 3 p.m.)			
6. 0 p.m. to 6.12 p.m.					1 P recently (say 5.30)									
8. 0 p.m.														
10.53 p.m.					1 P (11.5)									
Aug. 1.														
9. 0 a.m.	1 P some hrs. (say 4 a.m.	1 P some hrs. (say 4 a.m.		1 S		1 S	1 P some hrs. (say 4 a.m.)	1 S (9.25)			1 T (say 4 a.m.)	1 P some hrs. (say 4 a.m.)	2 P some hrs. (say 4 a.m.)	1 P some hrs. (say 4 a.m.)
11. 4 a.m.	1 S (say 10.0)						1 P (11.0)			1 S (say 10 a.m.)	1 P (about noon).			
Aug. 2.														
3. 0 p.m.			2 S	2 P 1 two or three hrs (say 1 p.m.)	1 S	1 P 1 S	1 S	1 P an hour or two (say 1 p.m.) 1 S		2 S		1 S	1 S	1 P
5.35 p.m.							1 P about an hour (say 4.30)	1 S (say 4 p.m.)		1 P (5.54)				

Larvæ introduced evening of July 29.	LIII.	LIV.	LV.	LVII.	LVIII.	LIX.	LX.	LXI.	LXII.	LXIII.	LXIV.	LXV.	LXVI.	XLVII.
Aug. 2. 11.12 p.m.			1 P about an hour (say 10 p.m.)											
Aug. 3. 9. 7 a.m.		1 S dead	1 P many hrs. (say 4 a.m.)		1 P many hrs. (say 4 a.m.)					1 P some hrs. (say 4 a.m.)	1 P an hour or two (say 7 a.m.)	1 dead.		
1.45 p.m.	1 P an hour or two (say 12.0)					1 P an hour or two (say 12.0)								
2.25 p.m.													1 P (2.30)	
3.17 p.m.								1 P only just (3.0)				1 P (3.17)		
7.20 p.m.										1 P an hour or two (say 6 p.m.)				
10.13 p.m.								1 P only just (10.0)						
Aug. 4. 10. 0 a.m.											1 P (10.0)			

Withered leaves and fæces had been left on the floor of LIII., LV., LXI., and LXIII., but in no other compartment.

No. of Experiment.	Receptacle.	Order of pupation.	Position of Pupæ.	Colour of Pupæ.	Length of Stage II.	Length of Stage III.
77	LIII. Lined with deep red paper.	1	Floor.	(1)	About 6½ hours.	About 30 hours.
		2	Roof.	(1)	19 hours (nearly correct).	50 hours (nearly correct).
78	LIV. Lined with deep orange paper.	1	Roof near together.	(5)	.. ..	27½ hours (nearly correct).
		2		(4)	About 6 hours.	About 30 hours.
		3	Dead.	....	About 6 hours.	
79	LV. Lined with pale yellow paper.	1	Roof near together.	(5)	Together about 78 hours.	
		2		(5)	Together about 65 hours.	
80	LVII. Lined with bright green paper.	1	All on roof.	(3)		
		2		(4)		
		3		(2)	Together about 69 hours.	
81	LVIII. Lined with dark green paper.	1	Floor.	(2)	.. ..	25½ hours (nearly correct).
		2	Roof near together.	(2)	About 4 hours.	27 hours (nearly correct).
		3		(1)	Together about 84 hours.	
82	LIX. Lined with very pale blue tissue paper.	1	Roof near together.	(4)		
		2		(4)	Together 92 hours (nearly correct).	
83	LX. Lined with light blue paper.	1	Floor.	(2)	About 4 hours.	About 32 hours.
		2	Roof close together.	(3)	Together 43 hours (nearly correct).	
		3		(2)	Together 72 hours (nearly correct).	
84	LXI. Lined with deep blue paper.	1	All on roof near together.	(1)	37 hours (nearly correct).	28 hours (nearly correct).
		2		(3)	Together 72 hours (nearly correct).	
		3		(3)	49 hours (nearly correct).	30 hours (nearly correct).

85	LXII. Lined with dark blue paper.	1	2 roof.	(4)		Uncertain.
		2	1 floor.	(4)		Uncertain.
		3		(4)		Uncertain.
		4	Roof near other 2.	(3)	.. ..	27 hours (nearly correct).
86	LXIII. Lined with light brown tissue paper.	1	Roof near together.	(1)	19 hours (nearly correct).	32 hours (nearly correct).
		2		(2)	Together about 61 hours.	
		3	Fallen.	(3)	Together 75 hours (nearly correct).	
87	LXIV. Lined with white paper.	1	Roof.	(4)	Together 44 hours (nearly correct).	
		2	Floor.	(5)	Together 64 hours (nearly correct).	
		3	Roof, isolated.	(5)	Together about 78 hours.	
88	LXV. Lined with black paper.	1	Roof near together, and near dead larva.	(2)	.. ..	26 hours (nearly correct).
		2		(1)	About 4 hours.	About 32 hours.
		3	Roof, isolated.	(2)	Together at least 90 hours.	
89	LXVI. Lined with black paper.	1	Floor and roof.	(1)	About 4 hours.	About 32 hours.
		2		(1)	About 4 hours.	About 32 hours.
		3	Roof, isolated.	(2)	Together at least 78 hours.	
90	XLVII. Silver paper lined cylinder domed roof.	1	1 isolated.		.. ..	26 hours (nearly correct).
		2	2 together.	(1) (3) (3)	About 9 hours.	About 32 hours.
		3				Uncertain.
91	XVIII. Polished Dutch metal lined cylinder.	1	....	(5)	Together 48 hours (nearly correct).	
92	XIX. Polished Dutch metal lined cylinder.	1	....	(5)	Together 57 hours (nearly correct).	

V. urticæ (see pp. 365—369), that the latter pass through a far shorter preparatory period. In this case the two conditions are probably intermixed, and there is no criterion by which the one can be distinguished from the other. It is therefore impossible to test by these figures the conclusion indicated by the parallel investigation upon *V. urticæ*, as to the protraction of the stages in the formation of dark pupæ. But in other respects the results are extremely interesting, enabling us to contrast the lengths of the stages with those of *V. urticæ*. Stage II. appears to be very short: in 5 cases it lasted about 4 hrs., in 3 about 6, in 1 about 9. Its far greater length in the remaining larvæ was probably a result of disturbance. Stage III., on the other hand, is very long,—about twice as long as its ordinary duration in *V. urticæ*. Stage III. was not subject to great fluctuations, with a single exception of 50 hrs'. duration (probably due to disturbance). On the other hand, it varied from $25\frac{1}{2}$ to 32 hrs., and variations of a rather less extent were quite common. Although there were many larvæ in which the length of this stage was accurately ascertained, they produced (with one exception) dark or darkish pupæ, so that we cannot compare the lengths with those passed through when light pupæ are formed. There is nothing, however, in the table to oppose the conclusions arrived at in the case of *V. urticæ*.

The apparently normal moderate fluctuation in the length of Stage III., as well as its great relative length, suggest that it includes far more of the susceptible period than is the case with *V. urticæ* (and this is proved to be the case further on; see Experiments 94—100). If so, and the conclusions derived from the study of the latter are sound, we must expect that Stage III. will be shorter in light than in dark pupæ of *V. io*, although such a tendency is restricted to Stage II. in the former species, corresponding to the inclusion of the chief susceptibility within its limits.

We may conclude from these experiments that in the production of dark pupæ the normal length of Stage II. is from 4 to 6 hrs., the shorter period being the commoner; while that of Stage III. varies from $25\frac{1}{2}$ to 32 hrs.: longer periods being commoner than shorter ones.

Dates.	Light Surroundings in Strong Light.						Darkness.
	XXV. Small cylinder lined with Dutch leaf. Experiment 94.	XX. Small cylinder lined with polished Dutch metal. Experiment 95.	Resembling XX. Small gold-lined cylinder. Experiment 96.	XXXI. Polished Dutch metal lined compartment. Experiment 97.	LXIX. Yellowish green tissue paper covered cylinder. Experiment 98.	L. White opal globe. Experiment 99.	XVI. Gilt cylinder in complete darkness, covered with rugs, &c. Experiment 100.
July 26, 8. 0 p.m.	Larvæ introduced into this and all the other cases.						
July 27, 1. 5 p.m.	1 suspended.						
,, 2.55 p.m.	....	....	....	2 suspended.			
,, 4.30 p.m.	....	2 suspended.	1 suspended.				
,, 5.15 p.m.	....	....	....	1 suspended.			
,, 7.10 p.m.	....	....	1 suspended.				
,, 7.15 p.m.	....	....	....	....	....	....	5 suspended (not examined before).
,, 10.30 p.m.	No further change in any of these.	....	....	....	....	....	Unexamined.
July 28, 10.15 a.m.	The remaining larva transferred to darkness, and another transferred from darkness here.	....	....	2 suspended. 1 transferred from darkness here.	.... 8 larvæ transferred to darkness (perhaps 1 or 2 of them from XXXI.), and 6 transferred from darkness here.	1 suspended.	3 suspended. The transferred larvæ were evidently towards the end of Stage II., although none had entered Stage III.

Aug. 9. Pupæ compared and tabulated.	1 (5). 1 transferred from darkness. 1 (5) on floor.	1 (5). 1 (3). None transferred.	Both (5). None transferred.	2 first suspended: 1 (4). 1 (3). 1 suspended later: 1 (3). 2 suspended later still: 1 (4). 1 (3). All the larvæ had been crowded together with others that died, and were probably affected reciprocally. 1 transferred from darkness: 1 (3) on floor.	2 transferred from darkness: 1 (4). 1 (5).	1 (4) on glass near top. 4 transferred from darkness: 1 (5). 2 (3). 1 (1). All on floor, except 1 (3) fixed to paper roof. The 3 larvæ close together on floor before pupation.	5 first suspended: 1 (3). 4 (2). 3 suspended later 1 (4). 2 (3). One of the latter had fallen, but is probably to be placed in this category. 9 transferred from gold, white, and green surroundings in light towards end of stage II.: 1 (4). 1 (3). 1 (2). 6 (1).

Effect of cold upon duration of stages and colours of pupæ. Experiment 93. 1892.

Although the experiment described below was unsuccessful, I think the method employed may be useful if lower temperatures are obtained, and I therefore give a brief description of it.

It has already been pointed out that larvæ (at any rate of *V. urticæ*) pass through longer preparatory stages when they produce dark pupæ. I was therefore anxious to test whether dark pupæ would be formed in bright surroundings if the stages were protracted by some other cause, such as cold. A number of similar bottles were lined with black and with gilt paper, in the form of a back-ground covering half the circumference and a roof. The latter was made by covering the bottom, the bottle being inverted when in use. Some of these bottles were sunk beneath the surface of water in a large glass vessel, the water being constantly changed so as to maintain a uniform temperature of 16° C. This was but little lower than the air of the room, but the high specific heat of water would cause it to produce more effect upon the larvæ. If, however, the temperature was sufficient, the effect would be beneficial rather than the reverse, and this was probably the case. It would be well to repeat the experiment, using ice to obtain the lowest temperature compatible with the process of pupation. This I was unable to carry out last summer, being much away from home at the time.

The results only serve to confirm those already obtained by the use of gilt and black surfaces in a strong light. Four larvæ belonging to the same company were placed in each bottle. The pupæ were compared Aug. 19, 1892.

In air, two black-lined bottles contained 7 dark pupæ, but they were dead, and it was impossible to state their degrees of colour with precision; one gilt bottle contained 4 bright green pupæ, evidently (5)s.

In water, two black-lined bottles contained 4 dark pupæ, like those in air; while five gilt bottles contained 11 green pupæ, evidently (5)s.

Transference and comparison Experiments to ascertain the susceptibility of the preparatory stages. Experiments 94—100. 1891.

A few larvæ, probably the last of a company, were found at Oxford, July 26, 1891. Being full-fed the experiments were arranged the same evening, about 8 p.m. They were divided into 2 lots, one of which was placed in gold, green, or white surroundings, in light; the other in gold surroundings in complete darkness, except when examined.

By the morning of July 28 (10.15), 11 larvæ were suspended among those exposed to light, and, as all appeared to be equally mature, it may be assumed that the remaining 9 were very near suspension, *viz.*, the beginning of Stage III. They were, therefore, transferred to darkness for this stage and the remaining part of Stage II. At the same hour 8 of the larvæ in darkness were suspended, and the remaining 8 were transferred to light for the rest of the period before pupation. The following table represents the course and results of the experiments.

(*See Table, pages* 416, 417.)

The results of these experiments are best shown by another method of tabulation.

Pupal Colours.	(1)	(2)	(3)	(4)	(5)	
In darkness for the whole period before pupation ..		4	3	1		= 8
Transferred from bright surroundings in light to darkness for Stage III. and end of II.	6	1	1	1		= 9
Transferred from darkness into gilt surroundings in strong light for Stage III. and end of II.			1		1	= 2
Transferred from darkness into green surroundings in strong light for Stage III. and end of II. ..				1	1	= 2
Transferred from darkness into white surroundings in strong light for Stage III. and end of II. ..	1		2		1	= 4
In gilt surroundings in strong light for the whole period before pupation			1	2	4	= 10
In white surroundings in strong light for the whole period before pupation				1		= 1
						36

This table proves, so far as is possible with so limited a number of individuals, that the sensitive period, during which the pupal colours are determined, is later in this species than in *V. urticæ*. Similar transference experiments (Trans. Roy. Soc., *l. c.*, p. 360) in the case of this latter species proved that Stage II. is the most sensitive part of the period before pupation. This table shows that in *V. io* Stage III. is probably far more important in this respect. In fact the results obtained, when this stage and the end of II. alone were passed through in certain conditions, were practically uniform with those witnessed when the larvæ were exposed to the same conditions for all three stages. There is one marked exception in the case of the dark pupa formed in white surroundings. The larvæ which were transferred into darkness formed even darker pupæ than those which were exposed throughout to this condition.

This high sensitiveness, during Stage III., harmonizes very well with the results obtained from Experiments 77—92, which showed that the stage is of extreme relative length in this species. In writing this paper from the notes taken at the time, as soon as I found the great difference between this species and *V. urticæ* in the relative lengths of the stages, I anticipated that the transference experiments would, when tabulated, lead to the conclusion indicated above. It is probable that the great length of Stage III. has caused the point of greatest susceptibility to be shifted into it. It has been shown (*l. c.*) that this period is somewhat sensitive, probably in its earliest part, even in *V. urticæ*. It is likely that the great extension of this earliest sensitive period accounts for, at any rate, the chief part of the difference between the lengths of Stage III. in these two species of *Vanessa*.

The results are also interesting in confirming the previously described effects of the various environments made use of, and in showing the influence of darkness.

Conflicting Colour Experiments. Experiments 101—103. 1892.

I was most anxious to repeat the experiments already described in the case of *V. urticæ* (see pp. 391—397), and thus, from the behaviour of this most sensitive species, to throw further light upon the physiology of the process, or, at any rate, to gain confirmation.

Some small experiments had already been made, and these had seemed to show that the freshly-formed pupa is certainly not sensitive, and that the larva, if transferred during Stage III., may be susceptible (see Expts. 42, 47, 88, and 89 of this paper; also Phil. Trans., 1887, B, p. 318).

In order to expose the anterior and posterior parts of the larval body to conflicting colours for the whole of the sensitive period, the case described on p. 393 and shown in Plate XV., Fig. 5, was made use of. The strips of the two upper rows of compartments were about half as wide as the length (30·0 mm.) of a suspended larva of *V. io*. In each of the 42 compartments a single larva was placed, all belonging to the same company, taken near Oxford towards the end of July. The pupæ were compared August 11, and the results are given in the following table:—

(*See Table, page* 422.)

The results in every way confirm those obtained in the case of *V. urticæ* (see pp. 394, 395), and support the same conclusions as to the probable existence of a nervous mechanism through which the cuticular colours are created or dismissed in response to the stimulus provided by the light reflected from adjacent surfaces. The pupæ are intermediate, tending rather strongly towards the dark side, very strongly in the lowest row of compartments where the black bands were much broader than the gilt. There was not the slightest tendency towards a particoloured pupal surface corresponding to the conflicting stimuli, nor was there any difference in the effects when the head or the tail were exposed to either colour. The *amount* of skin area receiving the reflected light was evidently the decisive condition, the anterior or posterior position of the area being of no importance.

Reflecting on these results, it occurred to me that the dorsal or ventral position of the skin area exposed to reflected light might be of more importance; for when the larvæ rest on some surface, during Stage II., the dorsal half of the body is but slightly exposed to reflected rays as compared with the ventral half.

In order, therefore, to test the relative susceptibility of dorsal and ventral surfaces, another form of case was constructed. The larvæ were placed separately in shallow

EXPERIMENT 101.

	Positions of the Pupæ.	Pupal Colours.					
		(1)	(2)	(3)	(4)	(5)	
Two upper rows with gold and black bands equally wide.	Fixed to junction of bands, head on black, tail on gold	1	1	1			
	Fixed to glass opposite this level	2		1	1		
	Fixed to junction of bands, head on gold, tail on black	2					
	Fixed to glass opposite this level			3			
	Fixed to middle of gold; head and tail on gold, body on black		2				
	Fixed to glass opposite this level		1				
	Fixed rather above middle of gold; much of tail and little of head on gold, body on black	2	1		1		
	Fixed from rather above junction up to middle of black; head and tail on black, body on gold	2	1		1		
	Fixed to glass opposite this level		2	1			
	Dead pupa in one compartment; position unknown. 1 pupa was unnoted ..		1				
	Totals ..	9	9	6	3	0	=27
Lowest row with narrow gilt and broad black bands.	Head and tail equally on black, body crossed by narrow gold band		1				
	Fixed to glass opposite this level	1					
	Head less and tail more on black, body crossed by narrow gold band	2					
	Tail on most or all of gold band, rest of body on black	3	1				
	Fixed to glass opposite this level			1	1		
	Black alone, but head close to gold floor, which reflected upwards strongly ..			1	1		
	Fixed to glass opposite this level (the position of the (2) *is probable, but not certain)*	1	1				
	Totals ..	7	3	2	2	0	=14

black-lined compartments or cells, 3.6 centimetres wide, 3.8 high (six of them were 6 0 high), and 8 to 9 mm. deep. The black tissue-paper lining sloped from the sides to the back of the cells, so that there were no sharp angles or corners. The frame, bearing 24 of these black compartments, was placed vertically, and covered in front with a sheet of white opal glass, which was turned towards a strong light. Each larva was, therefore, contained in a shallow black chamber with a white front, both black and white surfaces being well illuminated. When a larva suspends itself to a surface, it also rests upon it during Stage II., and even if disturbed by its cramped position it must rest on the surface for so much of this stage as is necessary for spinning the silken boss. It is, therefore, safe to conclude that the pupæ suspended to the glass had spent Stage III., and at any rate part, probably the whole, of Stage II., with the ventral surface closely applied to a white area and the dorsal surface exposed to a black area, only separated by a few millimetres from contact with the larval skin; and conversely with the pupæ fixed to the black compartments.

Mature larvæ belonging to the same company were placed in 21 of the cells at the beginning of August, and 3 belonging to another company rather earlier. Both companies were captured near Oxford. The pupæ were compared August 11. The results are shown below:—

Experiment 102.

(*See Table, page* 424.)

The results are quite clear; they prove that black is far more powerful than white when the two conflict, that there is no local effect of colour upon the skin, but that the whole larval surface is uniformly sensitive, dorsal and ventral alike. The two dull green pupæ, (4)s, found among the 9 dark ones which were attached to the opal glass, may be most reasonably explained by individual susceptibility to white rather than black, and to the greater proximity of the surface which was in actual contact with the larva. It is improbable that they afford any evidence for a more sensitive condition of the ventral area as compared with the dorsal, a view which is hardly compatible with the other results.

Experiment 102.

		Degrees of pupal colour.	1	2	3	4	5
21 pupæ of later company.	Ventral surface of larvæ during sensitive period exposed to black, and dorsal to white.	8 fixed to black tissue paper (attached to the sloping side which was uppermost, and formed the roof, or to the point where this roof joined the back)	4	1	3		
	Ventral surface of larvæ during sensitive period exposed to white, and dorsal to black.	9 fixed to opal glass front	4	1	2	2	
	———	Pupated without fixing, or fell off; so that original position uncertain	3		1		
2 pupæ of earlier company.	Ventral surface of larvæ during sensitive period exposed to white, and dorsal to black.	2 fixed to opal glass front	2				

This experiment thus confirms and extends the conclusions arrived at from the use of the other form of case, indicating that the light acts upon widely distributed nerve terminations in the skin.

The same experiment was also tried with another kind of case. Strips of glass were glued on to a glass-sheet in such a manner as to make compartments 9·6 centimetres high, 2·3 wide, and 1·6 deep below, ·3 deep above. Each row of compartments was closed by a single glass front, thus forming a set of wedge-shaped spaces tapering upwards in the position in which the whole was placed (see Plate XV., Fig. 6). The backs of half the compartments were lined with white tissue paper, and the glass front with black, the other half being treated in the converse manner. They were placed in a strong light, the white surface being in half the instances turned to the light and in half turned away from it.

The compartments tapered so that the larvæ could not reach the top, but suspended themselves somewhere about the middle of either the back or front; the white spots on the black surfaces represented in fig. 6 are the silken bosses. Hence the larval dorsal area was exposed to one surface, while the ventral area was in contact with the other, as in the last experiments, except that here the conditions were more uniform in that each surface could be turned towards the light. All the larvæ belonged to one company captured near Oxford, and the pupæ were compared Aug. 9. The results are tabulated below:—

Experiment 103.

Degrees of Pupal Colour.		1	2	3	4	5
White surfaces turned towards light, black away from it.	11 fixed to black surface away from light	5	3	3		
	10 fixed to white surface towards light	3	1	4	2	
	3 unfixed or fell off; position uncertain	2	1			
Black surfaces turned towards light, white away from it.	19 fixed to black surface towards light	11	5	3		
	4 unfixed, or having fallen off white; uncertain	1	2	1		

These results entirely harmonize with those obtained in the other set of conflicting colour experiments applied to dorsal and ventral areas. The rather less dark pupæ fixed to the white surface are to be accounted for by the greater proximity of white enabling it to neutralize the influence of the more distant black more completely than when their relative proximity was reversed. But even under the most favourable conditions, the white surface did not produce nearly so great an effect as the black. There were no particoloured pupæ, and no evidence that the ventral surface differs from the dorsal in sensitiveness.

In these experiments we meet with evidence that the larvæ sought black in preference to white surroundings, when placed under the same conditions, and that they also manifested a tendency to seek the side turned towards the light. When both these causes co-operated, *viz.*, when the black surface was turned towards the light, at least 19 out of 23 pupated upon it; when they were antagonistic, about half the larvæ followed the one tendency (to seek black), while half followed the other (to seek the side turned towards the light).

Effect of various backgrounds and screens upon the colour of the pupæ.

It will not be necessary to provide such a detailed analysis of the Experiments already described as in the case of *V. urticæ*, where the number of individuals was much larger and the effect of crowding therefore greater, nor shall I discriminate between the effects of the different kinds of gilt paper employed. But all necessary data are supplied in the account of the Experiments themselves, so that a more detailed analysis can be made at any time. In order to economize space, the comparison of the effects of the various conditions will be given in a tabular form, proceeding from the consideration of darkness, black, brown, white, and colourless surfaces to metallic backgrounds, and from these passing to the colours of the spectrum from red to blue. Percentages will not be calculated for very small numbers and single Experiments.

Reference numbers of Experiments.	Pupal Colours. (1)	(2)	(3)	(4)	(5)	Totals.	Results compared.
Black surface in complete darkness.							Experiment 68 was omitted (see description). The difference between these results and those produced by black surfaces in strong light is far greater than in *V. urticæ*, and resembled the relationship in *Pieris rapæ* (Phil. Trans., 1887, B, pp. 411—414). The colours of the pupæ are very irregular, and do not rise uninterruptedly to a maximum in some part of the scale.
Experiments 5 & 6	5	3	4	4	3	=19	
,, 18 & 19	3	2	6	3	2	=16	
,, 46	1		2		1	= 4	
,, 50	8	1	1	2	1	=13	
Totals..	17	6	13	9	7	52	
Results expressed as percentages of total	32·7	11·5	25·0	17·3	13·5		
Gilt surface in darkness.							Probably some effect was produced by the occasional exposure of the larvæ (see account of experiments). Allowing for this, the results are very similar to the above, and exhibit the same irregularity.
Experiments 51 to 54	5	4		4	6	=19	
,, 100		4	3	1		= 8	
Totals..	5	8	3	5	6	27	
Results expressed as percentages of total	18·5	29·6	11·1	18·5	22·2		
Zinc pocket box (darkness).							Results irregular, as above.
Experiment 69	3			1	3	=7	
Black surface in strong light.							Very uniform results, showing the powerful effect of these conditions in producing dark pupæ. There is one interesting exception.
Experiment 1	2					= 2	
,, 48	13	6				=19	
,, 66	4				1	= 5	
,, 88 & 89	3	3				= 6	
Totals..	22	9	0	0	1	32	
Results expressed as percentages of total	68·8	28·1			13·1		
Light brown paper in strong light.							Although the surface was much less dark than the above, its effects were not very different.
Experiment 86	1	1	1			=3	
White opal glass.							From this point onwards all the backgrounds were subjected to strong light. White surfaces tended strongly to produce the light pupæ, but not so strongly as gilt, although far more so than silver. The white paper and opal glass produced the same effect, corresponding to their similar reflecting powers; for both of them return the rays from all parts of the spectrum.
Experiments 31 & 32		1	1	6	5	=13	
,, 64					10	=10	
,, 76	1		3	1	5	=10	
,, 99				1		= 1	
White paper: Experiment 87				1	2	= 3	
Totals..	1	1	4	9	22	37	
Results expressed as percentages of total	2·7	2·7	10·8	24·3	59·5		

Clear glass.							In the absence of any background of sufficient reflecting power, the pupæ apparently tend towards the commoner darker varieties.
Experiment 65	4	7	1	2		=14	
"Gilt" surface (Dutch metal).							Experiment 55 was omitted (see description). Very powerful effect in producing bright pupæ, 71 °/₀ being the lightest forms. These are the most extreme results obtained in this direction, and contrast very strongly with the effect of silver, probably corresponding to the differences in absorption and reflection of light which make the "gilt" yellow and the silver grey. It was clearly shown in the account of Experiment 67, that the "gilt" surface is perfectly effective when separated from the larvæ by a layer of glass.
Experiment 2					4	= 4	
,, 7 to 13		1	1	5	22	=29	
,, 20 to 25			1	1	4	= 6	
,, 43			1	2	1	= 4	
,, 56 to 61	1	2		8	29	=40	
,, 67			1	1	3	= 5	
,, 70 to 74	1	2		2	4	= 9	
,, 91 & 92					2	= 2	
,, 93					15	=15	
,, 94 to 97			4	2	4	=10	
Totals..	2	5	8	21	88	124	
Results expressed as percentages of total	1·6	4·0	6·5	16·9	71·0		
Silver and tin surfaces.							This surface, bright as it is, tends somewhat strongly to produce dark pupæ rather than light. The difference between the effects of "gilt" and silver is far more pronounced than in *V. urticæ*.
Experiment 14			1	1	3	= 5	
,, 26 to 30		8	2	1	1	=12	
,, 62 & 63	15	9	2	5	1	=32	
,, 90	1		2			= 3	
Totals..	16	17	7	7	5	52	
Results expressed as percentages of total	30·8	32·7	13·5	13·5	9·6		
Deep red paper.							Beginning at the least refrangible end of the spectrum, we find that a deep red background in strong light produces the darkest pupæ. On the other hand, red glass and red gelatine, placed in front of white paper and light wood backgrounds respectively, produce light pupæ. The red gelatine especially gave a very pure light, almost exactly corresponding to the rays chiefly reflected from the red background. The remarkable difference in the effects of the same light will be considered at the end of this comparison.
Experiment 77	2					=2	
Red glass.							
Experiment 36					1	=1	
,, 45	1		1	1	2	=5	
Red gelatine.							
Experiment 35					3	=3	
Deep orange paper.							Passing from a red background to an orange one, which reflects the same rays, with the addition of a narrow strip of orange and yellow, we find an entirely opposite result, the pupæ being bright green.
Experiment 33					1	=1	
,, 78				1	1	=2	

Bright and pale yellow paper.						
Experiment 34					1	=1
,, 44					3	=3
,, 75					2	=2
,, 79					2	=2
						8
Yellow glass.						
Experiment 37				1	3	=4

A yellow background tends most strongly of all to produce the brightest pupæ, not a single exception occurring. In this case the paper reflects the same rays, with the addition of a broad strip of green, and the green-yellow rays are less absorbed. Comparison with the green backgrounds proves that it is the additional yellow rays rather than the green, which are effective. Light transmitted through yellow glass, and reflected from light wood, tends (in this case) in the same direction as the yellow background.

Faded yellowish green tissue-paper.						
Experiments 3 & 4					2	=2
,, 15					1	=1
,, 39					1	=1
						4
Bright green paper.						
Experiment 80		1	1	1		=3
Dark green paper.						
Experiment 81	1	2				=3
Green glass.						
Experiment 16					12	=12
Green gelatine.						
Experiment 38				1	1	=2

Although used as a complete covering, the tissue-paper acted as a background as well as a screen. Its thickness was very irregular, and there were many minute holes, so that a large amount of white light passed through it, and the conditions resembled those of a coloured background in light rather than those of a screen placed in front of a white surface. It reflected chiefly the green rays and most of the red, orange, and yellow, while the blue was much absorbed. It produced bright green pupæ without exception. On the other hand, the bright green paper, absorbing the red, orange, and yellow strongly, and reflecting much of the blue as well as green, produced far darker pupæ; while the dark green, absorbing much of every part except the green (and some of this), tended to form distinct dark pupæ. The green glass placed in front of white paper, and the green gelatine in front of light wood, produced effects entirely opposite to the green backgrounds, although the transmitted light was by no means rich in yellow and orange.

Very pale blue tissue-paper.								The blue backgrounds absorbing more and more of all rays except the blue tend to produce dark pupæ, even the faint blue shade of the tissue-paper being accompanied by some slight effect (compare with white paper). The comparatively slight effect of the darkest blue is almost certainly due to the larvæ having been introduced too late (see account of experiment, p. 410). The effect of a blue screen placed in front of a surface of light wood is not very different from that of the blue background.
Experiment 82				2		=2		
Light blue.								
Experiment 83		2	1			=3		
Deep blue.								
Experiment 84	1		2			=3		
Darkest blue.								
Experiment 85			1	3		=4		
Blue gelatine.								
Experiment 40			3			=3		

It is necessary to say a few words about this comparison of the effects of different parts of the spectrum, and the frequent antithesis between the results of screens and backgrounds of the same colour.

In the conclusions at the end of this memoir the colours of both will be given with greater precision, and their effects on all larvæ and pupæ subjected to them will be compared.

The results of the coloured backgrounds in strong light are perfectly regular: it is clear that the rays which check the formation of dark superficial pigment, and so allow the underlying green derived pigments to be seen, lie in the orange and yellow. The other parts of the spectrum do not seem to interfere with this power except by diluting the effective part of the reflected light. Thus red alone produced dark pupæ, but red with orange and yellow produced green ones: and approaching from the opposite side of the spectrum we see the same thing; for blue alone, green and blue, and green alone, produced dark pupæ, while green, yellow, orange, and red, produced green ones. Similarly white light reflecting all colours produced green pupæ.

These results are perfectly uniform and consistent: they are precisely similar to the behaviour of the *Pieridæ* (Phil. Trans., 1887, B., pp. 427-432), when exposed to similar backgrounds, and to the behaviour of the larva of *Amphidasis betularia*, as regards the production of green varieties (see pp. 355—357). Furthermore, the conditions imposed are in strict accordance with those which obtain in nature. The wild larvæ and those which pupate upon coloured backgrounds are freely exposed to bright daylight. Mixed with this, but immensely diluted by it, are the rays reflected from adjacent surfaces, and the yellow and orange constituents of these reflected rays determine the appearance of green pupæ by checking the formation of true pigment.

We are compelled to conclude from these results and those upon the *Pieridæ* (*l. c.*) that the greens of nature (due to chlorophyll) do not produce their effects in making larvæ and pupæ green, because of their brightest constituent, the green rays, but in virtue of the partially absorbed, but still bright, yellow and orange rays contained in their reflected light. And we must further conclude that if these yellow and orange rays were removed, the green rays, bright as they are, diluted by other reflected rays, and, above all, by the immense preponderance of direct white light, would be unable to check the formation of pigment and produce the green pupæ and larvæ. Diluted in this way, only the orange and yellow possess the power to effect such a change.

When, however, we employ coloured screens the conditions are entirely altered. The larva is not exposed to direct white light, but only to the light transmitted through the screen, and the same after reflection from a light background. Hence the rays fall upon the larval surface in an undiluted comparatively concentrated form, and their efficiency is correspondingly increased, extending beyond the orange into the red and beyond the yellow into the green. The effect begins to die away, however, in the feebler blue rays, even when present in this concentrated state. When screens are employed in this way, it is still the reflected rays rather than the direct transmitted ones which are effective; thus in Experiment 21 upon *V. urticæ* (see p. 376), a box (LXXVII.) with green glass windows and lined with *dark green paper* (the paper similar to that employed in Experiment 81 upon *V. io*), produced dark pupæ; while the same box, lined with *white paper*, produced uniformly bright pupæ of *V. io* (Experiment 16, p. 401).

Here the direct transmitted light was the same, but the amount reflected was different; for white paper returns the whole, while the coloured background only reflects a dim green band out of the transmitted light.

The above explanation corresponds to the fact which is apparent in the last table, that coloured screens, when they differ at all from backgrounds in strong light, only do so by producing green pupæ in place of dark ones, and never dark instead of green.

At first sight the tempting converse explanation of the phenomena is suggested, *viz.*, that the terminal parts of the spectrum, and especially the actinic blue, are instrumental in producing the animal pigments, while the orange and yellow rays merely fail to produce them.

I do not think that such a view can be sustained for a moment in face of the facts already adduced. The common appearance of dark pigmented larvæ and pupæ in complete darkness (and on the blackest backgrounds in light), shows that the pigment is a normal product of the animal organism, entirely independent of the agency of light. Furthermore, the region of the spectrum, by which such formation is normally checked, corresponds to the region of greatest intensity of light, and so supports the view that it acts as a definite stimulus, and not merely passively. All the facts hitherto brought forward (except perhaps the golden forms of *V. urticæ*), support the opposite view, that the pigmented form is the primitive one, and is still produced, as a rule, in the absence of any definite stimulus; but that certain conditions in the life of certain species have encouraged, by natural selection, a special susceptibility to certain stimuli which check the formation of pigment, and so produce an appearance which harmonizes with that from which the stimuli arise.

I am here alluding only to the power of becoming green by the non-appearance of true superficial pigment, and not to the power of altering the colour of the latter as in *A. betularia*, &c. This indicates another complex adaptation which has been already briefly considered (see pp. 353, 356, 359).

3. Experiments in 1892 upon the pupæ of Vanessa atalanta and Cynthia cardui.

A few experiments upon *V. atalanta* are described in my previous paper (*l. c.* pp. 398, 399), and the lighter glittering and darker non-glittering forms are shown in the accompanying plate (Figures 13 and 12, × 2). It is there shown that gilt surroundings, and, to a lesser degree, a clear glass cylinder roofed with white muslin, tend to produce light pupæ, with extremely brilliant metallic spots and patches, but without any suffusion of the whole pupal surface with gold, such as happens in the brightest pupæ of *V. urticæ.* Black surroundings in darkness, on the other hand, produced dark pupæ, with very slight traces of gold. No other experiments were attempted for want of material. The pupæ of *C. cardui* have, I believe, never hitherto been subjected to these experiments.

The following experiments have been conducted upon the larvæ during the past year, and one in 1888. The larvæ were captured in the field, and, as they are always isolated, it is impossible to obtain the product of a single pair of parents as in the gregarious *Vanessidæ.*

Experiment 1. *Black-covered cylinder in darkness.*—A single pupa of *V. atalanta* was suspended from the black paper roof. It was dark from the strong development of a network of black pigment over the whole surface : very slight development of gold.

A single pupa of *C. cardui* was similarly suspended, and was dark, due to the appearance of spots on the dorsal area and abdominal segments, and of a dark network on the wings and limbs. There was not much gold for this brilliant pupa, the dorsal line and lateral stripes glittering but feebly.

These and the other pupæ were compared Aug. 9.

Experiment 2. *Black-covered cylinder in strong light, the black paper being* outside *the glass* (*VI.*).—One pupa of each species was formed under these conditions. As in the last experiment, both were dark, with a slight development of gold.

Experiment 3. *Rather larger cylinder, similarly arranged* (*V.*).—A single dark pupa was suspended from the glass roof. Rather more gold was present than in the last experiments, although but little for the species.

Experiment 4. *Similar cylinder to the last, except that black was replaced by gold* (*XXVIII.*).—Two pupæ were formed, one suspended from the glass roof, and one from the food-plant near the gold background. Both were very light and glittering. A single pupa formed in another gilt cylinder, XXVII., in 1888, was also brilliant.

Experiment 5. *Gold-lined compartment of wooden box* (*XXXI.*).—6 larvæ, found July 17, were placed in these surroundings July 18. The 6 pupæ were scattered over the roof, and were very light and glittering.

Experiment 6. *Silver-lined compartment of same box* (*XLVI.*).—6 larvæ, found July 17, were placed here July 18. The 6 pupæ were distributed as in the last experiment, and were also light varieties, but did not exhibit nearly so much gold. The network of pigment covering the surface was also much stronger.

Experiment 7. *Clear glass lamp-shade almost filled with yellow paper spills.*—1 pupa was fixed to a spill, and 5 to the glass near the spills. All the pupæ, except one dark individual with little gold (on the glass), were light-coloured glittering varieties.

Experiment 8. *Opal glass globe* (*L.*).—6 pupæ, suspended from the glass near the top, were light, with brilliant gold spots.

Some of the larvæ, experimented with as described above, were light varieties, and some were dark. The larval colours were not attended by any special tendency towards the formation of light or dark pupæ. This was also noticed in 1886.

These results indicate that *C. cardui* is also probably sensitive, like the allied species; but more individuals are needed to test this satisfactorily.

In *Vanessa atalanta* dark pupæ are formed in darkness and on dark surfaces exposed to light. The black surface is perfectly effective, even when separated from the larva by a layer of glass. Gilt surfaces produce light and glittering pupæ, and the gilt also is effective outside the glass. Silver surfaces produce far less light and brilliant pupæ, the species resembling *V. io* in this respect. White opal glass and bright yellow paper are very effective, as in the other *Vanessidæ*, subjected to experiment.

Conflicting Colour Experiments, 1892.

A few of these experiments were conducted during the past summer. The pupæ in the compartments of the case already described (see p. 393), and shown in Plate XV., Fig. 5, were compared August 28.

Of two pupæ in compartments of the middle row, one was fixed on the junction of black and gold, the head being on the latter, while the other was fixed below the junction, so that the posterior half of the body was against black, and the anterior half against gold. The first pupa was dark, with very little gold, the second light, and with the gold spots rather developed (the large triangular spot was dull, the anterior part of each dorsal spot somewhat golden). Here, while there is no evidence for local effects, a lighter pupa was formed when a relatively larger surface was exposed to gold than when the surface so exposed was smaller.

Another pupa was fixed to the glass in a compartment of the upper row, with the middle of the body opposite a gold band, the head and posterior part equally opposite black. The pupa was dark, with very little gold.

Two were fixed to the glass of compartments of the same row, with the middle of the body opposite black, the head and posterior end equally opposite gold. One was a light variety with little gold, the other intermediate between a dark and light variety.

A single larva was introduced earlier in the summer into one of the shallow black cells, covered in front with white opal glass, described in the Experiments on *V. io* (see p. 423). The pupa was attached to the glass, and was moderately golden, being rather on the light side of an intermediate variety. This result, with the others recorded above, seems to show that the species has a greater susceptibility to white and gilt surroundings when conflicting with black than is the case with *V. io*. The difference between the effects produced by the two opposite backgrounds when used separately is, however, so much less in *V. atalanta* as to render the species far less suitable for the purposes of this enquiry.

There was not the least evidence for any local influence upon the pupæ, so that the results of these experiments confirm the previous conclusions as to the physiology of the process.

4. Experiments in 1888 upon the pupæ of Vanessa polychloros.

Two larvæ, found near Oxford, were subjected to experiment at the end of July, the pupæ being compared July 31. The larvæ passed all three stages preparatory to pupation under the conditions described below.

One had been placed in a moderate-sized cylinder, covered externally with two thicknesses of black tissue-paper and a roof of the same (IX). This being inverted on a black paper floor, was in almost complete darkness. The pupa (position unnoted) was much darker than the other, with no trace of the gold spots. It was comparable to a dark (3) of *Vanessa urticæ.*

The other was placed in the gilt compartment (XXXI.), and was fixed to the roof. Compared with *V. urticæ* it would be a light (3). The gold spots were present on the metathorax and 1st and 2nd abdominals, although they were not *very* bright, and there was no tendency to spread over the general surface, as is so commonly the case with the brighter forms of *V. urticæ.*

My friend Mr. O. H. Latter also experimented on the same species in 1888, and sent the pupæ to me for comparison, which took place August 15.

Three pupæ, formed in black surroundings in a dim light, were *much* darker than the others, with no trace of metallic spots.

Three pupæ, formed in gilt surroundings in a strong light, were all light varieties, with silver spots on the three usual segments.

The results were very uniform in both sets, and the difference greater than in my experiment. It is likely that the dimly illuminated dark surfaces produce more effect than the same in darkness. This is shown in many experiments on other larvæ and pupæ recorded in this paper.

For a much longer series of experiments made in the same year by the Rev. J. W. B. Bell, see 'Midland Naturalist,' December, 1889, pages 289-90. These results also show a very high degree of sensitiveness in the species. The colours appear to be such as to afford concealment, especially upon irregular dark surfaces of bark or rock.

5. Experiments in 1888 upon the pupæ of Argynnis paphia.

Twelve nearly mature larvæ purchased in the spring of 1888 formed the material of these experiments. When they ceased feeding, the larvæ, divided into two equal lots, were placed in two cases, the one with a white-paper roof, the other with a roof of clear glass, upon which was placed a sheet of black paper.

Black surroundings (seen through glass).—6 pupæ were obtained and compared June 22. They were all dark varieties, with a considerable development of cuticular pigment. The golden spots were as distinct as in the others.

White surroundings.—The 5 pupæ obtained were far lighter, being a light brown with a very slight development of pigment, except in one which was about the same as the lightest of the other lot. There is apparently no tendency towards the suffusion of gilt as in *V. urticæ,* but the 5 pairs of spots, on pro-, meso- and metathorax, and abdominals 1 and 2, are very distinct and bright, although those on the mesothorax are very small.

The pupa is evidently highly sensitive, and the effect upon the pigment is certainly such as to promote concealment.

It is interesting to find a case in which the pigment only is affected by the surroundings, and the glittering spots are equally present in dark and light forms. In this respect the species is at present unique, but no doubt further experiment will reveal the presence of others. In all the *Vanessidæ* the glittering spots are affected by the formation of dark pigment, and tend to disappear in many of the dark varieties.

6. Experiments in 1888 upon the pupæ of Pieris brassicæ and P. rapæ.

Before describing the experiments, it is necessary to give some account of the different colour varieties formed in these two species. In *P. brassicæ* we meet with the following classes :—

" (1). The normal form. In these pupæ the ground-colour is always more or less greyish from the abundance and relative size of minute black pigment spots which occupy depressions in the cuticle. . . . . The large black pigment patches and spots are nearly always abundant. . . . . The ground-colour may be of various tints—greyish green, orange, yellow, or a peculiarly opaque-looking greyish white. The amount of the grey colour, always present, subdues the differences between these tints, so that they resemble each other far more than the above description would seem to imply. . . . . The following subdivisions are well marked, although transitional varieties occur :—

(α) The darkest forms, with greyish green, orange, yellow, or white ground-colour.

(β) Intermediate forms, with lighter ground-colour of the same tints, and smaller and fewer pigment patches.

(γ) The lightest of these forms, with ground-colour still greyish, but the pigment patches very small relatively to (α) or (β).

(2) The last sub-division passes into this variety, in which the ground-colour is an opaque-looking whitish yellow, often with greenish areas on part of the surface, the pigment patches being very small. The greyish hue is lost, because of the minute size of the dots in the ground-colour. Hence the effect is very light. . . . .

(3) A still more abnormal, very well-marked, variety, possesses a deep transparent-looking bluish green ground-colour, in which the minute dots and the large patches are even less developed than in the last degree. An opaque whitish-yellow band, like the ground-colour in (2), occupies the anterior half of that part of the third abdominal segment which is seen dorsally, and extends on to the posterior part of the segment in front; and the dorsal surfaces of the abdominal segments behind the third are often mottled with the same colour. . . . .

The differences between the ground-colours of (1), (2), and (3) are very well-marked. . . . ." (Phil. Trans., 1887, B, pp. 409, 410.)

The words "normal" and "abnormal" are only used above in the sense of usual and unusual in the wild state. Every form is normally produced by its appropriate background, and it is only because the wild pupæ are almost invariably found on stone or brick walls, and on palings, that they assume the appearance of (1)s rather than (2)s or (3)s.

The pupæ of *P. rapæ* are divided into 11 classes, passing from very dark varieties:—*Dark* (1), (1), and (2), through the intermediate forms *dark* (3), (3) and *light* (3), into the various shades of light pupæ, *dark* (4), (4), and *light* (4), and finally into the green *pale* (5) and *deep* (5). I need not describe these further, as there are only 7 pupæ of this species tabulated below. But the full account will be found in my previous paper (*l. c.* pp. 410, 411), and 10 of the varieties are figured in the Plate (figs. 32-41, all × 2), as well as 7 of *P. brassicæ* (figs. 24-30, all × 2).

In the paper I have just referred to, a number of experiments, with papers of various colours, showed a great susceptibility on the part of these *Pieridæ* to reflected light within the limits of the orange and yellow. This light prevented the appearance of superficial pigment, and rendered the pupæ green. I was most anxious to experiment further with screens of coloured glass.

Such an investigation was undertaken in the autumn of 1888, nearly mature captured larvæ of *P. brassicæ* and a much smaller number of *P. rapæ* being placed in the cases described below and fed until pupation. Any conclusions from the results are much weakened by the small numbers subjected to the various conditions, and this was due to the excessive mortality of *P. brassicæ* during 1888 from the attacks of Ichneumons. The pupæ tabulated below are only a fifth of the larvæ introduced, 424 having died from this cause.

The pupæ were compared in the following spring, April 6. They were removed from the cases and placed side by side on white paper, and very carefully compared when subject to the same conditions of illumination.

As regards *P. brassicæ*, the differences between 1 (α), 1 (β), and 1 (γ) were well marked and distinct; but the various tints of ground-colour, orange, whitish, greenish, and yellowish (represented in the table by the letters *o*, *w*, *g*, and *y* respectively), found in each of these divisions were almost concealed by the predominant grey, so that they constitute features of very little importance, and it is doubtful whether it is necessary to mention them at all. But as the distinction was made at the time, I have repeated it. The greenest pupæ, the (**3**)s, were not transparent-looking like the forms described under this degree in 1887 (Phil. Trans., B., *l. c.*), and they had a greater development of the black patches, and a more dusky appearance over the whole surface. The opaque whitish yellow band crossing the 3rd abdominal was slightly marked or absent, and the green ground-colour was not so deep in tint.

The whole of the experiments are described in the following table :—

(*See Table, pages* 441, 442, 443, 444, 445.)

A more exact statement of the light transmitted through the screens and reflected from the backgrounds will be given in F. Conclusions, where the main results of all such experiments will be compared together.

It is very unfortunate that these experiments on the *Pieridæ*, which were conducted with the greatest care, should have lost much of their value from the death of so great a majority of the larvæ. With five times as many individuals to argue from—and this was the number introduced into the cases—tolerably safe conclusions might have been drawn. Even as it is, the conclusions are probably reliable, harmonizing as they do with those derived from the investigation of *V. io*.

In the latter species, and in the *Pieridæ* in 1886, it was ascertained that the larvæ are sensitive to the orange and yellow rays reflected from the adjacent background, when diluted with other rays from the same source, and an immense preponderance of direct white light. But in the case of *V. io*, it has been shown that when both these causes of dilution are reduced by the use of coloured screens, the larvæ became sensitive to reflected rays which would not ordinarily affect them, *viz.*, from the red rays beyond the orange, and the green beyond the yellow; but blue light, however concentrated, did not appear to affect them.

Let us now apply this conclusion to the experiments described above.

Red glass in front of white and orange paper produced a far greater effect in the direction of green pupæ than is usually produced by red paper in white light.

Yellow glass, in front of backgrounds which reflected the yellow light, produced much the same effects as yellow backgrounds in strong light; in front of non-reflecting backgrounds it produced darker pupæ.

Short description of Receptacles. (see G., Appendix).	Position of Pupæ.	Pupal Colours.					Results and further remarks.
		(1) α.	(1) β.	(1) γ.	(2)	(3)	
LXIV. White paper lined compartment in strong light (clear glass). Experiment 1.	1 on roof.					1	Strong effect of white surface. The pupa was unusually dusky for a (3), and with unusual development of black spots for this degree. Light yellowish band across 3rd abdominal fairly distinct.
LXVI. Similar compartment with black paper (varnished surface). Experiment 2.	1 isolated, roof. 1 isolated, top of side.	1 o 1 o					Both pupæ very dark. Characteristic effect of black, contrasting *very* strongly with that of white.
LXIII. Similar compartment with light brown tissue paper. Experiment 3.	2 separate, roof.	1 o	1 g				The (*a*) very dark. Effect nearly as strong as black paper.
LIII. Similar compartment with deep red paper. Experiment 4.	2 opposite sides, roof.		1 g			1	Both pupæ very grey and dusky for their degrees, and yet distinctly green. The (β) was *very* grey, although with slight development of black patches and spots; a very remarkable pupa. The light yellowish band hardly present on the (3). The effect on the (3) is very remarkable, and exactly opposite to that obtained in 1886 with much larger numbers. Red backgrounds usually make both species of *Pieridæ* very dark.
LXXI. White paper lined box with red glass front. Experiment 5.	2 on roof together.		1 o 1 w				Decidedly lighter pupæ than those generally produced by red backgrounds. Probably same explanation as that offered in the case of *V. io* (see p. 413).
	5 on roof separate.		1 y	1 y 1 w 1 o	1		

LXXII. Orange paper lined compartment with red glass front. Experiment 6.	2 on roof together.			1 y	1		The (2) is really intermediate between a (2) and a (3), because of the predominant green patches.
LIV. Orange paper lined compartment in strong light (clear glass). Experiment 7.	2 on roof together.			2 g			Same results as above: the paper reflected the red light.
LV. Similar compartment with pale yellow paper. Experiment 8.	4 on roof together.			3 o 1 y			Weak effects in direction of green as compared with the same conditions in 1886, when, however, some of the pupæ were (γ)s, and even (β)s.
LXXVI. White paper lined compartment with yellow glass front. Experiment 9.	3 on roof together.		1 o	1 y 1 w			Effect much the same as that produced by orange and yellow surfaces in strong light in Experiments 7 and 8.
LXXVIII. Compartment similarly lined and covered. Experiment 10.	2 on roof isolated.			1 y 1 w			
	1 loose on floor.			1 y			
LXXIX. Similar compartment lined with orange paper. Experiment 11.	3 on roof isolated.			1 g		2	Dusky (3)s for this degree. In this case we obtain the usual effect of orange and yellow surfaces. The orange paper was nearly as bright in the yellow light as in the spectrum of white light.
LXXX. Similar compartment lined with darkest blue paper. Experiment 12.	2 on roof isolated.		1 w	1 y			These two backgrounds are nearly the same under the yellow glass, which cuts off the blue rays. It is probable that the difference between these results and those of Experiments 2 & 3 is only another example of the observation that darkness has a smaller effect than a black surface in strong light.
LXXXI. Similar compartment lined with black paper. Experiment 13.	1 on roof.	1 w					
	2 loose on floor.		1 y	1 o			

LVIII. Dark green paper lined compartment in strong light (clear glass). Experiment 14.	2 on roof together.	1 w 1 y					This dark green produced the same effect as with *V. io*, leading to dark forms.
	1 on roof isolated.		1 w				
LXXXII. White paper lined compartment covered with green glass front. Experiment 15.	2 on roof together.		1 o	1 o			Some slight effect was apparently produced.
LXXXIII. Similar compartment lined with red paper. Experiment 16.	2 together.		2 o				This combination gave a very dark background, very little green being visible. Some effect may have been produced on the (γ), or probably the result may be one of the irregularities which often occur in darkness.
	1 separate.			1 w			
LXXXIV. Similar compartment lined with orange paper. Experiment 17.	4 on roof somewhat near together.	1 y		1 g		2	This combination reduced the spectrum to a dim yellow-green band, which nevertheless, in the absence of dilution by other rays, produced marked effects.
	1 on roof rather separate.			1 o			
LXXXV. Similar compartment lined with darkest blue paper. Experiment 18.	2 on roof together.	1 w 1 o					This combination cut off the blue, and left very little. In this case the results are those of a black surface. Comparing these 4 compartments covered with the same glass, we are led to believe that the reflected light is alone serviceable, and that, in the absence of dilution, a very little of it may produce considerable effects.
	3 on roof together.	2 o		1 g			
LXXVII. White paper lined box with large green glass windows in back and front (deeper in tint than the above). Experiment 19.	1 on side isolated.			1 g			Although the glass was deeper in tint, it produced more effect in the direction of green pupæ than in that of Experiment 15. This is probably due to the windows being in back, front, and a small one on the top, instead of only in front. The effect is very much below that produced upon *V. io* (see p. 401).
	1 on roof isolated.			1 g			
	2 on roof together.			2 o			
	2 on small green glass window in roof rather near together.	1 y		1 o			

LIX. Pale blue tissue paper lined compartment in strong light (clear glass). Experiment 20.	2 on roof separate. 1 loose on floor.	1 y	1 y	1 y			These blue surfaces of three shades produced mostly dark pupæ, harmonizing with their effect upon *V. io* in 1888, and upon *P. rapæ* in 1886. 1 pupa of *P. rapæ* was also present in compartment LXI.; it was a yellowish light (3); such forms were also produced in 1886 by a blue background.
LX. Similar compartment with light blue paper. Experiment 21.	2 on roof together. 2 on roof separate.		2 y 2 o				
LXI. Similar compartment with deep blue paper. Experiment 22.	1 on roof isolated. 1 on back isolated.	1 y	1 o				
LXXXVII. Red paper lined compartment with pale blue glass front. Experiment 23.	4 on roof together. 1 loose on floor.	1 w 1 w	3 w				The red was much dimmed by the glass, but remained much brighter than any other part of the spectrum. The effects are much like black or red in strong light.
LXXXVIII. Similar compartment lined with orange paper. Experiment 24.	1 on roof.			1 o			This combination cut off the extreme red, and produced general dimming of the light reflected from the paper, but not so much as with the green glass (Experiment 17). Some slight effect was probably produced.
LXXXIX. Similar compartment lined with yellow paper. Experiment 25.	2 on roof separate.			2 o			The glass cut off the extreme red, and dimmed the rest of the spectrum. Conclusion as above. Comparing these three compartments leads to the same conclusion as the comparison of 15—18.

XC. White paper lined box with cobalt blue glass front. Experiment 26.	1 on roof, together with 2 *P. rapæ* in one corner.	1 o					The 4 *P. rapæ* pupæ were a dark (1) apparently pinkish, a dark (3) apparently pinkish, a yellowish light (3), and a yellowish dark (4).
	1 in another corner with 2 *P. rapæ*.		1 y				
XCI. White paper lined compartment with cobalt blue glass (darker than XC.) front. Experiment 27.	2 on roof isolated.	1 o		1 g			
XCII. Similar compartment lined with orange paper. Experiment 28.	2 on roof separate.	1 g 1 w					With two striking exceptions, these results confirm those obtained in the cases of *V. io* (1888), and the *Pieridæ* (1886), for all of them show that dark forms are produced by blue light. These far deeper blue screens left very little light to be reflected from the orange and yellow papers, while the white and blue papers reflected chiefly blue light. The exceptions are such as occur not infrequently in darkness. The (3)s were both dusky for this degree, and the (γ) very dusky.
	1 loose on floor.		1 g				
XCIII. Similar compartment lined with yellow paper. Experiment 29.	1 on roof.	1 o					
	1 loose on floor.					1	
XCIV. Similar compartment lined with darkest blue paper. Experiment 30.	2 on roof together.	1 o				1	
LXXIII. Another compartment lined with orange paper and cobalt blue glass front (like XC. or XCI.). Experiment 31.	1 on roof.	1 o					
XCV. Compartment lined with black and orange paper squares of such a size that a pupa of both species of *Pieris* must lie on parts of at least two of them. Experiment 32.			1 w 1 g 3 o	2 y			2 *P. rapæ* pupæ were also in this case, and were a (2) apparently yellowish, and a pinkish (4). There was not the slightest tendency towards a local distribution of pupal colour corresponding to the contrasted colours on which the change took place. The pupæ are on the dark side of intermediate, and the results support the conclusions reached in the case of the *Vanessidæ*.

Green glass in front of reflecting backgrounds produced far more effect in the direction of green pupæ than green backgrounds (devoid of yellow and orange) in strong light. With non-reflecting backgrounds it produced dark pupæ.

Pale blue glass, transmitting much besides blue, similarly produced far greater effects than blue backgrounds in strong light, when placed in front of reflecting surfaces, but produced the same dark pupæ when the backgrounds reflected but little of the light it transmitted.

Deep blue glass, with one or two exceptions, always produced dark pupæ, and the exceptions were evidently not related to the background, but were simple irregularities such as often occur in darkness.

So far as the experiments go, they point to the same conclusions as those reached in the case of *V. io*.

Conflicting colour experiments.—The results of Experiment 32 (XCV.) entirely confirm those upon *V. urticæ* and *V. io*. They also show that the influence of black was stronger than the strongest antagonistic influence when both were working together upon the same organism; for, out of 7 *P. brassicæ*, 5 were in the darkest class except one.

D. Experiments upon the Cocoons of Lepidoptera.

For several years I have, from time to time, made experiments of this kind, whenever I met with a suitable species.

If the power occurs at all, we should chiefly expect to meet with it in species building cocoons upon the surface of the ground among leaves, sticks, &c., or freely exposed on bark, and, among such species, especially in those which pass the winter in the pupal state. Examples of these are to be found below; but all the experiments upon them have yielded negative results, except those upon the genus *Halias*.

The first three species have been experimented upon during the last few years, but I cannot now fix the exact date.

Cerura vinula.—Some careful experiments were conducted upon this species. The cocoons bear the most remarkable likeness to the surface upon which they are fixed, and I wished to ascertain whether this was entirely due to the abundant admixture of adventitious fragments gnawed off the surface, or in part to the colouring of the silk.

Six or more mature larvæ were placed in glass cylinders (1 in each) standing on sheets of glass; beneath the latter and round the lower half of the cylinder white paper was fixed, so that the larvæ were in brilliantly illuminated white surroundings, and yet were compelled to spin cocoons from the products of the silk-glands alone.

About 6 more were similarly placed, except that black paper was used instead of white.

Under these circumstances, most of the larvæ spun compact semi-transparent cocoons, the product of the glands apparently forming a continuous sheet. Some of them, however, failed to construct cocoons, and only used the secretion to form a covering to the glass floor.

The cocoons varied much in colour, being all shades of brown, but there was no evidence whatever for the existence of any sort of relation to the colour of the environment.

It is clear that the adjustment of colour which occurs in nature is, like that of the cocoons of *H. abruptaria* (see p. 317) entirely due to adventitious particles.

Endromis versicolor.—A single mature larva was placed among some shreds of white paper. It spun a cocoon of normally dark brown silk.

Trichiura cratægi.—Some experiments similar to those described below in the case of *P. populi* were made upon this species, with the same negative results. All the cocoons were dark. I have mislaid the notes with the exact numbers.

Hemaris fuciformis 1889.—Six cocoons were spun in two white paper boxes with clear glass covers, 5 of them being among shreds of white paper. The silk of all was more or less brown, but it varied through all shades from dirty white up to dark brown.

Four cocoons were spun among dark twigs in a box lined with dark tissue paper, also with a clear glass cover. These varied in tint in the same manner.

It seems clear that the species is not capable of modifying the colour of its cocoon into correspondence with its environment.

From the occasional occurrence of dark brown patches on a light brown cocoon, it is probable that the larva stains the completed structure, in the manner described by Mr. Bateson.

Pœcilocampa populi 1891.—Four cocoons were spun among leaves and twigs of *Quercus cerris ;* these were quite black on all exposed parts, while two spun between pieces of white paper were not nearly so dark. The blackness is, however, due to something which is not silk, the latter being of a much lighter brown. It probably comes from the digestive tract (for neither the paper nor the leaves or twigs around the cocoons appeared to be gnawed), and has the appearance of bitten up food or fæces. It will be interesting to ascertain accurately what this substance is and why the larva has so much less of it when the cocoon is constructed in the paper. It may only follow from an accidental separation from food just before maturity, or from disturbance. Under any circumstances, there seems to be no question of colour adjustment, for the larvæ in the paper made the most conscientious use of all the material they had, and spread it out so as to cover the exposed part of their cocoons as completely as possible.

Halias prasinana 1892.—I brought forward *H. prasinana* as an example of this power of colour-adjustment in 1887 (Proc. Ent. Soc., pp. l, li). When Mr. Bateson had shown a source of error in interpretation, owing to the effect of disturbance on the larvæ, I felt that this case could no longer be sustained without further experiment, in which such errors were specially guarded against. I have fortunately been able to make a few such experiments during the past autumn, which, so far as they go, entirely support my earlier conclusions.

A few nearly mature larvæ, beaten by Mr. Arthur Sidgwick and myself, were placed, directly after capture, in two cylinders. A twig of oak bearing leaves was placed in each of these, and each of them stood on a perforated plate and had a muslin top. The space around the oak twig was filled in one cylinder with white paper spills, in the other with dark sticks, chiefly of *Quercus cerris.* After this the larvæ were not touched, and it is clear that there is no reason for assuming that the larvæ of one cylinder were more disturbed than those of the other.

White surroundings.—3 cocoons were spun upon the muslin roof, which in this case was a considerable distance from the oak-leaves; 1 was light brown; 2 very light brown and almost white. 3 were spun on the glass side near paper spills *and* oak-leaves. Of these 1 was rather dark brown and two were light brown.

Dark surroundings.—1 was spun on the muslin top, in this case near the oak-leaves but away from the sticks; it was intermediate between the tints last described. 3 were spun on the undersides of oak-leaves in close proximity to the dark sticks, and all these were *dark* brown, far darker than any in the other cylinder. One of them was built low down, and some of the white cotton wool wrapped round the oak twig, where it passed through the hole in the plate, was spun into one end of it, while the ends of 3 dark twigs were also fixed to it. As in many other cases among larvæ and pupæ, where dark and light surroundings contend, the former proved to be more powerful, for the cocoon is as dark as the other two. Another 5th cocoon was fixed to the glass cylinder near the leaves, and closely surrounded by dark twigs. It is very dark brown, just like those upon leaves. Mr. Sidgwick tells me that he has always obtained such dark cocoons upon leaves.

Another kind of experiment was then begun. A very small twig of oak with few leaves was placed in each of two similar cylinders, which were then filled up with fragments of white tissue paper, slightly crumpled. One of these was then covered with a larger darkened cylinder so as to be in nearly complete darkness; the other was left in strong light.

In the latter a single cocoon was spun on the white muslin roof far above the oak-leaves, but closely surrounded by white paper, the corner of one piece being spun into it. It was the whitest cocoon obtained, with hardly a trace of brown. In the other darkened cylinder 2 cocoons were obtained, both spun, 4 centimetres apart, on the muslin roof, the white paper close to them, and abundantly spun into one, the leaves far away. The cocoon on the muslin alone was a slightly deeper shade than that on the muslin roof of the cylinder with dark sticks (*viz.*, intermediate between "rather dark brown" and "light brown"); the other spun on to muslin and paper was "light brown," lighter than the darkest on the muslin top and sides of the cylinder with white paper spills, but darker than the "very light brown" ones on the roof of the same cylinder. It was in fact intermediate between these two tints. Both were strikingly different from the white one in the corresponding cylinder exposed to light.

Hence darkness produced brown and light brown cocoons, under conditions which, with light, produced a white one. Experiments upon other species did not render it probable that darkness would produce very dark cocoons, but that it should produce any effect at all is inexplicable, except on the supposition of a colour which can be modified by the larva as a response to external conditions, and this in a normal manner, and not as the result of disturbance.

I was very anxious to apply the crucial test which suggests itself after reading Mr. Bateson's criticisms. He contends that the dark cocoons are normal, and are always formed in nature by healthy larvæ, and that the light ones are produced by disturbance or the presence of parasites.

If, therefore, a much disturbed larva spun a dark cocoon, or, better still, a larva, which had begun to spin a white cocoon on a white surface, afterwards spun a dark one in contact with the appropriate surroundings, it would be quite impossible for Mr. Bateson's criticism to be sustained.

A larva beaten from birch spun a considerable part of a perfectly white cocoon in a white chip box. A birch-leaf was also spun into the cocoon, but in this case the white surroundings predominated. Mr. Sidgwick has also obtained a white cocoon of this species in a chip box during the present year. The cocoon was opened and the larva removed, and it was then found that two eggs of ichneumons, probably of the genus *Paniscus*, were fixed to one or more of the thoracic segments. In trying to remove one of these with scissors, the larva was rather seriously cut, and bled freely. I therefore desisted from the attempt, and placed the larva in a cylinder with oak shoots bearing leaves. To my surprise, it spun on the glass, including the edge of an oak-leaf in its cocoon, but *every thread of silk spun after its removal was brown*, even including the "ladder" by which it ascended the side of the cylinder. To-day (Dec. 17) I opened it, and found, as I expected, the unfortunate larva shrivelled up, and an ichneumon cocoon lying beside it. Thus a distinct brown (by no means light brown) cocoon was spun by a larva which had been subject to almost every kind of disturbance—removed from a partially constructed cocoon, bearing the external eggs of a parasite, and mutilated.

In this case I think it is probable that the instant change in the colour of the silk, noticeable in the threads of the "ladder," and the framework around and beneath, no less than in the cocoon itself, is probably in some way associated with the irritation to which the larva had been subjected. The case suggests, although it does not prove, a source of the colouring matter other than that provided by an extract from the food, contained in the digestive tract; that is, so far as this species is concerned. It was also certain that in this particular case the silk was not darkened by the larva at some later time.

Another experiment of the same kind did not lead to the same results. A larva had begun to spin a white cocoon in a similar chip box. It had only constructed the platform when it was removed and wrapped in many folds of black net. Here it began to spin a white cocoon, but soon died without completing it. As regards this case, it may be remarked that we have no evidence as yet of the effect of black net or black paper upon normal larvæ of this species, although we should suppose that dark cocoons would be produced.

I think that these experiments, few as are the individuals made use of, prove the existence of some power of colour-adjustment in this genus; for such experiments as were conducted were specially arranged to avoid the sources of error present in the earlier ones.

Then, too, Mr. Tutt's observations upon the allied *H. chlorana* afford very strong confirmation; for it is hard to see how any disturbance of his larvæ, sufficient to account for the colour change, can have arisen. (See 'The Entomologist's Record,' Jan. 15, 1892, pp. 9—12).

Rumia cratægata, 1892.—Two beaten larvæ of this species spun *very* light brown transparent-looking cocoons in pieces of white tissue-paper in the cylinder described above as exposed to light. Both larvæ sought the innermost recesses of the crumpled papers. In the absence of comparison experiments I cannot claim that this evidence proves any susceptibility; but I will keep the cocoons to place beside others obtained in later experiments.

Acronycta tridens, 1892. — A captured mature larva spun a perfectly white cocoon on the muslin floor and among the white pieces of paper of the last-named cylinder. Small holes were gnawed in the muslin and the pieces fixed in the cocoon. It is probable that the cocoon is, in nature, entirely concealed by foreign particles, and that the colour of the silk cannot be adjusted.

Orgyia pudibunda, 1892. — Two captured larvæ spun light yellowish cocoons on the muslin floor and among the white tissue-paper of the cylinder in light, and another spun a similar cocoon among the paper fragments and on the muslin roof of the corresponding cylinder in darkness, no effect being produced by the different conditions.

The light yellow colour and slight opacity appear in this species to be solely due to the larval hairs spun into the wall of the cocoon.

Had I not been disappointed by a dealer, I should have again tested the larva of *Saturnia carpini* during the past season. I have no doubt that Mr. Bateson is right in concluding from his experiments that the colour of the cocoon cannot be adjusted; but I should wish, before feeling absolutely certain of this, to apply what I believe is the most searching test of all, viz., *dark and light surroundings as they occur in nature*, using such materials as chalk, light sand, peat, &c.

In admitting the mistake I formerly made in applying the principle of colour-adjustment to certain cocoons, I still think that it applies to some cocoons, and have now brought forward fresh evidence in proof of this conclusion.

In other respects, the amount of confirmation of my earlier work, and of support extended to principles suggested in it, which I have been able to bring forward in the present paper, has been a source of satisfaction.

E. Experiments upon Lepidopterous imagines, 1891.

1. *Experiments in* 1891 *upon the colours of the larvæ, cocoons, and imagines of Gnophos obscurata.*—I have been anxious to experiment upon this species for many years, but, until 1891, I was unable to obtain the material. I have suggested a probable influence of environment in determining the colours of the imago, which is well known to be light-coloured on chalk, and dark on peat ('Colours of Animals,' Internat. Sci. Ser., pp. 157, 158). The colours of these local varieties are certainly protective; for Mr. W. E. Nicholson, of Lewes, who has had a very wide experience of the species, tells me that the imago always rests upon the bare ground by day, although found on the grass if searched for with a lantern at night. This is equally true on chalk and peat, the moth usually resting on the face of pits or banks, beneath ridges or overhanging tufts of vegetation.

My friend Mr. Merrifield, of Brighton, knowing of my wish to experiment with the species, kindly suggested to Mr. Nicholson to obtain some larvæ for me. I wish to express my sincere thanks to both these gentlemen for their kind help, which enabled me to carry out an investigation I had especially looked forward to, and which was of very great interest, although the results obtained were negative.

I received 20 larvæ from Mr. Nicholson on May 16, 1891. These will be called the larvæ of the "first lot." They were obtained by searching with a lantern on the night of May 14, and all were resting on dry grass bents on a steep chalk bank near Lewes, facing S.W. The ground was very white, and the moth when taken in the neighbourhood is very light; in fact, the bank just mentioned is the best locality for the almost pure white variety of the species.

Mr. Nicholson also sent me 25 more larvæ,—the "second lot,"—captured on the night of May 22 in the same locality.

Although the results were negative, I will give some account of the experiments, for the value of the conclusions depends upon the very great care which was exercised. The same methods may also be of use in other species.

The colours of the 20 larvæ of the "first lot" were carefully compared May 17, before being arranged in the experiments on the same day. The 5 largest were about 21·0 mm. long, and were lighter in colour than the remaining 15, which averaged about 18·0 mm. in length. The amount of colour-variability was not great, but distinct. The various shades of colour are mentioned under the experiments. The 25 larvæ of the "second lot" were very uniform in size, the average length being 18·25 mm.; the colours of these larvæ were also more uniform, but 10 were somewhat darker than the others.

The larvæ were fed on various low-growing plants, such as *Achillea*, sorrel, buttercup, and plantain, as well as on the more well-known food-plants, rock-rose and burnet sanguisorb. They did not eat much, being nearly full-fed when received, and, indeed, some were probably quite mature.

The habits of the larvæ were such as to expose them very thoroughly to the materials made use of in the experiments. Small pieces of chalk scattered on white paper formed the light environments; coal and peat on black paper formed the dark. In both cases the larvæ generally hid under the chalk or coal by day, especially when the food consisted of green leaves. When, however, the rock-rose was employed alone, many of them hid by day among the crowded brown stems in the inner part of the plant.

The experiments were of three kinds—Dark Surroundings, White Surroundings, and Transference Experiments.

Dark Surroundings.

(*See Table, page* 455.)

Light Surroundings.

(*See Table, page* 456.)

Various Transference Experiments and others to be compared with them.

Fifteen of the lighter larvæ (although the difference was not great) of the "second lot" were placed, May 25, in a rectangular glass case (LII. Appendix), with a floor of peat and lumps of coal, standing on black paper (below the glass bottom). They were offered rock-rose alone.

May 27, 7 were on the black net roof, and 2 on the plant, the rest having buried deeply in the loose peat.

May 31, 10 buried, and had made cocoons; these were transferred as described below (p. 457); 1 was on plant, and 4 on roof.

June 22, the remaining 5 had buried, and 1 had pupated. They were transferred as described below (p 457).

DARK SURROUNDINGS.

EXPERIMENT I.	EXPERIMENT II.	EXPERIMENT III.
The floor of a large glass cylinder (of about 1000 cc. capacity) was black net resting on black paper; on this floor many small lumps of coal were scattered; the roof was black tissue paper. Larvæ of "first lot."	Arranged as in I. Larvæ of "first lot."	Dark Surroundings from May 27. Rectangular glass case (LII., Appendix) with floor of peat and lumps of coal standing on black paper (below glass bottom). Larvæ of "first lot."
May 17. — 2 of the lightest large larvæ & 3 of the lightest small introduced. *May* 24.—3 escaped. *July* 15.—1 had pupated recently, the other died. *Aug.* 15. — Moth emerged.	*May* 17. — 1 intermediate large larva & 4 intermediate small were introduced. *May* 24.—2 escaped. *July* 7.—1 had spun a slight cocoon, and pupated the following day. *July* 15. — The remaining 2 were nearly ready for pupation. *Aug.* 14. — Moth found emerged. *Aug.* 26. — Moth found emerged.	*May* 27. — 6 of the larvæ lost on May 24 were found on that day, but of course original arrangement was unknown. They were placed between 24th and 27th on rock-rose alone, with white paper floor; on 27th introduced here. *June* 23.—All buried, and 1 had recently pupated. *July* 8.—1 dead. 2 pupæ in cocoons. 1 larva ,, 1 pupa in which imago was developing. 1 missing. *Aug.* 3. — 1 imago emerged. *Aug.* 15. — 2 imagos emerged (1 probably on 14th). *Aug.* 26. — 1 imago had emerged. These last 3 imagos emerged from pupæ in well-made cocoons of peat.

Light Surroundings.

Experiment IV.

White paper floor & roof, with lumps of chalk scattered on former.

Cylinder as in I.

Larvæ of "first lot," except two.

May 17.—1 darkest of the large larvæ and 4 of the darkest small ones introduced.

May 24, morning.—A careful comparison of the I., II., IV. & V. was made, all the larvæ being placed on white paper, with the light falling on the same side of them from the same direction. There were no decided effects to be recognised, but *perhaps* those upon the chalk had become somewhat greyer, and those in dark surroundings a little browner.

2 escaped, and were replaced next day by 2 dark varieties of the "second lot." Fed from this date on rock-rose alone.

June 22.—1 had spun cocoon under chalk lump, 1 dead.

June 27.—Larva in cocoon had pupated.

July 7.—1 dead, 1 spun slight cocoon.

July 15.—2 pupæ & 1 larva in cocoon.

Aug. 3.—1 moth emerged.

Sept. 4.—Another moth had emerged.

Experiment V.

Arranged as in IV.

Larvæ of "first lot," except one.

May 17.—1 intermediate large and 4 intermediate small introduced.

May 24.—1 escaped, but another was added the following day—a dark larva from the "second lot."

July 7.—1 larva in a cocoon had just pupated; 3 died about this time.

Aug. 14.—1 moth emerged.

Sept. 1.—Another moth had emerged.

Experiment VI.

Arranged as in IV.

Offered rock-rose alone until June 23, after which nothing was eaten.

Larvæ of "second lot."

May 25.—7 out of the 10 darkest larvæ introduced.

June 13.—1 had spun a slight cocoon under a lump of chalk.

July 15.—1 had pupated without cocoon.

Aug. 27.—4 pupæ; the 3 other larvæ had died.

Sept. 4.—1 moth emerged. The other pupæ died.

Experiment VII. Dark Surroundings throughout; for comparison.	Experiment VIII. Dark Surroundings, then light.	Experiment IX. Dark Surroundings throughout; for comparison.	Experiment X. Dark Surroundings, then light.	Experiment XI. Dark Surroundings, then light.
May 31. — 5 cocoons transferred to another case, with peat and coal resting on black paper. Larvæ still lively, and some quitted cocoons as a result of the disturbance; on June 5 4 were in cocoons, but on 13th and later only 2. One had pupated recently on June 22, and was removed to chalk and white paper (X.). *June* 27. — 1 more pupated, and 3 lying in peat. *Aug.* 7.—1 moth emerged.	*May* 31.—5 cocoons similarly transferred to chalk on white paper. All quitted cocoons; by Aug. 27 all had died without pupating.	*June* 22. — 2 cocoons removed and placed in fresh dark surroundings, as in VII.; on June 27, 1 was in cocoon, and had pupated July 7. The other larva made cocoon, and pupated later, 1 moth had emerged Aug. 26, and another Sept. 4.	*June* 22.—1 pupa transferred and placed as in VIII. amid white surroundings. The pupa was evidently freshly formed: also the freshly formed pupa from VII. was transferred here at the same date. *July* 8.—Opaque appearance of wings showed that imagos were developing. The moths emerged Aug. 3rd and 6th.	*June* 22.—2 cocoons removed and placed as in X. Both died without pupating.
The comparison between the results of VII. and VIII. was intended to test the susceptibility of the pupal stage and prepupational period of larvæ, as contrasted with these periods plus a considerable part of later larval life.		The comparison between IX. and XI. was similar to that between VII. and VIII. In X. the susceptibility of pupal stage alone was tested.		

It has already been stated that there was not sufficient evidence that the colours of the larvæ were modified by the conditions of the experiments.

The colour of silk was variable, being sometimes white and sometimes brown, but there was no evidence for the existence of any power of adjustment. Adventitious particles were so freely used as to render the cocoon very hard to detect. In soft peat the larvæ made their cocoons at some considerable depth, but they also freely spun among loose blocks of chalk on the surface.

The imagines, when carefully compared on a white background, showed not the least tendency towards colour-variation in accordance with the environments which had been employed. Indeed they were, for this species, remarkably uniform, being light grey forms, but none of them extremely white, like the var. *pullata*.

It is clear that there is no susceptibility during the period over which the experiments extended. Either the period was not long enough, or the species is not sensitive in this way. If the latter be the true explanation, it is probable that the local races are to be accounted for by natural selection, the lighter varieties being more conspicuous, and therefore exterminated, in peaty districts, and the darker ones on chalk. Before seriously considering this suggestion, I should much like to repeat the experiments, keeping up the conditions for nearly the whole life of the larvæ. In the *Ephyridæ* we meet with pupæ the colours of which are determined by those of the larvæ. It is conceivable that, in this case, the colours of the larvæ may be modified by environment acting in the usual way during the early stages, and that the imaginal colours may follow those of the larvæ. I should also very much like to know the result of exposing the pupæ to different temperatures, as in Mr. Merrifield's most interesting researches.

F. Conclusions.

1. *The light which effects the chief colour-changes in larvæ and pupæ.*—Great interest attaches to the attempt to define the light rays which constitute the stimulus leading to the colour-changes. Of these we must distinguish two main kinds: (*a*) changes in the colour of

the true animal pigments, leading to various shades of brown, grey, &c.; (*b*) the change to a green colour modified from plant pigments in the food. When such a change of colour is possible, the true pigments are always superficial to the green, and cannot be retained without concealing the latter, the degree of concealment depending on the amount and distribution of pigment. Thus in *A. betularia* the true pigments are chiefly placed in the epidermic cells, the green in the subjacent fat, while in many others the former are in the superficial layer of the cuticle, the latter in the blood or sometimes in the lower layers of the cuticle. But the appearance of the green is not merely the removal of a screen, although this must occur; in some cases, at any rate, it also means the formation of the green colouring matter itself.

In discussing the effects of light it will be important, therefore, to discriminate between (*a*) modifications of true pigment; (*b*) its disappearance, accompanied by a change to green.

I propose to tabulate all the coloured backgrounds made use of in these experiments, and briefly to compare their effects on the species subjected to them in 1886 and in subsequent years. We shall thus be able to form a sound conclusion as to the constituents of a mixed reflected light (like that from leaves) which effect the change, and as to the existence of any common susceptibility on the part of such Lepidoptera to light from a particular part of the spectrum.

I wish to express my warm thanks to my friend Sir John Conroy for his great kindness in helping me to make an accurate statement of the quality of the light reflected from backgrounds and transmitted through screens. His well-known researches in this region of physics rendered his kind assistance invaluable.

The method we employed with the backgrounds was as follows:—The spectrum of lime-light, obtained by the use of a bisulphide of carbon prism, was projected on a white paper screen. The coloured backgrounds were then held so as partly to cover the spectrum, when the rays absorbed and reflected could be determined by comparing the covered with the uncovered part. In many cases, two backgrounds were placed in the spectrum together so that they could be accurately compared.

The effect of the screens upon the backgrounds was easily determined by comparing the effect upon the latter when the former was interposed in the path of the light on its way to the prism, with that of its withdrawal.

The reflecting power of the backgrounds having been thus determined, a few days later the whole process was repeated, and the second set of observations compared with the first. In most cases they agreed: when they did not, we made a third observation. These determinations were made in the laboratory of Balliol College, Oxford.

I propose to consider the backgrounds in the following order:—(1) Dark surfaces, such as black and brown, reflecting very faintly, but from every part or many parts of the spectrum; (2) coloured surfaces, chiefly reflecting particular rays: these will be considered in the order of the spectrum from red to blue; (3) white or bright surfaces (white or metallic), reflecting strongly from the whole of the spectrum.

(*See Table, pages* 461, 462, 463, 464.)

These results all combine to prove the validity of the suggestion made in my earlier paper, that rays from the yellow and orange part of the spectrum are effective in dismissing pigment, and favouring green (or bright) larvæ and pupæ. It seems tolerably certain that it is the yellow and orange rays which, reflected from leaves and shoots, stimulate the larvæ and pupæ to become green. It is shown above that if a red background be offered, pupæ become dark; but if an orange surface be substituted, only differing in reflecting an additional narrow strip of the spectrum, but in that strip including orange and yellow rays, both larvæ and pupæ are strongly influenced in the direction of green, although there is hardly any green in the light which reaches them. I attach less weight to the evidence from yellow backgrounds, because they reflect so much of the spectrum. But the evidence from the green backgrounds is the strongest of all. If the above argument holds good, artificial greens which are strong in the yellow and orange ought to act like leaves and shoots, while those which are weak in this part, although as greens they may be extremely bright, ought to produce dark larvæ

Light reflected from backgrounds.	Effects produced.					
	Larvæ.			Pupæ.		
	Amphidasis betularia.	Other sensitive larvæ.	*Vanessa urticæ*, 1886 and later.	*Vanessa io.*	*Pieris brassicæ* and *P. rapæ*, 1886 and 1888.	Other pupæ.
Black paper. Very faint continuous spectrum. It is probably this faint reflection, not stronger in one part of spectrum than another, which acts as the stimulus and accounts for the difference, which is usually very great, between darkness and black surfaces in strong light, the latter causing the more powerful effects. A dead or varnished surface produces the same results. The dark twigs also made use of may be safely included here.	Dark larvæ: blackness varying with that of background.	Dark larvæ.	Dark pupæ.	Dark pupæ.	Dark pupæ.	Dark pupæ.
Light brown tissue-paper on a background of white paper (LXIII.). Strong general absorption, least in red, becoming almost complete in blue.				Dark pupæ.	Dark pupæ.	
Brown twigs. Very similar to the above, except that no blue is reflected.	Brown larvæ.					
Deep red paper. Only one shade used. Spectrum reduced to red, which is but slightly dimmed. Compared with orange (below), it differs in the absorption of parts about solar line D, and above it.				Dark pupæ.	Dark pupæ.	
Deep orange paper. The only orange paper used. Absorption begins a little above line D, removing nearly all green and everything else. All below D reflected.	Green larvæ.			Green pupæ.	Green pupæ.	
Orange enamel (painted on twigs). Red, orange, and yellow reflected, the rest absorbed. Very similar to spectrum of orange paper, but a little shorter.	Green larvæ.					

Light reflected from backgrounds.	Effects produced.					
	Larvæ.		Pupæ.			
	Amphidasis betularia.	Other sensitive larvæ.	*Vanessa urticæ*, 1886 and later.	*Vanessa io.*	*Pieris brassicæ* and *P. rapæ*, 1886 and 1888.	Other pupæ.
Pale yellow paper. Whole of the blue and very little of the more refrangible end of the green very faint. All the rest as bright as with white paper (LV., LXVIII.; also *Pieridæ* in 1886).				Green pupæ.	Green & intermediate pupæ.	
Bright yellow tissue-paper on a background of white paper. As above, except that the blue and end of green are completely absorbed (LVI.).				Green pupæ.	Green pupæ of *P. rapæ* (Griffiths).	
Bright yellow opaque paper, somewhat deeper and more orange in tint than the last. No perceptible difference in the spectrum. Made into spills; placed in a clear glass lamp-shade.				Green pupæ.		Light & brilliant pupæ of *V. atalanta.*
Green leaves and shoots of living plants. The red and blue rays are much absorbed, but, in the small thickness traversed by the reflected light, the orange and yellow little, and the green hardly at all.	Green larvæ (in nature & in experiments).	Light brown larvæ: greenish brown or green in *Rumia cratægata* (experiment).	Healthy brilliant pupæ (sometimes found in nature).	Green pupæ (in nature).	Green pupæ (in nature); also of *P. napi* (Merrifield).	*V. polychloros* said to be light reddish brown, with metallic spots.
Bright yellowish green tissue-paper (faded). Blue much absorbed, green hardly at all, the rest but little (much in the unfaded paper. LXIX., LXX.; also *Pieridæ*, 1886).			Irregular results: paper in part unfaded; also considerable crowding	Green pupæ.	Green & intermediate pupæ. (Uncertain how far paper was faded).	
Light green enamel (painted on twigs). Green bright; red, orange, and yellow but little absorbed. Blue wanting.	Green larvæ (not very bright).					

Light reflected from backgrounds.	Effects produced.					
	Larvæ.		Pupæ.			
	Amphidasis betularia.	Other sensitive larvæ.	*Vanessa urticæ*, 1886 and later.	*Vanessa io.*	*Pieris brassicæ* and *P. rapæ*, 1886 and 1888.	Other pupæ.
Bright green paper (arsenite of copper). Considerable absorption of red, orange, and yellow, very slight of green; extreme blue absent and the rest dimmed (LVII. and spills).	Light brown & greenish larvæ (probably poisoned by the pigment)			Darkish pupæ.		
Pale bluish green paper. The same paper, rendered paler (probably as the effect of damp), was used with the experiments on *Pieridæ* in 1886. The spectrum, as described in Phil. Trans. (1887, B, p. 430), is very similar.					Dark pupæ, *P. brassicæ;* intermediate *P. rapæ.*	
Dark green enamel (painted on twigs). Red, orange, and yellow darkened, blue wanting; slight absorption of green.	Darkish larvæ predominate.					
Dark dull green paper. Some general absorption, least in green, most in blue, considerable in yellow, orange, and red (LVIII.).				Dark pupæ.	Dark pupæ (*P. brassicæ*).	
Very pale blue tissue-paper, on a background of white paper. Some slight absorption of red, yellow, and orange; the rest of spectrum unchanged (LIX.)				Green pupæ, but not the greenest.	Dark & intermediate pupæ.	
Light blue paper. All blue unabsorbed, and all other parts considerably weakened, but much less so than below (LX.).				Dark pupæ.	Darkish pupæ (*P. brassicæ*)	
Deep blue paper. Great absorption of all except blue (LXI., blue spills).	Dark larvæ.			Dark pupæ.	Dark pupæ (*P. brassicæ*)	

Light reflected from backgrounds.	Effects produced.					
	Larvæ.		Pupæ.			
	Amphidasis betularia.	Other sensitive larvæ.	*Vanessa urticæ*, 1886 and later.	*Vanessa io.*	*Pieris brassicæ* and *P. rapæ*, 1886 and 1888.	Other pupæ.
Darkest blue paper. Very great absorption of all except blue, which was slightly absorbed (LXII., blue spills).	Uniformly very dark larvæ: a deep purplish brown.			Dark pupæ.	Darkish pupæ (*P. rapæ*, 1886).	
White metallic surfaces of tin and silver. These give a strong, continuous spectrum, but the light is reflected regularly, and not much diffused.			Tend to produce light and brilliant pupæ, but not so much as below.	Tend to produce green pupæ, but not nearly so much as below.		*V. atalanta.* Produce light and brilliant pupæ, but not so much as below.
Yellow metallic surface of brass ("gilt") also appears to give a strong, continuous spectrum, but the yellow colour is due to the absorption of blue. Reflect regularly as above. More effect is produced when there is increased diffusion, owing to the surface being irregular.			Produces the lightest and most brilliant pupæ.	Tends very strongly to produce green pupæ.		*V. polychloros*, *V. atalanta.* Produces the lightest and most brilliant pupæ.
White opal glass. Gives a strong, continuous spectrum; the light is diffused.			Tends strongly to produce light and brilliant pupæ.	Tends strongly to produce green pupæ.		*V. atalanta.* Produces the lightest and most brilliant pupæ.
White paper. Spectrum as above.	White larvæ.		As above.	As above.	Light or green pupæ.	*Argynnis paphia.* Very light pupæ (no change in brilliancy).

and pupæ. And this is what has been found to occur. I attach great importance to the colour of copper arsenite in this respect. I hope to try it again on a larger scale, covering it with varnish so as, if possible, to prevent any poisonous effect.

The larvæ and pupæ are probably sensitive to diffused rather than regularly reflected light, the strong effect of "gilt" being explained by its absorption of blue rays, and the consequent greater prominence of yellow, as well as by its power of returning so high a proportion of the light which falls on it. Silver and tin with this same power, but without that selective absorption which gives prominence to yellow, exert a far inferior influence upon these insects. The effect of white paper and opal glass is easily explained on the principles laid down above.

I have hitherto only considered the production of green or bright pupæ and larvæ. But the table of backgrounds at once proves that the case is far more complex in certain species, and notably in *Amphidasis betularia*. These larvæ behave like the pupæ as regards green, black, and orange backgrounds, but entirely differently as regards brown, white, and, to some extent, deep blue. These do not make the larvæ green, but produce a special form of true pigment, in two cases corresponding to the coloured surface which emitted the rays forming the stimulus. It cannot be doubted that these effects also follow from the constitution of the diffused light reflected from the background (see also pp. 353, 356, 359).

The same contention is true of *R. cratægata*, the true pigments of which can certainly be modified, as well as dismissed (see p. 326), and probably of all sensitive larvæ; for it is unlikely that the great difference between the dark and light browns is only a question of quantity of pigment.

We are justified in concluding that a larva of a species which possesses this power of adjustment (as regards pupa or larva) is effected, during the sensitive period, by certain constituents of the diffused light reflected from surfaces in its *immediate* neighbourhood, diluted as it is by other constituents, and far more by the direct white light which falls on every part of its surface. It is sensitive to this very small proportion of effective rays, and can, as a response to the stimulus, produce true pigment, or dismiss it and become green, or in some cases can alter the constitution of the former so as to produce a variety of tints, each of which is more or less appropriate to some form of natural environment.

The use of coloured screens obviously alters the case entirely, for the larval surface is thus exposed to far more concentrated rays from certain parts of the spectrum.

The screens employed were kindly described for me by Sir John Conroy. I quote his determinations below:—

Red gelatine. — "Transmitted light. Red. The absorption begins abruptly on the less refrangible side of D at about a wave-length of 604, and extends through the remainder of the spectrum."—Receptacle LXXII. (see G, Appendix).

Although the light was thus a very pure red, the larvæ of *V. io* formed distinct green pupæ when exposed to it upon a reflecting background. In this concentrated form, red rays have the power only possessed by yellow and orange under more normal conditions.

Red glass.—"Transmitted light. Red and some yellow, together with a little green and a trace of blue. Light of wave-lengths between about 589 (D) and 559 strongly absorbed."—Receptacles LXXI., LXXII. (at one time), LXXV.

Green pupæ of *V. io* were similarly formed beneath this screen, and much lighter pupæ of *P. brassicæ* than those usually produced by a red background.

Yellow glass.—"Transmitted light. Red, yellow, and green. Slight general absorption of the red, yellow and green, and strong absorption of all the blue rays."——Receptacles LXXVIII. to LXXXI., and LXXVI.

Green pupæ of *V. io* were similarly formed, and intermediate or light pupæ of *P. brassicæ.* When the background reflected hardly any of the transmitted light, the pupæ of the latter were darker.

Green gelatine.—"Transmitted light. Red, yellow, and green. Some general absorption through red, yellow and green, and strong absorption of rays of wave-length greater than 462."—Receptacle LXXIII.

Green pupæ of *V. io* were similarly formed.

Green glass.—"Transmitted light. Some red, yellow, and green. Light of wave-length greater than 605 and less than 501 strongly absorbed. The rays between 605 and 576 considerably absorbed."—Receptacles LXXXII. to LXXXV.

Results with *P. brassicæ* much the same as with the yellow glass, but more irregular, and on the whole darker.

Green glass.—"Transmitted light. Green. Light of wave-length greater than 572 and less than 517 strongly absorbed."—Receptacle LXXVII.

Pupæ of *V. io* formed upon a reflecting background behind this screen, which is far more complete than the last, were uniformly green. Pupæ of *V. urticæ* formed behind it upon a feebly reflecting background were dark. Pupæ of *P. brassicæ* under the former conditions were intermediate.

Pale blue glass.—"Transmitted light. Some red and yellow, the yellow-green, and most of the blue. The extreme red below 645 absorbed, a faint absorption-band from 605 to 584, and a slight continuous absorption above 548."—Receptacles LXXXVI. to LXXXIX.

When in front of backgrounds which reflected all transmitted light, except the blue, intermediate pupæ were produced; when with a background which reflected only the red, the pupæ were much darker.

Blue gelatine. — "Transmitted light. Some red, and the yellow-green and blue. Slight general absorption of the red, and an ill-defined dark band from about 608 to 578."—Receptacle LXXIV.

Intermediate pupæ of *V. io* were formed behind this screen.

Blue cobalt glass.—"Transmitted light. The extreme red; yellow-green; a small amount of green, and the blue. Strong absorption of light of wave-length between 702 and 576, and also of wave-length greater than 553; the upper limit of this strong absorption too ill-defined to be measured."—Receptacles XCI. to XCIV.

With certain exceptions, dark pupæ of *P. brassicæ* were formed behind this blue screen upon reflecting and non-reflecting backgrounds alike.

Blue cobalt glass.—"Very similar to the above, but it transmits rather more light."—Receptacle XC. Receptacle LXXIII. was (at one time) covered with this glass, or that last described.

Same effects upon *P. brassicæ.*

The results, upon the whole, supported the argument already given. *V. io* is evidently far more sensitive than *P. brassicæ*, and I greatly regret that so few of the latter were subjected to the conditions described above.

On the whole it is probable that, when the direct white light is cut off by a screen, and in some cases the mixed reflected light reduced by the same means, the larvæ, when resting on reflecting surfaces, are sensitive to a larger part of the spectrum, comprising the red on the one side, and the green on the other, but not the blue.

In talking the matter over with Sir John Conroy, he suggested that the heating effects of the rays may have something to do with their power; for he informed me that the usual opinion as to the superior heating properties of the red and ultra-red rays is mistaken, and only holds for dispersed light, when the smaller refrangibility of these rays leads to crowding in a given area. Under the conditions of these experiments, he tells me that the yellow rays possess the greatest heating power.

But if it were a question of temperature, it is very difficult to understand why the effects of reflected light are not completely subdued by those of direct light. Nor is there any evidence that accessory conditions which must *greatly* affect the temperature of the larvæ, such as the amount of sunshine, have any influence upon the result. Upon the whole it appears far more probable that nerve-terminations in the skin are directly affected by the radiant energy, and, in most cases, are especially sensitive to those vibrations which appear to affect animal life most powerfully.

Some conclusions from the experiments on larvæ.— I have here brought together some of the chief results of the shorter experiments.

Regularly dimorphic forms, with intermediate varieties rare or wanting, are never, as far as our present knowledge extends, susceptible to surrounding colours, while variable species tend to be so. In this respect *Geometra papilionaria* is very interesting, being susceptible when variable during its youth, but not in advanced stages, when it is dimorphic. Among the *Geometræ*, so many of which are strongly susceptible, we meet with well-marked dimorphism in the genus *Ephyra*, which is apparently not affected by surroundings.

Noctuæ are far less sensitive than *Geometræ*, both in relative numbers and in the effect produced in the most marked cases. The most susceptible *Noctuæ*, the *Catocalidæ*, are purely arboreal forms, like the majority of

Geometræ, and specialised, like the latter, for concealment among twigs and on bark. It was the knowledge of this specialisation which led me to test for that further protection which is afforded by the power of colour-change.

The other larvæ (*Smerinthus, Sphinx, Aglia*) which I have tested are very inferior to the genus *Catocala* in this respect, but from what Col. Swinhoe tells me, it is evident that some of the Indian *Sphingidæ* are highly susceptible.

There may be a most extraordinary fluctuation in the amount of susceptibility within the limits of the same genus (*Catocala*, and in the pupæ of *Papilio*).

In *Geometræ* alone have distinct green larvæ been produced by these experiments. Probably the great majority of these larvæ are sensitive. Out of 11 species, many of which were selected at random, all but one have proved to be so.

There is no evidence that the results acquired by one generation can be transmitted to the next (*Rumia, Crocallis*). The susceptibility is essentially an adaptation to the fact that the individuals of each such species are liable to find themselves in different environments, so that any bias from the experiences of the past would of course be injurious, unless the earlier and later surroundings happened to correspond.

In the case of *R. cratægata* the test for hereditary effects was as complete as it could be in one generation.

Concerning the time which is necessary before the colour-changes begin to appear—

Some effect	was	produced in	8	days in young	*G. papilionaria.*
,,	,,	,,	8	,,	*C. electa.*
Much	,,	,,	12	,,	*C. elinguaria.*
,,	,,	,,	14 about	,,	*M. montanata.*
,,	,,	,,	11 ,,	,,	*C. elocata.*
,,	,,	,,	13 (or less)	,,	*H. abruptaria.*
,,	,,	,,	17	,,	*R. cratægata.*
,,	,,	,,	8	,,	*A. betularia.*

When carefully watched for, the changes are sometimes seen to occur quite suddenly (*C. elinguaria, R. cratægata*, 1886, II.).

The effects cannot be reversed by reversing the surroundings for a short time (*C. elinguaria, H. abruptaria, A. betularia*).

When the conditions are uniform, the response to environment does not necessarily destroy individual variability, but the most powerful forms of environment, when applied to highly sensitive species, very nearly do away with it.

If the environment be mixed, there does not appear to be any instinctive knowledge leading the larvæ to rest only on appropriate objects. Thus, if they have become green, and are beyond the power of change, they will nevertheless rest on brown twigs in preference to leaves, if offered to them.

The instinct of these *Geometræ* is to rest upon twigs under any circumstances, and this is probably the reason why so small a proportion of twigs produces so great an effect (*A. betularia*, 1889). Contact, or at all events the closest proximity, is required to effect the change. Although they are so much more susceptible to brown surroundings when these are mixed with green, there were *no* exceptions among 105 larvæ which in 1889 became green among leaves and shoots.

The effects produced on the larvæ do not influence the colours of the moths (*A. betularia*).

Darkness does not produce so great an effect as black surroundings in strong light (*A. betularia, R. cratægata, C. elinguaria*). Overcrowding tends to produce dark larvæ (*A. betularia, R. cratægata*).

In the case of *R. cratægata* and *A. betularia*, there is direct evidence of the power being efficient in concealing the wild larvæ.

The larvæ are probably chiefly sensitive at the time when they quit the leaves and first begin to rest on the twigs.

The protective significance of the colour changes.—Looking at the results here recorded, as a whole, there can be no doubt about these changes being such as to promote concealment. In the majority of the larvæ the only possible change appears to be from dark to light brown or greenish brown. But the latter are far less conspicuous on the leaves than the dark varieties would have been, although they are not nearly so well concealed as the latter upon the dark twigs. When the larvæ of any one of these species hatch upon a tree, or part of a tree, with a great abundance of young green shoots, their susceptibility would certainly lead them in the direction of concealment. It by no means follows that the power is useless in certain species because it leads to more perfect results in others. Concerning the latter, no one who has once seen the larvæ of *A. betularia* or *R. cratægata* upon their food-plants in the field, can doubt about the meaning of the changes in colour which they undergo.

The pupæ of many species have now been tested, and only in the case of one of them (*V. urticæ*) has any doubt been expressed as to the efficiency of the change in promoting concealment. The cases of *Vanessa io* and the *Pieridæ* (including *P. napi*) are nearly as clear as those of *A. betularia* and *R. cratægata*, and the same may be said of a few S. African species tested by Mrs. M. E. Barber, Mr. Roland Trimen, and Mr. Mansel Weale. The changes of *Vanessa atalanta* and *V. polychloros* certainly lead in the same direction; and there is not that excessive development of the golden appearance in the lighter forms which, in *V. urticæ*, is thought by some to be a conclusive argument against the protective significance of the change.

In *Argynnis paphia* we have a very interesting case. There can be no doubt about the change being strongly in the direction of concealment, but the metallic spots (which are not very large) are equally present in both dark and light pupæ. The ancestral relationship of the *Argynnidæ* to the *Vanessidæ*, as shown by Dr. Dixey in the comparison of the wing markings, suggests the possibility that the metallic spots are an ancestral feature of both pupæ which can be removed from the darker forms of *Vanessidæ*, but remain in the lighter ones, while they persist in both varieties of at least one species of *Argynnis*. In this respect it is interesting to note that the position of each metallic spot can generally be detected by its lighter colour in the dark pupæ of such species as *V. polychloros* or *V. atalanta*.

I must now consider the case of *V. urticæ* at greater length, because of the arguments brought forward by Mr. Bateson in a recent paper (Trans. Ent. Soc., Lond., 1892, pp. 212, 213).

This writer, in the first place, attempts to cut away the foundation of an interpretation based on natural selection, by arguing that there is no struggle for existence during the pupal stage of this species.

It is interesting to note the antagonistic objections which Mr. Bateson and Mr. Beddard urge against the protective efficiency of colouring, the one holding that enemies are purely imaginary, and the other that they are so supremely successful that no concealment is of avail against them.

No one feels more keenly than I the truth which Darwin so constantly urges in his letters, that we are profoundly ignorant of the conditions of existence of almost every organism. But Darwin never used this ignorance as grounds for the assumption that enemies are "imaginary" for any part of the life of any animal. He rather felt that the enemies were apt to be underestimated than over-estimated. I have great hope that this part of the evidence for natural selection will be tested as severely as possible by those who believe in the doctrine; for there seems to be little chance of such work being forthcoming from those who attempt to depreciate it. It is very much easier to assume that enemies are imaginary than set about a searching enquiry into the conditions of existence as they affect any one animal. But such expressions of opinion have their value in stimulating those who consider them to be eminently unscientific to obtain direct evidence.

I have for a long time wished to undertake such an investigation myself, but one man alone cannot do much, especially in the vast field of observation which must be covered in order to obtain adequate direct evidence. This paper and my other works are an indication that I have not been idle. In the hope that others may be induced to work at the subject, I will therefore mention some lines which I think would lead to useful results.

Larvæ of such species as *A. betularia* might be liberated upon plants which harmonize and upon others which do not harmonize with their colour. Only one larva should be placed on each branch, not many branches on the same tree should be employed, and the trees should be widely separated. The larvæ might be liberated at the last ecdysis, so that their colours would remain nearly constant. They should be observed and noted twice a day. If they disappeared at once, allowance would have to be made for wandering, but if they settled down on the branch, there would be no reason for suspecting them of this.

Pupæ may be observed more satisfactorily. Large stones could be placed in a case with a *few* mature larvæ, and when two or three (not more) pupæ were suspended to each, the stones could be removed to the borders of some wood or field and noted twice a day. This would be a fairer test than a garden. In this way the pupæ would be accessible to such probable enemies as insectivora and rodents. In other comparison experiments light pupæ could be fixed to dark stones and *vice versâ*. This test could be satisfactorily applied to many species, and other objects made use of as well as stones.

With regard to imagines, we first require to find where many of them conceal themselves at night and in rainy weather. This could be accomplished by tracking the butterflies at dusk, marking the spot where they finally come to rest, and again examining it at night with a lantern. Butterflies bred in confinement could then be placed at night in natural and unnatural situations, observed in half an hour to see whether they had moved, and again observed and noted in the morning before they begin to fly. The same kind of observation could be made with hybernating species.

In the meantime, however, there is some very strong indirect evidence which is worthy of attention. Assuming that a female *V. urticæ* lays 300 eggs, every pair of butterflies would be represented by 300 offspring in the next generation, were it not for the deaths which ensue at some period of development. Owing to this cause, however, we know that, on the average, they only produce 2 mature offspring to take their place, and themselves become parents. The extinction of 298 out of 300 means a severe struggle for existence, and does not support the assumption of "imaginary" enemies during any stage or in any week, especially when we remember that there are two or more generations in a year. And, contrary to the commonly received opinion, I should maintain that extinction is least during the first of the three stages. The larvæ are perfectly exposed and obvious during their whole lives, and we know their conditions fairly well; of the pupæ, in nature, and the imagines, when concealed, we know comparatively little. The larvæ have been proved to be distasteful to certain insect-eating animals, and the persistence of large colonies through the whole of larval life proves that they are not subject to much extermination from this cause. Their chief foes at this period are dipterous and hymenopterous parasites, but the deaths are not nearly so numerous as might be inferred from Mr. Bateson's experience. In 1886 I experimented on 700 larvæ belonging to many colonies (the exact numbers can be ascertained in my paper, Phil. Trans., *l.c.*), and in 1888 upon the many hundred larvæ tabulated in this memoir; but I am quite sure that the deaths from this cause did not come to anything like 10 per cent. The *Tachina* larvæ nearly always emerge before the *Vanessa* pupates, and are quite obvious, together with the dead or dying larvæ. The proportion of deaths in *V. io* was not widely different.

There are great differences between the colonies in this respect, as is well shown by Mr. Bateson's experience of 5 or 6 deaths to 1 survival. It would be very interesting to observe whether there are any individual differences in the methods employed by these larvæ in keeping off their insect foes, so as perhaps partially to explain why some colonies are almost swept away, while others are nearly untouched. I hasten to anticipate Mr. Bateson's objection by stating that this suggestion is not intended as a "basis for argument," but as a stimulus to observation. Everyone who has observed these larvæ must have noticed the twitching of the wild larvæ when disturbed, and how readily the movement becomes concerted and common to a whole detachment of a colony. This is probably one of their methods of defence against such foes.

The numerical argument alone drives us to the two remaining stages for the chief extermination, and it is impossible, on these grounds alone, to admit that the pupal stage, short as it is, can escape.

Mr. Bateson considers that the theory of the protective significance of colour has only been "applied to the case of these pupæ by an indiscriminate extension of deductions made in other cases fairly enough, as, for example, in that of the larvæ of *A. betularia.*" And yet we can only suppose that these latter are large enough to be the prey of insect-eating vertebrates for about the length of the pupal period of the *Vanessa;* and, as for concealment, the latter would be far more perfectly hidden were it not for walls and palings, which are not a strictly natural environment.

When we also remember that, wherever they pupate in a natural environment, it is almost certainly within reach of small insectivorous or omnivorous mammals, which can hardly have the chance of reaching the larvæ of *betularia*, we are led to connect their more complete concealment with their greater dangers. In speaking of "more complete concealment," I refer to the result, however brought about,—to the instinct which leads them to scatter and hide we hardly know where, as well as to the colour and shape.

Mr. Bateson states that he would have been less surprised if the golden pupæ of *V. urticæ* had been brought forward as examples of warning than of protective coloration. But the most prominent feature of the latter is the habit of adopting a conspicuous position or attitude; for this, even more than the colour, displays the organism to its enemies. In the pupæ of *Euplœa core* we probably have an example in which the metallic appearance has this significance, but it is always freely exposed, and, as Mr. Minchin tells me, most conspicuous, and can be seen from a great distance. It is impossible to say this of *V. urticæ* as it occurs in nature. Again, I have experimented with *V. urticæ*, and find that the most fastidious of all insect-eating animals I have come across, a marmoset, devoured the golden varieties, one after the other, with the greatest relish.

Mr. Bateson argues that the golden varieties cannot be protective because they are conspicuous against certain artificial backgrounds, which nevertheless stimulate their production. It is strange that he should have employed such an argument, considering that I showed, in 1887, strong reason for believing that only *some* of the constituents of the reflected light are effective in the production of the far more perfectly concealed green pupæ of *Pieridæ*. If the yellow constituent of the light reflected from leaves is proved to be efficient rather than the green, it by no means follows that the power is not directed towards concealment, because yellow backgrounds are effective in producing green pupæ.

The same argument would deny any "'attempt' on the part of the animal to approximate to the colour of its surroundings" to the larvæ of *A. betularia*, and the pupæ of *V. io* and the *Pieridæ*, because all these become bright green against orange backgrounds. And yet Mr. Bateson admits such an "attempt" on the part of *betularia* (*l.c.*; p. 212).

Mr. Bateson fails to apprehend that if the pupæ *had* resembled the various artificial backgrounds, it would have been the strongest blow against the theory of the protective significance of the change. We can hardly imagine the production, under the theory of natural selection, of adaptation to surroundings which had never before been met with in the life of the species, and it would be clear that we had to deal with some other power. I have no prejudice against my own discoveries that I should seek to minimise them; but the chief reason why I have failed to see in them what some others have believed they have seen, *viz.*, the indications of some new power in the moulding of species, is because I have only been able to produce those changes which can be produced by a natural environment. Even the golden pupæ of *V. urticæ* form no exception; for healthy individuals are known to occur, although rarely, upon the leaves of nettles.*

Mr. Bateson does not seem to see that his opinion that the golden form is conspicuous is really at variance with his contention that the pupal susceptibility does not tend towards concealment; for, in nature, the susceptibility is chiefly employed in checking the production of this very form. Until my experiments, the golden pupæ were little known, except when diseased.

We have seen that the colour-changes of all species proved to be susceptible certainly tend towards concealment, *V. urticæ* being alone disputed; that the protective green and dark forms of *V. io* certainly correspond physiologically to the gilded and dark forms of *V. urticæ*, while the dark forms of the latter are certainly protective; for the pupa would be dark on a

* Mr. Merrifield tells me that, during the last week of August, 1892, he found about 50 pupæ of *V. urticæ*, evidently belonging to one company, suspended to the stalks of nettles, or sometimes of other plants growing with them. All were entirely golden, and all produced ichneumons. A few days later Mr. Merrifield found a colony of over 200 nearly mature larvæ, and among them about a dozen pupæ, also on the nettle-stalks. These were equally golden, and about half produced imagos, the remainder being ichneumoned (one died from some unknown cause). See also Experiment 63, p. 382.

dark stone, and light on a light one. Which is the more improbable hypothesis,—that the light form, now nearly always withheld, originally possessed a protective significance like the dark form of the same species, and the corresponding light form of the nearly allied *V. io*,—or that one form of one species stands on an utterly different biological level from all the rest? I think it far more likely that "all zoological science will be thrown into confusion" by such gratuitous assumptions than by any attempt I have made to suggest, with all due caution, a possible environment in the past history of the species with which the golden form may have harmonised.

I still hold, and on far stronger grounds than formerly, that all the changes are, or were, in the direction of concealment; that the golden appearance applied chiefly to some former environment, or one which may still exist in other countries; that in one species (*V. io*) it has been almost replaced by the green variety, while it has been hidden by the habits of another (*V. atalanta*), and removed from the darkest forms of all *Vanessidæ;* that in *V. urticæ* it occasionally occurs on the natural food-plant, and is still protective, in that it is less conspicuous in this situation than the dark form would have been; but that the latter is so far more effective in promoting concealment that the larvæ have developed a strong instinct to wander, and are rarely found on the nettle-plants in the healthy state.

This whole question is considered by Mr. Bateson to be an "unprofitable field for study": he may have found it so; but any attempt to limit the investigations of others by the barrenness of his own experience, cannot be tolerated. It has been the guidance of this hypothesis of the protective value of the colour-changes which has chiefly directed me to seek the forms which are most suitable for the purposes of this enquiry, and to apply the most efficient experiments, and so to accumulate facts which have an interest far beyond their relation to the hypothesis itself.

G. APPENDIX.

An account of the various receptacles used in the experiments on pupæ. (C.)

In the experiments upon pupæ a great variety of receptacles was employed. Inasmuch as the crowding of the pupæ greatly affects their colour, it is necessary to give the approximate dimensions. A full description will now be given, in which each receptacle will be denominated by the number which represents it in the experiments described in the paper.

A. Black Surroundings.

I. A low wide glass cylinder, 1·86 decimetres diameter, ·91 high; lined inside with black tissue-paper (1 layer), and 2 layers for roof.

II. A very similar cylinder, 1·76 decimetres diameter, ·77 high; lined with 1 and covered with 2 thicknesses of black tissue-paper; roof, 2 thicknesses.

III. A very similar cylinder, 1·6 decimetres diameter, 1·0 high; lined and covered as in II.

These 3 cylinders were sometimes employed in strong light, being placed on their sides, and the open end closed by a sheet of clear glass. The upper part of the side then became the roof, and the paper roof a black background.

In other experiments they were used in darkness, being placed on their open ends on a floor of black tissue-paper. In many cases the darkness was rendered complete by a further covering of mats, rugs, &c., although it was tolerably complete when these were omitted.

IV. A tall glass cylinder, ·825 decimetres diameter, 1·79 high; lined inside for half the circumference with a single layer of black-tissue paper; roof, 2 layers of same.

This was always used in strong light, the clear half of the cylinder being turned towards the window.

V. A similar cylinder, with the black background fixed *outside* the glass, the roof consisting of a single layer of tissue-paper gummed on to a sheet of glass, which was turned glass-downwards on the open end of the cylinder.

This was always used in strong light, and it was employed to determine whether a black paper surface was as effective when separated from the larvæ by the thickness of the glass.

VI. A similar arrangement, with a domed cylinder, like those described below.

VII. This was one out of three compartments in a wooden box, measuring 3·3 decimetres high, 1·43 wide in front, 1·85 wide at back, 1·25 deep; lined throughout with black tissue-paper.

A clear glass sheet closed the front, and this was always turned towards a strong light.

The remaining black receptacles were always used in darkness, sometimes with the addition of rugs and mats, sometimes without. They were always placed open end downwards on a black tissue-paper floor, except when the larvæ were fed in them, and this was only very occasionally.

VIII. A cylinder similar to IV., covered with 2 layers of black tissue-paper, and a roof of the same.

IX. A smaller cylinder of the same kind, ·71 decimetres diameter, 1·53 high; covered and roofed as in VIII.

X. A cylinder, probably of the same size as IX., or perhaps IV., possibly domed like the succeeding ones. In any case, the covering was as in these.

XI., XII., XIII., XIV. These 4 cylinders were ·70 decimetres diameter, 1·98 high, with the upper end domed, so that the diameter was reduced to rather less than half that of the lower end. They were all covered with 2 layers of black tissue-paper, and had roofs of 2 or generally many more thicknesses.

XV. A wooden box, about 3 decimetres long, 2 wide, and 1½ deep; lined with black tissue-paper, and inverted on a floor of the same.

B. "Gilt" Surroundings.

The various so-called gilt papers employed were in all cases covered with "Dutch metal," a mixture of copper and zinc, the proportion of the former metal being very high. Three kinds of such gilt paper were employed:—(1) The metal had been applied in the form of "leaf," and bore a strong resemblance to true gold-leaf. The surface was very bright and golden, but was not highly polished. This was the only gilt-paper made use of in my earlier experiments, and erroneously described as "gold-leaf" in my paper (Phil. Trans., *l.c.*, p. 324). It will be spoken of as "Dutch leaf." (2) A very highly polished metallic surface, often tending to become tarnished and copper-like. This will be called "polished Dutch metal." (3) A very similar metallic surface, apparently not quite so brilliant, with an embossed pattern on it. This will be called "embossed Dutch metal."

I wish to express my thanks to Mr. W. W. Fisher and Mr. Walker for kindly analysing samples of these and the "silver" papers employed, in the Oxford University Laboratory.

XVI. A low wide cylinder, 2·38 decimetres diameter, 1·02 high; lined with embossed Dutch metal, and a roof the same. The external surface of cylinder and roof was covered with one layer of black tissue-paper, and this receptacle was sometimes used for testing the effect of gold surroundings in darkness. It was then covered with rugs, mats, &c.

At other times it was placed on its side, with the open end closed by a sheet of clear glass directed towards a strong light.

XVII. A very similar cylinder, 2·42 decimetres diameter, 1·16 high. Half the internal surface was lined with polished Dutch metal, and one open end closed by the same. When placed on its side the gilded surface was uppermost and formed a roof, while the covered end formed a background. When placed on its open end the latter formed the roof.

This and the succeeding gold receptacles were always used in a strong light, unless otherwise stated.

XVIII., XIX., XX., XXI., and XXII. Five small cylinders, all about 6·2 centimetres diameter, 8·4 high. They were always placed on the open end on a floor of white paper or polished Dutch metal. A polished Dutch metal roof sloped from the front part of the upper end to the back part of the lower end (in the position placed during use), so that little more than half the capacity of the cylinder was available for larvæ. The clear front of the cylinder was placed so as to face a strong light.

XXIII. A similar cylinder, lined in the same manner with Dutch leaf.

XXIV. and XXV. Two similar cylinders, also lined with Dutch leaf, but the roof sloped much less steeply from the front to a point about $\frac{2}{5}$ down the back of the cylinder in the case of XXIV., about $\frac{1}{5}$ in XXV., so that nearly the whole of the capacity was available (about $\frac{4}{5}$ in XXIV., and much more in XXV.). Below the level at which the roof joined the back, the latter was lined with the same gilt paper, extending round half the circumference of the cylinder.

XXVI. A rather taller cylinder (1·01 decimetres), of the same diameter. The sides were gilt two-thirds round, and the gilt paper brought together to form a ridged roof with very sloping sides, the ridge running from back to front. There were deep shadows in the higher part of the roof within the ridge, which was nearly 2 centimetres higher than the cylinder. About two-thirds of the capacity was available. Owing to the gilt lining extending so far round the cylinder, the clear front was reduced, and the gold surface much less illuminated than in the other small cylinders, XVIII. to XXV. The gilding was polished Dutch metal.

XXVII. A tall cylinder, the same dimensions as IV.; lined in the same manner as XXV., with embossed Dutch metal, so that nearly the whole capacity was available.

XXVIII. A similar cylinder, treated exactly like V., except that the black paper outside the glass was replaced by polished Dutch metal.

XXIX. A tin box, 2·35 decimetres long, 1·07 wide and deep; placed on end with glass sheet in front. There was a sloping roof, as in XVIII., so that about half capacity was available. On the floor and a small area of bottom of sides the bright tin surface was exposed, but the rest was gilt. The gilt paper was crumpled to make cavities and reflections in all directions. The gilding was embossed Dutch metal.

XXX. A large flat wooden box, about 3 decimetres high, 6½ wide, 6 centimetres deep; lined in upper part (standing on 1 long side) with polished Dutch metal, and a clear glass front.

This box was subsequently divided into 14 compartments, lined with various colours (see LIII. to LXVI.).

XXXI. Compartment of wooden box, 2·2 decimetres high, 1·14 wide, 1·06 deep; lined with polished Dutch metal (1888, with Dutch leaf in 1886 and 1887) everywhere, except the lower end which formed the floor, and this was covered with brown paper. The gold-paper back curved gradually into the roof and sides, and both roof and back were well crumpled. Nearly all the space available. Clear glass front.

XXXII. This was another compartment in the same wooden box which contained VII., 3·3 decimetres high, 1·4 wide in front, 1·2 wide at back, 1·25 decimetres deep. The roof sloped back at an angle of 45° to increase the illumination, and was "coffered" (12 recesses divided by ridges). There were 2 shelves on each side, flat above, making an angle of 45° with the side of the box below. The whole was lined with embossed Dutch metal, except the floor, which was covered with brown paper. Clear glass front.

XXXIII. The third compartment in the same wooden box, similar to XXXII., except that the lining was polished Dutch metal.

XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX. 6 out of 12 small compartments in a wooden box, each 9·2 centimetres high, 5·4 deep, and varying from 4·5 to 3·4 in width. All were lined throughout with gilt paper, XXXIV., XXXV., and XXXVI. being polished Dutch metal, and the other three partly of this and partly embossed Dutch metal. A single sheet of clear glass covered the front of these and the remaining 6 compartments.

C. Silver and Tin Surroundings.

The silver-paper employed was of two kinds:—(1) Covered with true silver, having a very bright, but not polished surface: this will be called "silver paper"; (2) covered with metallic tin. The surface was more polished than the silver, but not nearly equal to tin-plate. This will be spoken of as "tin-paper." In addition to these, boxes of tin-plate were employed, and will be spoken of merely as "tin boxes."

XL., XLI., XLII., XLIII., XLIV., XLV. The 6 remaining compartments of the same box, of the same dimensions, except that the narrowest was only 2·8 centimetres wide. XL. was lined with silver, and the rest with tin paper.

XLVI. The second compartment in the same box which contained XXXI. The dimensions and arrangements were the same, except that gilt paper was replaced by silver-paper. Previous to 1888 this compartment had been lined with Dutch leaf.

XLVII. A glass cylinder 1·69 decimetres diameter, and 1·60 high. About two-fifths of the circumference at the bottom was lined with silver paper, which widened to half the circumference at the top. The silver paper roof was domed, the summit extending nearly 1 decimetre above the top of the cylinder. All the silver-paper was well crumpled. In use, the cylinder was placed on a white paper floor, and the clear part of the circumference was turned towards a strong light. The silvered back was highly illuminated, but the inner part of the dome was in shadow, especially its upper part.

XLVIII. A low wide glass cylinder, 2·63 decimetres diameter, ·812 high. Arranged as in XVII., except that tin-paper was used, and was crumpled, and that roof and back passed gradually into each other. Nearly all space available.

XLIX. A bright tin box, similar to XXIX., except that it was not lined with paper, the surface of the tin-plate being used as an environment; another similar box was also employed in 1887.

D. White Surroundings.

L., LI. Two white "opal" glass gas globes, 1·78 decimetres high, placed, narrow opening upwards, on a sheet of white paper. The upper open end was provided with a white paper roof.

E. Clear Glass.

LII. Rectangular clear glass box about 2·6 decimetres high, and 1·6 square in section, with open end uppermost, and covered with clear sheet of glass. All angles and edges bound with black paper. Placed in strong light.

This was also used in the experiments on *G. obscurata*, when the clear glass roof was replaced by perforated zinc.

F. Surroundings of various colours.

LIII. to LXVI. 14 compartments of a wooden box, 12 of them 8·3 centimetres wide, 1·35 decimetres high, and 6·0 centimetres deep; 2 of them (LIII. and LXV.) were rather wider (9·1 centimetres), In the centre of the back of all, except LVII., LIX., and LXIV., a small cardboard box (8·7 centimetres high, 4 wide, and 1·7 deep) was fixed with its long axis vertical. In LVI., however, the box was 7·8 centimetres wide. Each box was covered with paper similar to that which lined the compartment in which it was contained. The object was to provide irregularities of surface in the shape of angles, shelves, &c. Clear glass sheets covered the whole box, which was turned towards a strong light. The colours of the compartments were as follows:—

LIII.	Deep red.	LX.	Light blue.
LIV.	Deep orange.	LXI.	Deep blue.
LV.	Pale yellow.	LXII.	Dark blue.
LVI.	Bright yellow (tissue-paper).	LXIII.	Light brown (tissue-paper).
LVII.	Bright green.	LXIV.	White.
LVIII.	Dark green.	LXV.	Black (dead).
LIX.	Very pale blue (tissue-paper).	LXVI.	Black (bright; varnished surface).

The colours of LIII., LIV., LV., and LXII., are figured in my previous paper on the colours of pupæ (Phil. Trans., *l. c.*, Plate 26, figs. 16, 17, 18, and 21). The colours of all, except LVI., LIX., and LXIII., were very opaque and uniform; those of the three compartments just mentioned, being produced by tissue-paper pasted on to white paper, were far less regular, and contained a much larger admixture of white light. This was especially the case in LIX., in which the white light greatly preponderated.

These compartments were used in the experiments on *Pieridæ*, as well as *Vanessidæ*.

LXVII. and LXVIII. 2 compartments of a wooden box, 1·08 decimetres wide, ·61 high, ·47 deep, covered in with a clear glass front.

LXVII. was lined throughout with deep orange paper, similar to LIV.

LXVIII. was lined throughout with pale yellow paper, similar to LV.

LXIX. A glass cylinder, 7·2 centimetres diameter, 1·57 decimetres high, covered with 1 thickness of faded yellowish green tissue-paper, and roof of same. Much white light passed through, as well as green. The paper was the same as that figured in Phil. Trans., *l. c.*, Plate 26, fig. 19.

LXX. A glass cylinder, about 1·1 decimetres high, and rather less diameter than LXIX. Similarly covered and roofed.

G. Light transmitted through Coloured Glass or Gelatine.

LXXI. A wooden box, 1·7 decimetres wide, 1·75 high, and ·6 deep, lined with white paper and covered with red glass ("flashed," *viz.*, a clear glass with a red surface).

Used for *Pieridæ* as well as *Vanessidæ*.

LXXII. to LXXVI. Five compartments of a wooden box; 3 of them 7·5 centimetres wide, 9·3 high, 4·8 deep.

Of these, LXXII. was covered with a sheet of red gelatine, the interior being plain light coloured wood. When the *Pieridæ* were experimented with, the interior was lined with deep orange paper, and the gelatine replaced by red glass, like that of LXXI.

LXXIII. was covered with a sheet of bright green gelatine, the interior plain. In the experiments on *Pieridæ*, the gelatine was replaced by blue glass, and the interior lined with deep orange paper.

LXXIV. was covered with a sheet of blue gelatine, the interior being plain (not used with *Pieridæ*).

LXXV. was only 2·15 centimetres wide (otherwise similar). It was covered with red glass like LXXI., the interior plain (not used with *Pieridæ*).

LXXVI. was 2·22 decimetres wide (otherwise similar). It was covered with a sheet of yellow glass, the interior plain. When used with *Pieridæ* the interior was lined with white paper.

LXXVII. A wooden box, 2·53 decimetres square, 1·53 deep, standing on one side. Quite three-fourths of area of top and bottom (2 largest sides in the position in which it stood) covered with green glass, and a small window of the same in upper side (roof). Lined everywhere with white paper.

When used for *Vanessa urticæ* it was lined with dark green paper. Afterwards, lined with white paper, it was employed for *Pieridæ*, as well as *Vanessa io*.

The remaining receptacles were employed for *Pieridæ* alone.

LXXVIII. to LXXXI. Four compartments of wooden box, covered with a single sheet of yellow glass.

LXXVIII.: 9·5 centimetres wide, 1·0 decimetre high, and 6·0 centimetres deep; lined with white paper.

LXXIX.: Similar, only 1·1 decimetres wide; lined with orange paper.

LXXX.: Similar to LXXVIII.; lined with blue paper.

LXXXI.: Similar to LXXIX.; lined with black paper.

LXXXII. to LXXXV. Four compartments of wooden box, covered with a single sheet of green glass. The compartments were all about 1·22 decimetres wide, 1·44 high, and ·81 deep.

LXXXII. was lined with white paper.

LXXXIII. was lined with red paper.

LXXXIV. was lined with orange paper.

LXXXV. was lined with blue paper.

LXXXVI. to LXXXIX. Four compartments of the same box, covered with a single sheet of pale blue glass. The compartments were rather wider than those just described (1·28 decimetres), but otherwise similar.

LXXXVI. was lined with white paper.

LXXXVII. was lined with red paper.

LXXXVIII. was lined with orange paper.

LXXXIX. was lined with yellow paper.

XC. A wooden box, 2·12 decimetres square and ·62 deep, lined with white paper, and covered with a sheet of blue cobalt glass.

XCI. to XCIV. Four compartments of wooden box, covered with a single sheet of blue cobalt glass, considerably deeper in tint than that of XC. The compartments were all about 1·0 decimetre square and ·6 deep.

XCI. was lined with white paper.

XCII. was lined with orange paper.

XCIII. was lined with yellow paper.

XCIV. was lined with blue paper.

XCV. Compartment of wooden box (1·09 decimetres wide, 1·35 high, and ·56 deep), covered with a sheet of clear glass, and lined throughout with black and orange squares of equal size, regularly alternating. Each was 12·5 mm. square, and thus a size which ensured that a pupa of *Pieris brassicæ* and *P. rapæ* would lie on at least two of them.

Explanation of Plates XIV. & XV.

PLATE XIV.

All the figures are drawn of the natural size, which in all cases is that of the larvæ either mature or approaching maturity.

Figs. 1, 2, and 8 were drawn by Miss Cundell; figs. 9 to 17 by Mr. J. T. Murray; the remainder by the writer.

Fig. 1.—The larvæ of *Hemerophila abruptaria*, reared among green shoots and leaves of lilac (food-plant), upon which they are shown in the figure.

Fig. 2.—The larvæ of the same species fed on the same food, with which a number of very dark twigs were intermixed. The larvæ are seen at rest on a branch of *Quercus cerris*. The attitude of the resting larvæ in this and fig. 1 is not quite natural. A cocoon is shown on the right side of the base of the branch. Its strong resemblance to the bark is produced by the number of small fragments gnawed off and woven into it.

Fig. 3.—A dark larva of *Rumia cratægata* brought up among dark twigs. A bluish "bloom" is seen upon it.

Fig. 4.—Another dark larva of the same species brought up under the same conditions. The "bloom" covers more of the surface, and a small patch of green colour is seen behind the dorsal humps.

Fig. 5.—A very black larva without "bloom," brought up under the same conditions.

Fig. 6.—A brownish green larva of the same species, fed on the same food-plant (hawthorn), but brought up among green shoots and leaves. A bluish "bloom" is present.

Fig. 7.—A light brown larva with green marks and patches, brought up under the same conditions as the last described.

The larvæ represented in figs. 3—7 were bred from eggs laid by one moth, and were fed on the same food. It is interesting to note considerable individual differences among the dark and light forms respectively. The stimulus being the same, the reaction differs somewhat according to individual predisposition.

Fig. 8.—A large mature green larva of *Amphidasis betularia* (one of the results of the 1889 experiments), shown in a very characteristic attitude on a green twig of *Populus nigra*. The brownish shade over the dorsal area is more or less present in the majority of green larvæ of this species.

Fig. 9.—This and all remaining figures represent the results of the 1892 experiments.

This bright green larva was the single exception found in a lot of 34 exposed to dark surroundings (Experiment I.). It is represented upon a twig of *Quercus cerris*, which serves to show the nature of the conditions employed. It became mature much before the other larvæ, and probably passed through the most sensitive period before the experiment began. Compare its size with that of fig. 10 from the same experiment.

FIGS. 11 and 12.—Two larvæ from Experiment II. They had been subjected to dead brown twigs of some species of *Salix*, the appearance of which is seen in these figures. One larva (fig. 12) is rather lighter and greyer than the other, but the resemblance to the surroundings is very strong; and no greater divergence occurred between any of these larvæ than that shown in figs. 11 and 12.

FIG. 13.—Three larvæ were transferred from the last Experiment (II.), and were exposed to green surroundings (XXVII.) from July 27th to the end of larval life. On Aug. 10th a drawing of the lightest one was made, and is reproduced here. The effect was but slight, the larva being rather lighter and greyer than any in II. It is represented upon a twig of *Populus nigra*.

FIG. 14.—A typical result of Experiment VI. is shown in this figure. The posterior claspers of the larva are fixed to a dead brown ivy leaf, thus showing the appearance of the environment with which most of the larvæ harmonised well, and from which only one differed considerably. The painting was made about Aug. 5th

FIG. 15.—A greenish white larva from Experiment XXVIII., resting on one of the white paper spills which formed the environment. The larva was mature when it was painted about Aug. 5th.

FIG. 16.—A brownish white larva from XXVIII., also resting on a white paper spill. When it is remembered that these were examples of the *least* white larvæ in this experiment, the effect of the white spills is seen to be most remarkable. A whitish larva, exhibiting no tendency to brown or green, was selected for painting, but it began to pupate, and altered in appearance before this could be accomplished.

FIG. 17.—A dark purplish brown larva from Experiment XXXI., resting on a dark blue paper spill. All the 10 larvæ in this set assumed this particular shade of brown. The larva was painted about Aug. 5th.

FIG. 18.—Abdominal segments 1 to 4 (indicated by numbers) of an intermediate larva, divided along the median ventral line, and spread out flat, as seen from the internal surface. The digestive tract has been removed. The tracheal system is shown on the left hand only. The arrow indicates the anterior direction. The

anterior brown band in each segment and the brown median dorsal stripe are due to true pigment in the epidermic cells, while the broader green band crossing the posterior part of each segment is due to green fat lying beneath the epidermis, which is of a pale yellowish colour over it. The yellow patches on each side of the middle line in the anterior part of each segment are due to part of the more deeply placed yellow fat.

PLATE XV.

Figs. 1 and 2.—The dark and light varieties of the larvæ of *Catocala elocata*, obtained in the experiments described on pp. 302, 303. The larvæ are represented about three-quarters of the natural size, and the difference in shade was far greater than appears from these figures.

Fig. 3.—The dark and light larvæ of *Hemerophila abruptaria*, obtained in the experiments described on pp. 316, 317. The larvæ are represented about three-quarters of the natural size, and the difference of shade is very well expressed.

Fig. 4.—A lamp-shade, like that used in Experiment IV. upon *Amphidasis betularia* (1889), see pp. 331, 332. In front of and beside the lamp-shade are represented the five pieces of stick which were used in the experiment. The figure is about one-fourth the real size of the articles. These pieces of stick, placed among the green leaves of nut in the cylinder, turned far more than half the larvæ dark.

Fig. 5.—About one-fifth the real size. The conflicting colour case used chiefly in the experiments on *Vanessa urticæ* and *V. io* (see pp. 391—397 and 420—426). A complete description of it is given on p. 393). The difference between the alternate strips of gilt and black paper is not distinct, although it can be made out.

Fig. 6.—About one-fifth the real size. The conflicting colour case used in the experiments on *Vanessa io* (see p. 425, where the case is described). The distinct white spots in this and the last figure represent the bosses of silk spun by the larvæ. In use, the cover (the upper part of the figure) was placed over the compartments (the lower part), so that the white compartments had a black cover, and *vice versâ*, and the dorsal and ventral surfaces of the larvæ within were subjected to opposed conditions.

THE

PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY

OF

LONDON

For the Year 1892.

February 10, 1892.

Frederick DuCane Godman, Esq., F.R.S., President, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

Nomination of Vice-Presidents.

The President nominated Lord Walsingham, LL.D., F.R.S., Henry J. Elwes, Esq., F.L.S., and Dr. D. Sharp, M.A., F.R.S., Vice-Presidents for the session 1892–93.

Election of Fellows.

Mr. Thomas W. Cowan, F.L.S., F.G.S., of 31, Belsize Park Gardens, Hampstead, N.W.; Mr. Wm. Farren, of Union Road, Cambridge; Mr. Philip de la Garde, R.N., of H.M.S. 'Pembroke,' Chatham; the Rev. J. A. Mackonochie, B.A., of Douglas Castle, Lanarkshire, and the Hirsel, Coldstream; and the Rev. A. Thornley, M.A., of South Leverton Vicarage, Lincolnshire, were elected Fellows of the Society.

Exhibitions, &c.

Mr. E. Meyrick exhibited a number of specimens of *Euproctis fulviceps*, Walk., taken by Mr. Barnard, showing the extraordinary variation of this Tasmanian species, all the males of which had been "sembled" by one female. The males were represented by various forms ranging from black to white, which had all been described as distinct species. Dr. Sharp, Mr. Hampson, Mr. McLachlan, Colonel Swinhoe, Mr. Elwes, Mr. Tutt, Mr. Poulton, and Mr. Jacoby took part in the discussion which ensued.

Dr. Sharp exhibited samples of pins which he had tried for preventing verdigris, and stated that annealed silver-wire was the best material to use, as insects on silver pins remained intact, whilst those on gilt pins were destroyed by verdigris.

Mr. G. T. Porritt exhibited a series of specimens representing Huddersfield forms of *Polia chi*, including nearly melanic specimens, found there during the last two seasons. He said these forms had not hitherto been observed elsewhere.

Mr. Tutt exhibited a series of *Hadena pisi*, comprising specimens very grey in tint, others of an almost unicolorous red with but faint markings, and others well marked with ochreous transverse lines. Three distinct forms of *Hadena dissimilis;* red and grey forms of *Panolis piniperda*, and a dark form of *Eupithecia fraxinata;* also a specimen of *Sciaphila penziana*. With the exception of the last-named, which was taken in Anglesey, all the specimens were taken or bred by Mr. Tunstall in the neighbourhood of Warrington.

The Rev. Dr. Walker exhibited specimens of *Arge titea*, *A. lachesis*, *A. psyche*, *A. thetis*, and other species of the genus from the neighbourhood of Athens; also specimens of *Argynnis phœbe*, taken in Grenada in May, 1891.

Mr. W. Farren exhibited a series of specimens of *Peronea variegana* var. *cirrana*, and *P. schalleriana* var. *latifasciana*, from Scarborough; *Eupœcilia vectisana*, from Wicken Fen; and *Elachista subocellea*, from Cambridge.

Mr. G. A. J. Rothney sent for exhibition and communicated notes on a number of species of ants collected by himself in Australia, in May and June, 1886, which had recently been named for him by Dr. Forel. The collection included:—*Camponotus nigriceps*, Smith; Melbourne. *C. æneopilosus*, Mayr; Adelaide. *C. novæ Hollandiæ*, Mayr; Adelaide and Brisbane. *Iridomyrmex purpureus*, Sm., ☿ and ♂; at Adelaide, Melbourne, and Brisbane. *I. rufoniger*, Lowne; Adelaide and Brisbane. *I. gracilis*, Lowne; Adelaide and Melbourne. *I. itinerans*, Lowne; Adelaide. *Ectatomma metallicum*, Sm., ☿, ♂; common at Adelaide, Melbourne, and Brisbane. This is a very beautiful ant when seen alive, its metallic colours being strikingly brilliant in the sunlight. The prominence of metallic-coloured ants in Australia is very noticeable to anyone fresh from the Indian fauna. *E. nudatam*, Mayr; Adelaide, and *E. mayri*, Emery.; Brisbane, are also nice species. *Aphænogaster longiceps*, Sm.; with its nests in the earth generally under stones, is a common species occurring at Albany, Adelaide, Melbourne, Sydney, and Brisbane. *Polyrhachis ammon*, Fab., *daemali*, Mayr, *guerini*, Roger; the last a very pretty species, are all common at Brisbane. *Myrmecia nigriventris*, Mayr, and *nigrocincta*, Sm.; two species of "bull-dog" ants, occur near Brisbane. Mr. Rothney said that there is a pale-coloured *local race* of the curious long-legged ant, *Leptomyrmex erythrocephalus*, Fabr., from Brisbane, and a *variety* of *Camponotus rubiginosus*, Mayr, "*variété toute noire*," also from Brisbane. He also sent a few species from Honolulu S. I., taken during the two or three hours' stay of the S.S. 'Mariposa'; the little cosmopolitan ant, *Solenopsis geminata*, Fab., was extremely common, its nests being under stones, pathways, almost everywhere: there is also a *Monomorium* which Dr. Forel has not yet determined, and which is probably new.

Papers read.

Mr. C. O. Waterhouse read a paper entitled "Some Observations on the Mouth Organs of Diptera," which was illustrated by numerous diagrams. A long discussion ensued in which Mr. Champion, Mr. McLachlan, Mr. Jenner Weir, Mr. Slater, Mr. Poulton, Mr. Distant, Dr. Sharp, Mr. Hampson, Mr. Elwes, and Mr. Barrett took part.

Mr. E. Meyrick read a paper entitled "On the Classification of the Geometrina of the European Fauna." Mr. Hampson, Mr. Elwes, Mr. McLachlan, Colonel Swinhoe, Mr. Tutt, and Mr. Distant took part in the discussion which ensued.

February 24, 1892.

Frederick DuCane Godman, Esq., F.R.S., President, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

Election of Fellows.

Mr. Walter Cuthbert Biddell, of 32, The Grove, Bolton Gardens, S.W.; and Mr. Douglas Stuart Steuart, of North Leigh, Prestwich, Lancashire, were elected Fellows.

Death of an Ex-President.

The President referred to the loss the Society had recently sustained by the death of Mr. Henry Walter Bates, F.R.S., who had twice been its President; and he also read a copy of the resolution of sympathy and condolence with Mrs. Bates and her family, in their bereavement, which had been passed by the Council of the Society at their meeting that evening.

Exhibitions, &c.

Mr. Frederick C. Adams exhibited a specimen of *Telephorus rusticus*, taken in the New Forest, in which the left mesothoracic leg consisted of three distinct femora, tibiæ, and tarsi, apparently originating from a single coxa; he also exhibited specimens of *Ledra aurita.*

Mr. G. A. James Rothney sent for exhibition a series of specimens of two species of Indian ants (*Myrmicaria subcarinata*, Sm., and *Aphænogaster barbarus*, L. var. *punctatus*, Forel), which had recently been determined for him by Dr. Forel. He also communicated the following notes on the subject :—

" *Myrmicaria subcarinata*, Sm."

" This species is not uncommon in Bengal, and forms its nests by excavating the earth round trees and throwing it up in mounds of *fine* grains on the side away from the trunk.

" The sexes swarm early in the rains about July 7th to 10th.

" There was a fine nest, or rather colony, at the big Banian-tree in Barrackpore Park, near the trunk-road, which I have known, from 1872 to 1886, fourteen years (and in all probability it is there now) ; not only was the great main trunk more or less encircled by these ditches, but a large proportion of the minor stems were also surrounded by earth-works, many being completely so.

" These *fosses* also appeared to act as traps for various insects which might fall off the tree and then have some difficulty in getting out, as they are not unlike gigantic ant-lion pits in their construction, only with the exception that no lurking enemy lay concealed at the bottom, for I never once detected *Myrmicaria* taking the least notice of its accidental visitors or prisoners, for it is a mild and gentle ant and not, I think, carnivorous.

" No break occurred in the life of this colony for these fourteen years, though in some the ants would be in much greater numbers than others, and the earth-works more extensive, but as a rule these fosses formed the largest and most important '*ant-works*' that I have met with in India."

" *Aphænogaster* (*Messor*) *barbarus*, L. var. *punctatus*, Forel."

" This ant, like the bee, *Apis dorsata*, seems to have a great liking for the gardens and buildings of the old Mogul Emperors, the bee disfiguring the arches and roofs with its huge nests, and the ant frequenting the gardens and steps.

" You can always find the ant in the beautiful gardens of the Taj Mahal; also at Secundra and Itmad-ud-Daulah's tomb at Agra. At Futtehpore Sikré (near Agra), under the roof of the great gateway hangs an immense nest of *Apis dorsata*, and on the steps beneath I have found *Messor punctatus* in great force. I have also taken it at Tughlukabad, Delhi, at the tomb of Jehangir, Lahore, and at the Man-Mander, Benares.

"I do not for a moment suggest that *punctatus* has any special business relations with *dorsata*, but only that ant and bee are always associated in my own mind with these grand old buildings of the North-West Provinces and Punjaub.

"There is a very distinct and handsome looking *black variety* which is rather common in the Mussoorie Hills."

Paper read.

The Hon. Walter Rothschild communicated a paper entitled "On a little-known species of *Papilio* from the Island of Lifu, Loyalty Group." The paper was illustrated by a beautifully coloured drawing, by Mr. F. W. Frohawk, of the male, variety of the male, female, and under-side of the species.

March 9, 1892.

Frederick DuCane Godman, Esq., F.R.S., President, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

Election of Fellows.

Captain Clement Alfred Righy Browne, R.E., care of Messrs. Grindlay, Groome, and Co., of Bombay; His Grace the Duke of Devonshire, LL.D., Chancellor of the University of Cambridge, of Devonshire House, 78, Piccadilly, W.; Mr. J. H. Leslie, of 44, Cheriton Square, Upper Tooting, S.W.; Mr. R. M. Lightfoot, of Bree Street, Cape Town, Cape of Good Hope; and Mr. Sidney Robinson, of Goldsmith's Hall, E.C., were elected Fellows of the Society.

Exhibitions, &c.

Professor C. Stewart, President of the Linnean Society, exhibited and made remarks on specimens of *Cystocœlia immaculata*, an Orthopterous insect from Namaqualand, in which the female is far more conspicuously coloured than the male, and the stridulating apparatus of the male differs in certain important details from that of other species. A long and interesting discussion ensued, in which Dr. Sharp, Mr. Poulton, Mr. Distant, Mr. H. J. Elwes, Colonel Swinhoe, and Mr. Hampson took part.

Mr. Elwes exhibited specimens of *Ribes aureum* which were covered with galls, as to the nature of which the Scientific Committee of the Horticultural Society desired to have the opinion of the Entomological Society. Mr. Fenn, Mr. Tutt, and Mr. Barrett made some remarks on these galls. Mr. Elwes also exhibited a large number of species of Heterocera recently collected by Mr. Doherty in South-east Borneo and Sambawa. Colonel Swinhoe, Mr. Hampson, and Mr. Distant took part in the discussion which ensued.

Mr. Barrett exhibited a series of specimens of *Noctua festiva*, bred by Mr. G. B. Hart, of Dublin, which represented most of the known forms of the species, including the Shetland type of the form formerly described as a distinct species under the name of *Noctua conflua*. Mr. Fenn and Mr. Tutt made some remarks on the specimens.

Mr. W. C. Boyd exhibited a specimen of *Dianthœcia Barrettii*, taken at Ilfracombe last summer. It was remarked that Mr. W. F. H. Blandford had recorded the capture of *D. Barrettii*—which had until recently been supposed to be confined to Ireland—from Pembrokeshire, and that its capture had also since been recorded from Cornwall.

Mr. Tutt exhibited specimens of *Polia xanthomista* from Mr. Gregson's collection, which had recently been sent to him by Mr. Sydney Webb. They included amongst others a specimen much suffused with yellow, and resembling Hübner's type and Gregson's type of var. *statices*, which Mr. Tutt stated was practically identical with Treitschke's *nigrocincta*. He remarked that certain localities appeared to produce different forms of this species responding largely to their environment as far as colour is concerned, and were thus protected by resemblance to their surroundings.

Mr. G. A. James Rothney exhibited a large collection of Indian ants, numbering about ninety species, collected by himself on the Bengal side of India in the years 1872 to 1886, and which he thought might be considered as fairly representing the ants of the Calcutta district. He also read the following notes on the subject:—

"The following eighteen species were described from my specimens by Dr. Mayr in his 'Beiträge zur Ameisen Fauna Asiens,' 1878:—*Camponotus opaciventris*, *Polyrhachis spiniger*, *Dolichoderus gracilipes*, *Anochetus punctiventris*, *Lobopelta punctiventris*, *Lioponera longitarsus*, *Ænictus bengalensis*, *Æ. brevicornis*, *Monomorium orientale*, *Holcomyrmex scabriceps*, *Tetramorium Smithi*, *Pheidole striativentris*, *P. rhombinoda*, *P. indica*, *Crematogaster subnuda*, *C. Rogenhoferi*, *C. Rothneyi*, *C. contemta*; and Dr. Forel, to whom I am immensely indebted for a most careful examination and revision of my collection, has recently named the following new species:—*Plagiolepis Rothneyi*, *Crematogaster Minchinii*, and *Camponotus junctus* (new race of *maculatus*); and there are also some ten species and one new genus which Dr. Forel has not yet determined. In reviewing the collection, there are *four* species which are so common and conspicuous that they force themselves on everyone's notice, and are familiar to Europeans and natives alike; they are:—*Camponotus compressus*, Fab. (the 'black ant'), *Solenopsis geminata*, Fab., var. *armata*, Forel (the 'red ant'), *Œcophylla smaragdina*, Fab. (the 'yellow ant'; it is only the ♀ that has a green tinge), *Sima rufonigra*, Jerdon (the 'red and black ant'). The first may be said to be represented, in ant economy, in this country by our *Lasius niger*; the second, by a combination of the social qualities of *Lasius flavus*, *Myrmica ruginodis*, *Myrmica scabrinodis*, and *D. molesta* (*M. Pharaonis*, Linn.), but for the two last, which are tree-ants, we have no equivalent in our English species. After these *four* there are some twenty-six species which are sufficiently in evidence to attract the notice of any entomologist or observer, and which are thoroughly representative; they are:—*Camponotus opaciventris*, Mayr, *C. micans*, Nyl. (*paria*, Emery), *C. mitis*, Sm. (var. *fuscithorax*, Forel), *Polyrhachis lævissima*, Sm., *P. spinigera*, Mayr, *Plagiolepis longipes*, Jer., *Prenolepis clandestina*, Mayr, *P. longicornis*, Latr., *Tapinoma*, *melanocephalum*, Fabr., *Bothroponera tesserinoda*, Mayr, *Lobopelta chinensis*, Mayr, *L. diminuta*, Sm., *Diacamma vagans*, Sm., *Meramplus bicolor*, Gué., *Holcomyrmex scabriceps*, Mayr (harvesting ant), *Myrmicaria sub-carinata*, Sm., *Monomorium vastator*, Sm., *Pheidologeton laboriosus*, Sm., *Pheidole indica*, Mayr, *P. rhombinoda*, Mayr, *Crematogaster subnuda*, Mayr, *C. Rothneyi*, Mayr, *C. Rogenhoferi*, Mayr, *Sima nigra*, Jerdon, *Dorylus orientalis*, West. (male), and a male *Ponera* which smells strongly of mushrooms and comes in numbers to light, but which cannot be determined. From this list I exclude *Myrmecocystus viaticus*, Fabr., and *Messor barbarus*, L., var. *punctatus*, Forel, which are conspicuous North-West Province species. The remaining species, or about 66 per cent., would have to be sought for and "collected," and, unless by chance, would hardly be noticed except by the specialist. Further additions to my Bengal typical list will no doubt be made by future collectors; for just now, under the energetic and able auspices of my friend Mr. R. C. Wroughton, of Poona, Indian ants are "booming"; but I do not think the Calcutta district, situated just within the tropics and with a good rainfall, can ever be considered as rich in variety of species for its position. Dr. Forel has kindly made the following corrections in a few of the names given in my paper, 'Notes on Indian Ants,' read April 3rd, 1889, and which were those affixed to my specimens by my old friend the late Frederick Smith.

Camponotus sylvaticus, Oliv., should be *C. mitis* var. *fuscithorax*, Forel.

Pseudomyrme bicolor, Smith (*Sima rufo-nigra*, Jerdon) = *Sima rufo-nigra*, Jerdon.

Sima carbonaria, Smith = *Sima nigra*, Jerdon (older name).

Solenopsis geminatus, Fab. = *Solenopsis geminata*, Fab., var. *armata*, Forel.

Dorylus longicornis, Shuck. = *Dorylus orientalis*, Westw. (older name, 1835).

Plagiolepis gracilipes, Sm. = *Plagiolepis longipes*, Jerdon (older name).

Meranoplus bicolor, Sm. = *Meranoplus bicolor*, Guér.

Polyrhachis lævissimus, Sm. = *Polyrhachis lævissima*, Sm.

Polyrhachis schrinax, Roger = *Polyrhachis thrinax*, Roger (errata, Trans. Entom. Soc. v. 1889).

Holcomyrmex indicus, Mayr = *Holcomyrmex scabriceps*, Mayr.

The last name was corrected in the errata, Trans. Entom. Soc. v. 1889, and was a very curious error. All my type-specimens of this genus and species were labelled by Mr. Frederick Smith *H. indicus*, and I can only surmise that he confused the species with *Pheidole indica*, which Dr. Mayr described from my specimens at the same time."

Mr. H. Goss exhibited, for Mr. T. D. A. Cockerell, of Kingston, Jamaica, several specimens of palm leaves, from the garden of the Museum in Kingston, covered with *Aspidiotus articulatus*, Morgan, and read the following letter on the subject from Mr. Cockerell:—

"Kingston, Jamaica, Feb. 16th, 1892.

"Dear Sir,

"I enclose pieces of the leaf of a palm, from the garden of the Museum in Kingston, covered with *Aspidiotus articulatus*, Morgan. It may interest some to see how severely the plant is attacked, the scales almost entirely covering the upper surface of the leaf in places. The species is notable for the sharp division between the thorax and abdomen, and makes an interesting microscopic object.

"I had formerly distributed it under the MS. name of *A. rufescens*, because Morgan's figure in the Ent. Mo. Mag. seemed to indicate a different species; but Mr. Morgan has kindly sent me one of his *A. articulatus* from Demerara, and so I am able to satisfy myself that the two are identical. *A. articulatus* feeds on a variety of plants, and is at present known from Demerara, Jamaica, and Barbados.

"Will you kindly give some of the specimens to any Fellow of the Society who cares to have them?

"Yours very truly,

"T. D. A. Cockerell."

"The Secretary,

"Entomological Society of London."

Papers read.

Mr. F. D. Godman contributed a paper by the late Mr. Henry Walter Bates, with an introduction by himself, entitled "Additions to the Longicornia of Mexico and Central America, with remarks on some previously recorded Species."

The Rev. A. E. Eaton communicated a paper entitled "On new Species of Ephemeridæ from the Tenasserim Valley."

March 23, 1892.

Dr. David Sharp, M.A., F.R.S., Vice-President, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

Election of Fellows.

The Hon. Mrs. W. Carpenter, of Kiplin, Northallerton, Yorkshire; and Mr. S. G. C. Russell, of 19, Lombard Street, E.C., were elected Fellows of the Society.

Exhibitions, &c.

The Secretary read a letter from the City of London Entomological and Natural History Society on the subject of a proposed Catalogue of the Fauna of the London District. The assistance of Fellows of the Society in the compilation of this Catalogue was asked for.

Mr. G. C. Champion exhibited a number of new species of Longicornia from Mexico and Central America, recently described by the late Mr. H. W. Bates, in his paper entitled "Additions to the Longicornia of Mexico and Central America, with remarks on some previously recorded Species," read at the last meeting of the Society.

Mr. S. Stevens exhibited three very rare species of *Noctuæ*, viz., *Noctua flammatra*, *Leucania vitellina*, and *Laphygma exigua*, all taken by Mr. H. Rogers at Freshwater, Isle of Wight, in the autumn of 1891.

Mr. F. C. Adams again exhibited the specimen of *Telephorus rusticus* in which the left mesothoracic leg consisted of three distinct femora, tibiæ, and tarsi, originating from a single coxa, which he had shown at the meeting on the 24th of February last. The specimen was now reversed, to admit of the better examination of the structural peculiarities of the leg, upon which Dr. Sharp, Mr. Champion and Mr. Jacoby made some remarks.

Mr. Osbert Salvin exhibited a series of mounted specimens of the clasping organs in the male of several species of *Hesperidæ*.

Dr. Sharp exhibited, for Mr. F. D. Godman, a collection of Orthoptera recently made in the Island of St. Vincent, West Indies, by Mr. H. H. Smith, the naturalist sent to that Island by Mr. Godman in connection with the operations of the Committee appointed by the British Association and the Royal Society for the investigation of the Fauna and Flora of the Lesser Antilles. It was stated that the collection had recently been referred to, and reported on by, Herr C. Brunner von Wattenwyl and Professor J. Redtenbacher.

Mr. J. W. Tutt exhibited and remarked on a series of various forms of *Orrhodia vaccinii* and *O.* (*spadicea*) *ligula*.

Mr. C. G. Barrett exhibited and made remarks on a series of specimens—including some remarkable varieties—of *Bombyx quercus* and *Odonestis potatoria*. A long discussion ensued as to the probable causes of the variation exemplified, in which Mr. Tutt, Mr. E. B. Poulton, Mr. H. Goss, Mr. Jacoby, Mr. Salvin, Mr. Bethune-Baker, Dr. Sharp, and Mr. Distant took part.

Mr. G. A. James Rothney sent for exhibition a number of specimens of *Camponotus compressus*, Fab., *C. micans*, Mayr, *Œcophylla smaragdina*, Fab., *Sima rufo-nigra*, *Solenopsis geminata* var. *armata*, Forel, and other species of ants, from Calcutta. He also communicated the following notes explanatory of the specimens exhibited :—

" I send for exhibition a few specimens illustrating traits in Calcutta ant-life.—1. *Camponotus compressus*, Fab.; with the Aphidæ which it tends. I have never found these insects present in the nest itself. 2. *Lobopelta diminuta*, Smith, and the mode it has of carrying its pupæ held beneath it when on the march. 3. *Camponotus micans*, Mayr, and a mimicking spider, *Salticus*, which frequents tree-trunks in company with the ants; but this spider is not so common as the species which so closely mimics *Sima rufo-nigra*, which I have previously exhibited. 4. *Camponotus compressus*, Fab., illustrates the results of the little family feuds the soldiers of this species often indulge in. 5. *Camponotus compressus*, Fab., and *Solenopsis geminata* var. *armata*, Forel. Both these species are very common in Calcutta and Barrackpore; both frequent the verandahs of houses, and consequently often meet, and when they do they generally fight with a result disastrous to *armata*, unless that species happens to be an overpowering force. 6. *Œcophylla smaragdina*, Fab. Here we have the workers of one nest meeting the workers of a neighbouring but independent nest, &c."

April 13, 1892.

Henry John Elwes, Esq., F.L.S., Vice-President, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

Election of a Fellow.

Mr. Francis Jaffrey, M.R.C.S., of 8, Queen's Ride, Barnes, S.W., was elected a Fellow of the Society.

Exhibitions, &c.

Mr. R. McLachlan exhibited specimens of *Anomalopteryx chauviniana*, Stein, a Caddis-fly remarkable for the abbreviated wings of the male, the female having fully developed wings: he alluded to the *Perlidæ* as including species in which the males were frequently semi-apterous. Dr. Sharp enquired if any Fellow was aware of any order of insects, except the Neuroptera, in which the organs of flight were less developed in the male than in the female. Mr. C. G. Barrett and Mr. H. J. Elwes cited instances amongst the *Bombycidæ* in which the wings of the male were inferior in size and development to those of the female.

Dr. Sharp exhibited specimens of both sexes of an apparently nondescript phasmid insect allied to *Orobia*, obtained by Mr. J. J. Lister in the Seychelles islands, together with *Phyllium gelonus*. He also exhibited specimens of both sexes of an Acridiid insect, of the group *Proscopides*, remarkable for its great general resemblance to the *Phasmidæ*, though without resemblance, so far as is known, to any particular species. In reference to the *Phyllium*, Dr. Sharp called attention to the fact that the similarity of appearance of parts of their organisation to portions of the vegetable kingdom was accompanied by a similarity, amounting almost to identity, of minute structure. He said that it had been stated that the colouring-matter is indistinguishable from chlorophyll, and that Mr. Lister had informed him that when in want of food a specimen of the *Phyllium* would eat portions of the foliaceous expansions of its fellows, although the *Phasmidæ* are phytophagous insects. The resemblance to vegetable products reached its maximum of development in the egg ; and Mons. Henneguy had observed that when sections of the external envelope of the egg of *Phyllium* are placed under the microscope no competent botanist would hesitate to pronounce them to belong to the vegetable kingdom. Dr. Sharp also stated that in some species of *Phasmidæ* it was easy to obtain the egg by extraction from a dried specimen.

Mr. Barrett exhibited, for Major J. N. Still, a specimen of *Notodonta bicolora*, which had been captured in a wood near Exeter. Major Still had stated that the captor of the specimen was unaware of the great rarity of the species. Mr. Barrett also exhibited, for Mr. Sydney Webb, some remarkable varieties of *Argynnis adippe* and *Cænonympha pamphilus ;* also two specimens of *Apatura iris*, and two of *Limenitis sybilla* in which the white bands were entirely absent.

The Hon. Walter Rothschild sent for exhibition some hundreds of Lepidoptera, representative of a magnificent collection of about 5000 specimens recently made in five weeks, by Mr. W. Doherty, in the South-west of Celebes, and contributed the following preliminary notes on the subject :—

"I have sent for exhibition to-night a series of Lepidoptera picked from a very fine collection sent by Mr. William Doherty from S.W. Celebes. The collection numbers about 5000 specimens, and is the result of five weeks' collecting. The collection is a very representative one, and has a fair proportion of new species, although the season of 1891 in Celebes was extraordinarily dry, and very unfavourable for collecting.

"I have used this series as a base for working out Doherty's collection, the result of which I hope to communicate to the Society in a paper which will be ready to be read at the first May meeting. As I have not yet been able to finish putting all my notes on the collection in order, I am unable to give an exact list of species of the genus *Terias*, and of the species of the families *Lycænidæ* and *Hesperidæ* at this meeting, although I send them for exhibition. I, however, hope to put everything before the Society in May. The following is a list of the species of all families of Rhopalocera except those above-mentioned :—

"DANAIDÆ.—*Nectaria Blanchardii*, *Ideopsis vitrea*, *I. Dohertyi* (new species), *Salatura conspicua*, *Limnas chrysippus*, *Ravadebra luciplena*, Butl., *Radena ishma*, *Tirumala choaspes ? ?*.

"EUPLŒINÆ.—I here put all under the genus *Euplœa ;* in the final paper I shall put them under their proper subdivisions. *Euplœa causina*, *E. viola*, *E. Mniszechii*, *E. hyacinthus*, *E. eupator*, *E. Horsfieldii*, *E. gloriosa*, *E. euctemon* ♂, *E. configurata* ♀ (this was not recognised hitherto as the female of *euctemon*), *Nasuma celebensis* (new species).

"SATYRINÆ. — *Lethe aveto*, *Melanitis leda* (var. ? ? or new species), *M. hylecoetes*, Holland, *M. velutina*, *Mycalesis Yopas*, *M. janardana*, *M. Perseus ? ?*, *M. Medus*, *M. Dinon*, *Yphthima lorima*, *Y. asterope*, *Y. philomela*, *Y. celebensis* (new species near *Pandocus*), *Bletogona satyrus*, *Elymnias Hewitsoni*, *E. hicetas*.

"MORPHINÆ. — *Amathusia phidippus* var. *virgatus*, *Pseudamathusia Ribbei*, Honrath, *Zeuxamathusia Plateni* (the female is new to science), *Discophora bambusæ* = *celebensis* of Holland, *Clerome chitone*.

"ACRÆINÆ.—*Acræa Dohertyi.* Doherty caught two males at Macassar several years ago, and now he sends two of the unknown female; and these four are all that are known of this species.

"BYBLIADÆ.—*Ergolis merionoides, E. celebensis.*

"APATURIDÆ.—*Cethosia picta, C. myrina, Cynthia deione* var. *celebensis, Cupha mænoides, Atella alcippe* var. *celebensis* (this is probably a good species), *Terinos abisares, Cirrhochroa satyrina, C. thule, C. semiramis, Symbrenthia hippoclus, Junonia erigone, J. atlites, J. asterie, J. almona, Precis intermedia, Pseudergolis areota, Rhinopalpa megalonice, Xoma sabina, Doleschallia polybete, Cyrestis thyonneus ? ?, C. rahria* var. *peraka* (I believe this is a good species), *C. strigata, Hypolimnas fraterna, H. anomala* var. *celebensis, Euripus robustus, Rohana macar, R. athalia, Charaxes nitebis, C. hannibal, C. cognatus, C. mars* var. *Dohertyi* (new var.); these *Charaxes* will be exhibited at a future meeting; *C. affinis*, also not exhibited.

"NYMPHALIDÆ.—*Parthenos sylvia, Neptis* sp., *N.* sp., *N.* sp., *N.* sp., *N.* sp. (I have not yet marked out these as they are very obscure), *Athyma eulemene, Symphædra ætes, S. ætes* var. *tyrtæus, Euthalia dermoides* (new species), *E. amanda, Limenitis lymire, L. lyncides, L. libnites, L. lycanias* (very rare, female undescribed).

"ERYCINIDÆ.—*Abisara echerius.*

"LYCÆNIDÆ.—Will be fully described in future paper.

"PIERINÆ.—*Huphina affinis, H. eperia, H. timnatha, H. celebensis* (new species), *Catopsilia flava* (island form of *C. crocale*), *C. catilla, C. scylla.*

"TERIAS.—This genus will be fully discussed in the final paper. *Eronia tritæa, Hebomoia celebensis, Appias zarinda* ♂, *A. zatima* ♀, *A. nathalia* var. *nigerrima*, Holland (this is a good species), *A. Dohertyi* (new species), *Delias Wallacei?* (new species ? ?); I cannot find this, but doubt it being new; *A. paulina, A. polisma, A. lycaste, A. celebensis; A. ithome*, Wallace, is probably same as *Huphina affinis.*

"PAPILIONINÆ.—*Ornithoptera hæphæstus, O. hippolytus, O. haliphron, Papilio polyphontes, P. aristolochiæ* (first record of this species from Celebes), *P. gigon, P. ascalaphus, P. alphenor, P. hecuba, P. pertinax, P, adamantius, P. Blumei, P. encelades,* *P. veiovis*, *P. deucalion*, *P. rhesus*, *P. androcles*, *P. agamemnon*, *P. miletus*. *P. telephus*, *P. Meyeri*, *P. codrus* (seen but not caught).

"Hesperidæ.—To be described."

Many of the species were new, and others very rare. Mr. Elwes, Colonel Swinhoe, and Mr. S. Stevens commented on the interesting nature of this collection, and a vote of thanks to Mr. Rothschild for exhibiting it was passed by the meeting.

Paper read.

Mr. E. B. Poulton gave a lecture "On the denudation of Scales in certain Species of Lepidoptera," and illustrated it by a large nnmber of photographs shown by means of the oxy-hydrogen lantern. Mr. G. F. Hampson, Mr. Elwes, and Mr. Poulton took part in the discussion which ensued.

April 27, 1892.

Robert McLachlan, Esq., F.R.S., Treasurer, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

Election of Fellows.

Mr. William Edward Baily, of Lynwood House, Paul Churchtown, Penzance; and Mons. Edmond Fleutiaux, of 1, Rue Malus, Paris, were elected Fellows of the Society.

Exhibitions, &c.

Mr. C. G. Barrett exhibited, for Mr. Sabine, varieties of the following species, *viz.*, one of *Papilio machaon*, bred by Mr. S. Baily, at Wicken, in 1886; one of *Argynnis lathonia*, taken at Dover in September, 1883; one of *A. euphrosyne*, taken at Dover in 1890; and one of *A. selene*, taken at St. Osyth, in 1885, by Mr. W. H. Harwood. He also exhibited a long series of *Demas coryli*, reared by Major

Still from larvæ fed exclusively on beech, which he said appeared to be the usual food of the species in Devonshire, instead of hazel or oak. Mr. Barrett also exhibited, for Mr. Sydney Webb, a number of varieties of *Arge galathea*, *Lasiommata megæra*, *Hipparchia tithonus*, and *Cœnonympha pamphilus*, from the neighbourhood of Dover.

The Rev. J. Seymour St. John exhibited a variety of the female of *Hybernia progemmaria*, taken at Clapton in March last, in which the partially developed wings were equally divided in point of colour, the base being extremely dark and the outer portion of the wing very pale.

The Rev. Canon Fowler made some remarks on the subject of protective resemblance; he said his attention had been recently called to the fact that certain species of *Kallima* apparently lose their protective habit in some localities, and sit with their wings open, and that Dr. A. R. Wallace had informed him that he had heard of a species of *Kallima* sitting upside down on stalks, and thus, in another way, abandoning its protective habits. It therefore seemed that when a species is so well protected that it becomes very abundant, it may with impunity, in some localities, lose a portion of the protection by change of habits. Mr. W. L. Distant said that a species of butterfly in South Africa, which when its wings were vertically closed resembled the reddish soil on which it settled, in the Transvaal rested with open wings on quartzite rock, which the upper surface of the wings protectively resembled. Mr. Barrett, Mr. McLachlan, Mr. Jacoby, Mr. Champion, Mr. H. Goss, Canon Fowler, and Mr. Frohawk continued the discussion.

Mr. Goss informed the meeting that, in pursuance of a resolution of the Council passed in March last, he and Mr. Elwes had represented the Society at the recent Government enquiry, as to the safety and suitability of the proposed Rifle Range in the New Forest, held at Lyndhurst by the Hon. T. W. H. Pelham, on the 20th, 21st, 22nd and 23rd inst., and that they had given evidence at such enquiry, and addressed a large meeting of Counsel, Solicitors, War Office officials, Verderers, and Commoners.

May 11, 1892.

Frederick DuCane Godman, Esq., F.R.S., President, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

Election of Fellows.

Dr. Edward Alfred Heath, M.D., F.L.S., of 114, Ebury Street, Pimlico, S.W., and Mr. Samuel Hoyle, of Audley House, Sale, Cheshire, were elected Fellows of the Society.

Death of an Honorary Fellow.

The President announced the death, on the 4th of May, of Dr. C. A. Dohrn, of Stettin, who was elected one of the Honorary Fellows of the Society in 1885. Mr. Stainton expressed his regret at the death of Dr. Dohrn, whom he said he had known for many years, and commented on his work and personal qualities. He stated that Dr. Dohrn was for many years Secretary of the Stettin Entomological Society, and on the death of Dr. Schmidt, in 1843, he was elected President, and filled the chair for many years.

Exhibitions, &c.

Dr. D. Sharp exhibited drawings of the eggs of a species of Hemiptera, in illustration of a paper read by him before the Society; and also a specimen of a mosquito—*Megarhina hæmorrhoidalis*—from the Amazon district, with the body, legs, and palpi furnished with scales as in Micro-Lepidoptera.

The Rev. Canon Fowler, on behalf of Mrs. Venables, of Lincoln, exhibited cocoons of a species of *Bombyx* from Chota Nagpur; also the larvæ-cases of a species of *Psychidæ*, *Cholia crameri*, from Poona, India; and a curious case, apparently of another species of *Psychidæ*, from the island of Likoma, Lake Nyassa. Mr. McLachlan, Mr. Poulton, and Mr. Hampson made some remarks on the subject.

Mr. F. W. Frohawk, on behalf of the Hon. Walter Rothschild, exhibited a specimen of *Pseudacræa miraculosa* mimicking *Danais chrysippus;* also a specimen of the mimic of the latter, *Diadema misippus*, and read notes on the subject.

Mr. C. G. Barrett exhibited, and commented on, a long series of specimens of *Melitæa aurinia* (*artemis*) from Hampshire, Pembrokeshire, Cumberland, and other parts of the United Kingdom ; also a long and varied series of *Coremia fluctuata*.

Mr. H. Goss exhibited, for Mr. W. Borrer, jun., of Hurstpierpoint, a photograph of a portion of a wasp's nest which had been built in such a way as to conceal the entrance thereto, and to protect the whole nest from observation. He also read the following note on the subject, which he had received, through Mr. Borrer, from Mrs. Blackburn, of Henfield, Sussex, the owner of the nest:—

"What is shown in the photograph is only a flat piece built over the wall, behind which the nest is situated, in order apparently to hide the entrance, and make it exactly to resemble the surrounding stone and mortar, thereby seeming to show an instinct of mimicry. From a study of Dr. Ormerod's book, the nest appears to be that of *Vespa vulgaris*. It was situated close to a window in the upper story of an old farmhouse, built with cross-beams of oak, the squares filled in with stone, rubble, and mortar, giving a sort of yellow-grey appearance between the oak-beams, which the nest exactly resembled. As the swarm was large, it had to be destroyed. From below the nest showed itself only as a little hole close to the beam, but, on closer inspection, the man who took the nest saw what looked like the whole side of it exposed, but it was so like the surrounding stone and mortar as to make it most difficult to see where that left off and the wasps' work began. On inserting a knife at the edge he found he could take off the piece, and then the reason for it appeared. At some time or other, when the house was repaired, the workmen, not having enough stone, put in one large red tile to fill up, so the red patch was very conspicuous ; the wasps therefore, for some reason of their own, covered it with their 'curtain' so cleverly that no red tile was left showing as a mark for their nest, the whole of which was *behind* the tile in a space between the wall and the battening. That it was the intention of the wasps to hide the red tile appears certain, for, not being able to take the nest that evening, the man brought away the piece which covered the tile, and, on returning the next night, he found the wasps had again begun to build, and had made some progress in hiding the red tile with the same sort of covering as before."

It was suggested that the wasp "paper" is probably a very bad conductor of heat, and that it *might* be a question of temperature rather than of concealment of the nest.

Papers read.

The Hon. Walter Rothschild communicated a paper entitled "Notes on a collection of Lepidoptera made by Mr. William Doherty in Southern Celebes during August and September, 1891. Part I. Rhopalocera." He also sent for examination the types of the new species described therein.

Dr. Sharp read a paper entitled "On the Eggs of an Hemipterous Insect of the Family *Reduviidæ*."

June 1, 1892.

Robert McLachlan, Esq., F.R.S., Treasurer, in the chair.

Donations to the Library were announced, and thanks voted to the respective donors.

Exhibitions, &c.

The Hon. Walter Rothschild sent for exhibition *Neptis mimetica*, n. s., from Timor, mimicking *Andasena orope*, one of the *Euplæidæ*, and *Cynthia æquicolor*, n. s., a species remarkable for the similarity of the two sexes, from the same locality; also a hybrid between *Saturnia carpini* and *S. pyri*, and specimens of *Callimorpha dominula* var. *romanovii*, var. *italica*, and var. *donna*, bred by a collector at Zurich; he further exhibited a very large and interesting collection of Rhopalocera made by Mr. W. Doherty in Timor, Pura, Sumba, and other islands, during October, November, and December, 1891, and communicated the following Notes on the subject:—

"The collection was made in November and December, also the latter part of October, and is the finest collection yet sent home from the Timor group, in spite of the unusually dry season. There are many new species, and also some fine series of various species described by Doherty in his Sumba paper.

"The moths are not so numerous as in the Celebes collection, but contain fine new things, among them a magnificent *Zeuzera* near to *Z. mineus*, and a *Clanis* near to *C. malaccana*. I am able only to exhibit this evening the Rhopalocera, but hope to exhibit the moths when the final papers on the Celebes collection and this collection are read in October.

"The following is a rough list of the species, which will be of course carefully revised in the final paper. This exhibit consists of my private set; in the final paper the total number of specimens in the collection will be enumerated.

"*Nasuma hamhasa*, Doherty, *Salatura genutia* var., *S. timorensis*, n. sp., *Limnas chrysippus*, *Tirumala melissa?* var., *T. litoralis*, Doherty, *T. limniace*, *Radena vulgaris?* var., *R. oberthurii*, Doherty, *Salpinx meizon*, Doherty, *Stictoplœa? timorensis*, n. sp., *Vadebra* sp. incert., *V.* sp. incert., *Calliplœa sumbana*, Doherty, *C. sumbana* var. *albina*, n. var., *C. hyems*, *C.* sp. incert., *C.* sp. incert., *Rasuma leroa*, *Trepsichrois dongo*, Doherty, *Salpinx* sp. incert., *S.* sp. incert., *Stictoplœa lacordairei*, *Euplœa?* sp., *Andasena orope*, *Charaxes orilus*, *C. athamas* (or *Ganymedes*, Stgr.), *Hypolimnas bolina*, *H. alimena*, *H. anomala*, *H. Saundersii*, *Elymnias dohertyi*, n. sp., *Melanitis constantina*, *Lethe europa*, *Mycalesis* sp. incert. (*medus*), *M.* sp. incert. (*wayewa*, Doh.), *M.* sp. incert. (*mynois*, Hew.), *Yphthima aphnius*, *Y.* sp. incert., *Y. leuce*, Doherty, *Acræa andromache* var. ?, *Ergolis ariadne*, *E. timora*, *Cethosia leschenaultii*, *C. lamarckii*, *C. tambora*, *C. penthesilea*, *Messaras sinha*, *Atella phalanta*, *Junonia orithya*, *J. velleda*, *J. erigone*, *J. timorensis*, *J. atlites*, *Libythea geoffroyi*, *Precis iphita*, *Symbrenthia hippoclus??*, *Toma sabina*, *Cynthia æquicolor*, n. sp., *Cyrestis* sp. incert., *Limenitis hollandi*, Doherty, *L. procris*, *Neptis columella*, *N.*

mimetica, n. sp., *N. varmona*, *N. hordonia*, *Doleschallia* sp. incert., *Ixias reinwardtii*, *I. vollenhovii*, *Huphina julia*, Doherty, *H. temena*, *Delias sumbana*, n. sp., *D. timorensis*, *D. dohertyi*, n. sp., *D. alorensis*, n. sp., *D. oraia*, Doherty, *Huphina naomi*, *Eronia hippia*, *Callidryas scylla*, *C. crocale*, *C. catilla*, *C.* sp. incert., *Huphina læta* (♂ & ♀), *H. pitys* (♂ & ♀), *Appias albina*, *A. lyncida*, *A.* sp. incert., *A.* sp. incert., *A.* sp. incert., *A.* sp. incert., *Elodina* sp. incert. (there may be two or three mixed up), *Huphina mentes?*, *H.* var.?, *Hebomoia timorensis*, *Belenois coronea*, *Nychitona xyphia*, *Terias hecabe*, *T. harina*, *T.* sp. incert., *T.* sp. incert., *T.* sp. incert., *T.* sp. incert., *T.* sp. incert., *Ornithoptera naias*, Doherty, *O. plato*, *Papilio liris*, *P. orion*, Doherty, *P. solonensis*, n. sp., *P. pumilus*, n. sp., *P. pericles*, *P. peranthus*, *P. sarpedon* var., *P. erithonius* var., *P. helenus* var. ? ?, *P. merope*, *P. theseus*, *P. dohertyi*, n. sp., *P. albocincta*, n. sp., *P. œnomaus;* fifty-six species of *Lycænidæ;* seventeen species of *Hesperidæ*."

Colonel Swinhoe remarked that the various species of *Neptis* were usually protected and imitated by other insects, and did not themselves mimic anything, and that the pattern of the *Neptis* in question was very common among the butterflies in the Timor group. Mr. Jenner Weir, Prof. Meldola, Mr. Trimen, and others continued the discussion.

Mons. A. Wailly exhibited about fifty species of Australian Lepidoptera, mostly from Queensland, and fertile ova of *Trilocha varians*, which are arranged in small square cells, fastened together in large numbers, and present an appearance quite different from the usual type of lepidopterous ova.

Mr. F. Merrifield exhibited a series of *Drepana falcataria*, half of which had been exposed for a week or two, in March or April, to a temperature of about 77°, and the other half had been allowed to emerge at the natural out-door temperature. The latter insects were in all cases darker than the former, all being equally healthy. Mr. McLachlan, Mr. Barrett, Mr. Jenner Weir, and others took part in the discussion which followed.

Mr. C. G. Barrett exhibited a curious variety of the male of *Arctia mendica*, bred by the Rev. W. F. Johnson, of Armagh.

Canon Fowler exhibited the egg-case of a species of *Mantidæ* from Lake Nyassa, and specimens of *Bledius dissimilis*, Er., from Bridlington Quay, Yorkshire.

Mr. McLachlan called attention to the re-appearance in large numbers of the Diamond-back Moth, *Plutella cruciferarum*, which was very abundant in gardens near London, and expressed his opinion that the moths had been bred in the country and had not immigrated. Mr. Jenner Weir and others concurred.

Mr. Jenner Weir, Mr. Bower, and Prof. Meldola stated that they had recently seen specimens of *Colias edusa* in several localities near London.

Mr. Jenner Weir and others also commented on the immigration of large numbers of *Plusia gamma*, and also on the appearance of a large number of *Cynthia cardui* and other *Vanessidæ*.

Paper read.

Mr. A. G. Butler and the Hon. Walter Rothschild communicated a paper, entitled "On a new, and also on a little-known, species of *Pseudacræa*."

October 5, 1892.

Henry John Elwes, Esq., F.L.S., Vice-President, in the chair.

Donations to the Library were announced, and thanks voted to the respective donors.

Election of a Fellow.

Mr. W. H. Yondale, F.R.M.S., of Cockermouth, was elected a Fellow.

Exhibitions, &c.

Mr. C. O. Waterhouse exhibited specimens of the larvæ of *Latridius nodifer* feeding on a fungus, *Trichosporium roseum*.

The Rev. A. E. Eaton sent for exhibition the male specimen of *Elenchus tenuicornis*, Kirby, taken by him on the 22nd August last, at Stoney Stoke, near Shepton Montague, Somerset, and described by him in the 'Entomologist's Monthly Magazine,' Oct. 1892, pp. 250–253. Mr. McLachlan stated that another specimen of this species had been caught about the same date in Claygate Lane, near Surbiton, by Mr. Edward Saunders, who discovered that it was parasitic on a homopterous insect of the genus *Liburnia*, and had also described it in the Ent. Mo. Mag., pp. 249–250.

Mr. J. M. Adye exhibited, for Mr. McRae, a large collection of *Colias edusa*, *C. edusa* var. *helice*, and *C. hyale*, all taken in the course of five days' collecting in the neighbourhood of Bournemouth and Christchurch, Hants. There were twenty-six specimens of the variety *helice*, some of which were remarkable both in size and colour. He stated that Mr. McRae estimated the proportion, this season, of the variety *helice* to the type of the female as one in fifty, and the proportion of *Colias hyale* to the type of the female of *C. edusa* as one in one hundred. Mr. Adye also exhibited two specimens of *Deiopeia pulchella*, recently taken near Christchurch. The Chairman, Mr. Hanbury, Mr. Jenner Weir, and Mr. Merrifield commented on the interesting nature of the exhibition, and on the recent extraordinary abundance of *C. edusa* and the var. *helice*, which was probably not exceeded in 1877.

Mr. Dallas Beeching exhibited four specimens of *Plusia moneta*, lately taken in the neighbourhood of Tunbridge Wells.

Mr. Gervase F. Mathew sent for exhibition, and contributed notes on, two specimens of *Plusia moneta* and their cocoons, which were found at Frinsted, Kent, on the 3rd September last. It was stated that the first moth, the male, emerged on Sept. 5th, and the second, the female, on Sept. 13th. The cocoons, of which seven were discovered, were not difficult to see, being spun-up upon the under side of the leaves of monkshood, without any attempt at concealment. Unfortunately five of the moths had already emerged, so that it was probably a fortnight or so too late for what was presumably the second brood. Mr. Mathew stated that he found two small larvæ of a *Plusia* feeding upon monkshood on the 10th Sept.; that they had grown a very little since then, and on the 4th Oct. appeared as if they intended to hybernate. He thought they might be *moneta*, but they bore a strong resemblance to *gamma*. He enquired if anyone knew in what stage *P. gamma* passes the winter?

Mr. B. G. Rye exhibited a specimen of *Zygæna filipendulæ* var. *chrysanthemi*, two varieties of *Arctia villica* and a black variety of *Homaloplia ruricola*, taken at Lancing, Sussex; also dwarf specimens of *Euchloë cardamines* from Wimbledon; a variety of *Thecla rubi* from Bournemouth, and specimens of *Coccinella ocellata* var. *hebræa*, and *C. oblongo-guttata*, from Oxshott.

Mr. A. H. Jones exhibited specimens of *Argynnis pales* var. *isis*, and var. *arsilache*, the females of which showed a tendency to melanism, recently taken at Campfer, in the Upper Engadine; one of the females was especially dark, and on the under side presented a remarkable variety, the basal half of the hind wings, with the exception of the nervures, being pearly white, and the marginal spots were replaced by long white dashes. A male also showed a melanic tendency in the hind wings. The under side was not unlike the type, but the marginal silvery spots, as in the female, were replaced by dashes. He also showed melanic forms of *Erebia melampus*, and a specimen of *Erebia nerine*, taken at Bormio, at the foot of the Stelvio Pass.

Mr. Elwes exhibited specimens of typical *Erebia melas*, taken by himself at Campiglio, in the Western Tyrol, on the 25th July last, at an elevation of 7000 feet; also specimens of the same species from Hungary, Greece, and the Eastern and Central Pyrenees. He stated that the supposed absence of this species from the Alps, which had seemed to be such a curious fact in geographical distribution, had been first disproved by Mrs. Nichol, who discovered it at Campiglio two years ago. He also exhibited fresh specimens of *Erebia nerine*, taken on very hot rocks at Riva, on the lake of Garda, at an elevation of about 500 feet; also specimens of the same species, taken at the same time, at an elevation of about 5000 feet, in cool forest glades. He remarked that the great difference of elevation and climate did not appear to have produced any appreciable variation in this species. Mr. Elwes also showed a pair of *Dasydia tenebraria* var. *wockearia*, Stgr., from Campiglio, which appeared to him to be sufficiently constant and distinct from the typical form to be treated as a species.

Mr. G. T. Porritt exhibited two fine varieties of *Abraxas grossulariata*, bred by Mr. George Jackson during the past summer from York larvæ; also, on behalf of Mr. T. Baxter, a curious Noctua taken on the sandhills at St. Anne's-on-Sea on August 20th last, and concerning which a difference of opinion existed as to whether it was a melanic form of *Agrotis cursoria* or of *Caradrina cubicularis*. He also exhibited a small dark form of *Orgyia antiqua*, which had occurred in some numbers at Longridge, near Preston.

Mr. A. Eland Shaw exhibited a specimen of *Mecostethus grossus*, Linn., taken lately at Irstead, in the Norfolk-broad district. He stated that this was the first recorded capture of this species in Britain since 1884.

Mr. C. G. Barrett exhibited a specimen of *Syricthus alveus*, caught in Norfolk, about the year 1860, by the Rev. J. H. Marsh; a beautiful variety of *Argynnis euphrosyne*, caught this year near Godalming by Mr. Oswald Latter; and a series of varieties of *Ennomos angularia*, bred from a female taken at Nunhead.

Mr. P. Crowley exhibited a specimen of *Zygæna filipendulæ* var. *chrysanthemi*, taken last August at Riddlesdown, near Croydon, by Mr. Murton Holmes.

Lord Walsingham sent for exhibition several specimens of larvæ of *Sphinx pinastri* and *Aphomia sociella*, preserved by himself, which were intended for presentation to the British Museum. The larvæ of *S. pinastri* had been sent to him by Lord Rendlesham, who obtained them from ova laid by a female which he had captured in Suffolk last August.

Papers, &c., read.

Mr. de Nicéville communicated a paper entitled "Notes on a protean Indian butterfly, *Euplœa* (*Stictoplœa*) *harrisii*, Felder"; and Captain E. Y. Watson exhibited, on behalf of Mr. de Nicéville, the specimens referred to in this paper. Colonel Swinhoe, Mr. Hampson, Mr. Poulton, and the Chairman took part in the discussion which ensued.

Mr. W. Bateson read a paper entitled "On the Variation in the Colours of Cocoons and Pupæ of Lepidoptera; further Experiments." In this paper the author gave an account of further experiments on the variation of lepidopterous cocoons, &c. Evidence was brought to show that the cocoons of *Saturnia carpini* do not always colour in accord with the substances to which they are attached, as has been alleged. The colouring substance was shown to be derived from the contents of the alimentary canal, being probably a chlorophyll-derivative. Experiments were also described which confirmed Mr. Poulton's statements as to the influence of surroundings on the colour of pupæ of *Vanessa urticæ* and larvæ of *Amphydasis betularia.*

Mr. Poulton said that he was glad to admit that Mr. Bateson had proved his point with regard to the cocoons of *Saturnia carpini*, and he wished to take the opportunity of acknowledging that he had been mistaken in the belief that the larva modified the colour of its cocoon in response to the influence of reflected light. At the same time, he was not convinced that other larvæ do not possess this power. He had obtained some very conclusive results with *Halias prasinana*, in which it did not appear that any of the sources of error demonstrated by Mr. Bateson in the cases of *S. carpini* and *E. lanestris* could have operated. The cocoons had been shown at a meeting of the Society in 1887 (Proc. Ent. Soc. Lond. 1887, pp. l, li). Since then Mr. Tutt had made similar observations on a very large scale in the case of *Halias chlorana.* Mr. Poulton stated that he was now experimenting again with *H. prasinana*, and hoped soon to be able to bring further evidence. He also said that he had not been able to obtain many individuals of the species, but the results had been uniformly in favour of the view that the susceptibility exists. He further said that Mr. Arthur Sidgwick was observing the species, and had arrived at the same opinion.

Mr. Poulton read a paper entitled "Further Experiments upon the Colour-relation between certain Lepidoptera and their surroundings."

Miss Lilian J. Gould read a paper entitled "Experiments on the Colour-relation between certain Lepidopterous larvæ and their surroundings, together with Observations on Lepidopterous larvæ." A long discussion ensued, in which Mr. Jenner Weir, Dr. Sharp, Mr. Merrifield, Mr. Poulton, Mr. Tutt, and the Chairman took part.

November 2, 1892.

Frederick DuCane Godman, Esq., F.R.S., President, in the chair.

Donations to the Library were announced and thanks voted to the respective donors.

A Lantern for the Society.

The President announced that a new Oxy-hydrogen lantern had been purchased for the Society, the cost of which had been generously defrayed by Mr. H. J. Elwes, Prof. R. Meldola, Mr. R. McLachlan, and Mr. E. B. Poulton.

Exhibitions, &c.

Mr. S. Stevens exhibited, for Mr. J. Harrison, of Barnsley, and read notes on, a beautiful series of *Arctia lubricipeda* var. *radiata*, which had been bred by Mr. Harrison this year. Mr. Harrison stated in his notes that in the spring of 1891 he offered ova of *Dasypolia templi* for distribution; at the same time he asked for a few pupæ of *Arctia lubricipeda* in return; his intention being to try and pair them, on emergence, with some Huddersfield forms of *Arctia mendica*, which he knew would be out about the same time. The *mendica* having been in-bred two or three seasons, he had a doubt about continuing the strain. The attempt proved a failure, and he lost the *mendica*. He said that he had two lots of *lubricipeda* pupæ of about twenty each sent him, one from London, and the other from Lincolnshire, and all that came out were of the ordinary form, except one female specimen of the var. *radiata*. This he sacrificed to pair with one of the ordinary males, simply as an experiment. The result was about 500 ova, part of which he kept for himself, and the rest he distributed. The batch of eggs which he kept produced about 160 imagos in 1892, and of these about one-third resembled the female parent (*A. lubricipeda* var. *radiata*), one-third partly resembled the male parent (*A. lubricipeda* type) and partly resembled the female; and the remainder resembled the male parent.

Mr. G. T. Bethune-Baker exhibited specimens of *Polyommatus dispar* var. *rutilus*, taken in England by his father about sixty years ago. He stated that it was generally believed that this form of the species was confined to the Continent, but his specimens proved that it formerly occurred in England.

Mr. C. G. Barrett exhibited dark varieties of *Acronycta leporina*, bred by Mr. J. Collins, of Warrington; also a white variety of *Triphæna pronuba*, taken at Swansea by Mr. W. Holland.

Mr. M. Jacoby exhibited a specimen of *Sagra femorata*, from India, with differently sculptured elytra, one being rough and the other smooth.

Mr. J. A. Clark exhibited a long series of remarkable varieties of *Liparis monacha*, bred from a pair (♂ and ♀), one of which was taken in the New Forest, and the other on the Continent. Several of the specimens were as light in colour as the typical form of the species; others were quite black; and others intermediate between these two extremes.

The Rev. J. Seymour St. John exhibited a monstrosity of *Abraxas grossulariata*, and a specimen of *Tæniocampa stabilis*, with a distinct light band bordering the hind margin of the upper wings. He stated that he had bred both specimens.

Mr. E. B. Poulton exhibited two series of imagos of *Gnophos obscurata*, which had been subjected to dark and light surroundings respectively. The results were seen to be completely negative, the two series being equally light.

Mr. F. Merrifield showed a number of pupæ of *Pieris napi*. About eight of them, which had attached themselves to the leaves of the cabbage plant on which they were fed, were of a uniform bright green colour, with light yellowish edgings; of the others, nearly seventy in number, those which had attached themselves to the black net covering the pot, or the brownish twigs which supported it, the great majority were ash-coloured, with dark spots and lines, and the remainder of a green colour, much less vivid than in those which had spun up on the leaves, with numerous dark spots and lines on them.

Mr. R. Adkin exhibited three bred female specimens of

Vanessa c-album, two of which belonged to the first brood, and the third to the second brood. One of the specimens of the first brood was remarkable in having the under side of a very dark colour, identical with typical specimens of the second brood. Mr. Adkin stated that out of a number of larvæ reared from the egg he received six nearly full-fed on June 15th, 1892. The first imago emerged on July 2nd, followed by two on the 3rd, and one on the 7th, all of the ordinary spring form. On the 5th a fourth attempted to emerge, but did not get free of the pupa case, and its wings did not expand; and on the 23rd the sixth appeared, a perfect specimen, but having the under side coloration of the autumn brood. The weather during the seventeen days between the last complete emergence of the ordinary form and that of the one bred on the 23rd was chiefly cold, with a considerable amount of rain, the mean temperature on the 17th being 20° below the average; but it became somewhat warmer on the 21st and 22nd. No doubt the low temperature and absence of sunshine delayed the emergence of this insect, and thus caused the altered colouring of the under side.

Mr. F. W. Frohawk exhibited a series of striking varieties of *Satyrus hyperanthus*, bred from ova laid by a female taken in the New Forest in July last.

Mr. F. D. Godman exhibited a specimen of *Amphonyx medon*, Cr., received from Jalapa, Mexico, having a pouch-like excrescence at the apex of its body. Mr. McLachlan, Mr. H. J. Elwes, and Mr. Poulton commented on it.

Papers, &c., read.

Mr. C. J. Gahan communicated a paper entitled "Additions to the Longicornia of Mexico and Central America, with notes on some previously recorded species." The author stated that this paper was a supplement to that by the late Mr. H. W. Bates, which had already appeared in the 'Transactions' for this year. Twenty new species were described, of which nineteen belong to the family *Lamiidæ*, the remaining species being placed in a new genus of *Prionidæ*. With these additions the number of Longicornia recorded from Central America was brought up to a total of 1372 species.

Mr. W. L. Distant communicated a paper entitled "Contributions to a knowledge of the Homopterous family Fulgoridæ."

Mr. Oswald Latter read a paper,—which was illustrated by the Society's new oxy-hydrogen lantern,—entitled "The Secretion of Potassium-hydroxide by *Dicranura vinula*, and the emergence of the imago from the cocoon." The author stated that the imago produced, probably, from the mouth, a solution of caustic potash for the purpose of softening the cocoon. The solution was obtained for analysis by causing the moths to perforate artificial cocoons made of filter paper. The imago emerges wearing over its head and eyes the corresponding structures of the pupal stage: these serve as a shield, and protect the underlying parts of the imago. The shield is locked on to the head of the imago by hooks fitting into sockets on the head. From beneath the shield project a pair of sharp hard processes from the labrum of the imago. These serve as instruments of attack upon the walls of the cocoon, and tear away the portions successively moistened by the alkaline secretion.

Professor Meldola said that the larva of *D. vinula* secretes strong formic acid, and Mr. Latter had now shown that the imago secretes potassium-hydroxide, a strong alkali. He stated that he had long been familiar with the fact that the secretion from the imago of *D. vinula* was alkaline to test-paper, but he had never investigated its composition; and he also stated that the fact that any animal secreted a strong caustic alkali was a new one.

Mr. Merrifield asked Mr. Latter if he had tried the converse experiment, and proved that potassium-hydroxide would soften the cocoon. Mr. Latter stated that he had done so.

Mr. J. F. Hanbury asked if Mr. Latter could say where the potassium was obtained by the larva. Mr. Latter said he thought it was obtained from the leaves on which the larva fed.

Mr. Gahan, Mr. Poulton, Mr. Merrifield, and Prof. Meldola continued the discussion.

Mr. H. J. Elwes and Mr. J. Edwards read a paper—also illustrated by the oxy-hydrogen lantern—entitled "A revision of the genus *Ypthima*, principally founded on the form of the genitalia in the male sex."

Mr. McLachlan said he attached great importance to the genitalia as structural characters in determining species, and he believed that he could name almost any species of European Trichoptera simply from an examination of the detached abdomens of the males.

Mr. Osbert Salvin said he had examined the genitalia of a large number of Hesperidæ, with the view of considering their value in distinguishing species, but at present he had not matured his observations.

Mr. Jacoby, Mr. Bethune-Baker, Colonel Swinhoe, Mr. George Lewis, Dr. Sharp, Mr. G. F. Hampson, and Mr. Champion continued the discussion.

Mr. S. H. Scudder communicated a paper entitled "New light on the formation of the abdominal pouch in *Parnassius*." Mr. Elwes said he had based his classification of the species of this genus largely on the structure of this abdominal pouch in the female. It had been considered doubtful whether the fluid which formed this pouch was secreted by the female or the male; but he thought that it was secreted by the latter, as after pairing the male frequently died from exhaustion. He was glad to find that this supposition had been proved by Mr. Scudder to be correct.

Mr. Jenner Weir remarked that a similar abdominal pouch was to be found in *Acræa*, especially in that division of the genus which Doubleday had separated under the name of *Hyalites*. The pouch was very well developed in the female of *Hyalites horta*, L., and was also found in *H. neobule*, Doubl., and *H. anemosa*, Hewits. It was worthy of remark, as had been pointed out by Mr. Roland Trimen in his 'South African Butterflies,' that *Parnassius* presents two other characteristic features of *Hyalites*, *viz.*, semi-transparent wings, and simple tarsal claws lobed at the base.

Mr. Hampson referred to specimens in Mr. Leech's collection of a male of one species of *Parnassius* taken *in copulâ* with a female of another species, in which the pouch peculiar to the species to which the female belonged had been formed, and, not fitting the claspers of the male, had come away from the female on the specimens being separated, and remained attached to the male.

December 7, 1892.

Frederick DuCane Godman, Esq., F.R.S., President, in the chair.

Donations to the Library were announced, and thanks voted to the respective donors.

Death of an ex-President.

The President announced the death, on the 2nd December, of Mr. Henry T. Stainton, F.R.S., an ex-President of the Society. A vote of condolence with Mrs. Stainton was passed by the meeting.

Election of Fellows.

Mr. Frank Bouskell, of 11, Lansdowne Road, Stoneygate, Leicester; Mr. George C. Dennis, of Tower Street, York; Mr. Charles B. Headley, of Stoneygate Road, Leicester; Mr. William Mansbridge, of Luther Place, Horsforth, near Leeds; and the Rev. George W. Taylor, of St. Barnabas, Victoria, British Columbia, were elected Fellows of the Society.

Exhibitions, &c.

Mr. Jenner Weir exhibited a species of *Acræa* from Sierra Leone, which Mr. Roland Trimen, who had examined the specimen, considered to be a remarkaple variety of *Telchinia encedon*, Linn. It was a very close mimic of *Limnas alcippus*, the usual Western African form of *Limnas chrysippus*. The upper wings of the specimen were rufous and the lower white, as in the model, and the resemblance in other respects was heightened by the almost total suppression of the black spots in the disc of the upper wings, characteristic of the usual markings of *T. encedon*.

Mr. F. J. Hanbury exhibited a remarkable variety of *Lycæna adonis*, caught in Kent this year, with only one large spot on the under side of each upper wing, and the spots on the lower wings entirely replaced by suffused white patches. He also exhibited two specimens of *Noctua xanthographa* of a remarkably pale brownish grey colour, approaching a dirty white, obtained in Essex in 1891; and a variety of *Acronycta rumicis*, also taken in Essex, with a beautiful dark hind margin to the fore wings.

Mr. H. J. Elwes exhibited a living specimen of a species of *Conocephalus*, a genus of *Locustidæ*, several species of which, Mr. C. O. Waterhouse and Mr. McLachlan stated, had been found alive in hothouses in this country.

Dr. T. A. Chapman exhibited immature specimens of *Tæniocampa gracilis*, *T. gothica*, *T. populeti*, *T. munda*, *T. instabilis*, and *T. leucographa*, which had been taken out of their cocoons in the autumn, with the object of showing the then state of development of the imagos.

Mr. F. W. Frohawk exhibited a living specimen of the larva of *Carterocephalus palæmon* (*Hesperia paniscus*), hybernating on a species of grass which he believed to be *Bromus asper*. The Rev. Canon Fowler and Mr. H. Goss expressed their interest at seeing the larva of this local species, the imagos of which they had respectively collected in certain woods in Lincolnshire and Northamptonshire. Mr. Goss stated that the food-plants of the species were supposed to be *Plantago major* and *Cynosurus cristatus*, but that the larva might possibly feed on *Bromus asper*.

Mr. C. G. Barrett exhibited a long series of remarkable melanic and other varieties of *Boarmia repandata*, bred by Mr. A. E. Hall from larvæ collected near Sheffield.

Mr. W. Farren exhibited, and commented on, four varieties of *Papilio machaon* from Wicken Fen; also a series of two or three species of *Nepticulæ* pinned on pith with the "minutien Nadeln," for the purpose of showing these pins.

Canon Fowler exhibited specimens of *Xyleborus perforans*, Woll., which had been devastating the sugar-canes in the West Indies. Mr. C. O. Waterhouse stated that the larvæ had done great damage to beer-casks in India.

Mr. E. B. Poulton showed, by means of the oxy-hydrogen lantern, a number of slides of various larvæ and pupæ, in illustration of his paper, read at the October meeting, entitled "Further experiments upon the colour-relation between certain lepidopterous larvæ and their surroundings." He stated that he believed that nineteen out of twenty larvæ of

Geometridæ possessed the power of colour adjustment. Mr. F. Merrifield, the Rev. J. Seymour St. John, and Mr. Jacoby took part in the discussion which ensued.

Papers read.

Mr. F. Merrifield read a paper entitled "The effects of temperature in the pupal stage on the colouring of *Pieris napi*, *Vanessa atalanta*, *Chrysophanus phlœas*, and *Ephyra punctaria*." The author stated that some of the artificial temperatures to which he had subjected pupæ in the course of these experiments corresponded to natural ones, though, in most cases, in a necessarily incomplete manner; natural temperatures were so fluctuating that it was difficult to imitate them artificially, but he did not think the difference was for his purposes an important one, for in many instances he had used both artificially equable and naturally fluctuating temperatures, and in these cases he had found that a fluctuating temperature produced results similar to those obtained from an equable temperature corresponding to the mean of the fluctuating one. In reference to the known English mean temperatures of the spring and summer months, it must be borne in mind that these are shade temperatures, and are below, and, under certain circumstances of exposure or absence of cloud, considerably below, those to which objects exposed to both sunshine and shade, under natural conditions, would be subjected. He would also premise that in his experiments the pupæ were exposed to the different temperatures, in nearly all cases, within a day or two, and often within a few hours, after pupation. Pupæ of the summer emergence of *P. napi*, iced (*i. e.* at 33° F.) for from three to four months, and then subjected to the temperature of spring, at which they emerged in five or six weeks, showed most but not all of the characteristic features of the spring emergence; those plunged at once from the artificial winter into the temperature of a very hot summer, emerged in six days, and were intermediate in most of their features. The summer pupæ of this species, or a portion of them, were very apt to go over to the spring, and, when so disposed, the subjecting them for many days to a forcing temperature seemed to have no effect in accelerating emergence. Eight out of thirty-one, the whole number of pupæ of this brood, had "gone over." Pupæ of *V. atalanta* were subjected to (1) a temperature of 90°, emerging in six days; (2) temperatures ranging from 64° to 51°, emerging in from eighteen to fifty-six days; (3) a temperature of 45° for from five to seven weeks, and then temperatures ranging from 90° to 55°, emerging in from nineteen to thirty-four days more. In No. 1 the black was rusty, but the orange was wide in area and bright, and in two of the twelve at this high temperature an additional small orange spot appeared on the under side of the fore wings; in No. 2 the black was more intense and the orange deeper and narrower, and the general intensity and contrast of colouring greater, especially on the under sides of the hind wings; in No. 3 the invasion of black had made further progress, the orange band being broken into several, lavender scales had spread over the black and white parts, and several minute blue spots appeared in the centre of the small black spots in the orange band on the hind wings: on the under surface most of the markings were less sharply defined, and a new submarginal narrow band appeared. The results obtained by extreme and protracted cold (*i. e.* 45°), though probably such as would rarely be met with in nature, were interesting, first, as proving by this extreme case that the less-marked intermediate results were caused by temperature; and secondly, because, owing to the great alteration in markings and colouring which they exhibit, they may possibly throw some light on the evolution of the markings in the *Vanessas*. One marking on *Vanessa atalanta* which had lately been the subject of some discussion, the minute white spot on the orange band of the fore wing, did not seem dependent on temperature; about one in four showed this spot, or traces of it, on the upper surface, and the whole of them—over sixty in number—showed the spot or faint traces of it on the under surface. Icing (at 33°) appeared to have little effect unless protracted for more than six weeks, when it was generally fatal or injurious. He had found a half-fed larva as late as October 16th, and had no doubt that the species was in England partially double-brooded, though he had obtained no evidence that it could survive an English winter in the pupal stage, as it is stated to do in the very different North American winter. Pupæ of the summer emergence of *Chrysophanus phlœas* were exposed to temperatures ranging from 80° to 90°, emerging in six days; and down to 45°, emerging in about eight weeks. In those at the highest temperature the coppery colour was dusky, the spots large and not sharply defined; as the temperature was lowered, the copper colour became brighter, the black more intense, and the spots smaller and more sharply defined, and the copper band on the hind wings much broader. Some that were iced (33°) for ten weeks, and then plunged into a high temperature, showed most of the features of those which had been throughout at the high temperatures. The results seemed to indicate that the dusky colouring of *C. phlœas* in Southern Europe, and the varying colour of the American *C. hypophlœas*, according to the season of its emergence, as described by Mr. Scudder, were in a large measure owing to the temperature to which the individual pupæ were subjected. Of *E. punctaria* he had a large brood of the summer emergence from the same parent. These were subjected to varying temperatures, and showed a gradual disappearance of the conspicuous submarginal blotches, an increase of the sprinkling of dark scales on the ground colour and an intensification of the central line, as the temperature was lowered from 90°, through 70° and 56° to 45°. There was no great difference between those at 90°, which emerged in from four to five days, and those at 70°, emerging in from ten to eleven days; but the difference was considerable in those at 56°, emerging in from twenty-two to twenty-seven days; and greater still in those at 45°, which emerged in from fifty-seven to seventy days; in these last the blotches had disappeared. A temperature of 33° seemed to suspend the physiological changes without much, if any, other effect; for those which were thus iced for over three months, and then exposed to a high temperature, emerging in from five to seven days, closely resembled in appearance those exposed to a similar temperature without having been iced at all. A large number of specimens were exhibited in illustration of the paper.

Mr. Poulton said the experiments appeared to show that the temperature operated at the pupal stage in which the pigment of the perfect insect was being formed, and the stronger colouring seemed to be the effect of retardation in the formation of this pigment. This would be in accordance with his observations as to the colouring of the pupa itself, which was deeper when the formation of it was retarded.

Dr. F. A. Dixey said that, by the kindness of Mr. Merrifield, he had been enabled to examine the specimens of *Vanessa atalanta* that afternoon before the meeting. He had at present only seen them by artificial light, but had nevertheless been able to satisfy himself that the series was of great interest in view of the conclusions he had previously arrived at with regard to the phylogeny of the *Vanessas* and allied groups (Trans. Ent. Soc. 1890, pp. 89 *et seq.*). He might say at once that the characters of those individuals that had been exposed to the greatest cold seemed to him on the whole the most ancestral, as evidence of which he would especially mention the blue centres with which the black submarginal spots of the hind wings were provided in at least two of Mr. Merrifield's "winter" specimens. These, he thought, must be considered as a revival of a character which had belonged to the earliest members of the Vanessid group (Ibid., p. 97 *et seq.*). Other features in the colouring appeared to him to point in the same direction; but as to these he must ask to be allowed to reserve his full opinion until he had had an opportunity of studying the specimens more carefully, and with the help of daylight. Mr. Merrifield had pointed out that the minute white spot ($D\zeta$ in the system proposed, *loc. cit.*) in the red band of the fore wing of *V. atalanta* was, in his specimens, often visible on the under side, though absent from the upper. It might be of interest to add that the same was not infrequently the case in instances of the occurrence of the corresponding spot in *Pyrameis cardui*, as also of the next preceding member of the same series, *viz.* D_ϵ. When the spots occurred on both surfaces of *P. cardui*, they were, as in Mr. Merrifield's specimens of *V. atalanta*, larger and more diffused on the under than on the upper surface (Trans. Ent. Soc., 1890, p. 93

and note). A similar feature might be recognised in *Argynnis niphe*, ♀ (*Ibid.*, p. 96), in which insect he had drawn attention to the existence of the same series of markings.

Mr. Elwes, with reference to the American *Chrysophanus hypophlœas*, remarked that he was not able to distinguish it as a species from the European *C. phlœas*, and suggested *Pieris brassicæ* as a very suitable subject for experiment; it varied greatly according to locality, and specimens from the Canary Isles being particularly fine in colouring.

Mr. Jenner Weir said he was particularly interested in the results obtained with *Vanessa atalanta* as a monomorphic species, and one very invariable in its markings and colouring.

Mr. Merrifield, in reference to Mr. Poulton's observations, said that the stage in which he had found temperature most operative was the one just preceding the appearance of the colouring of the perfect insect in the pupa. He had not been able to distinguish between cold and retardation as causes, seeing that they were generally so closely associated, but in his experiments he thought cold should be pointed to as the agent. He referred to a beautiful series of *Pieris napi* of the two emergences, from the same brood, exhibited by Mr. Hawes.

Mr. Kenneth J. Morton communicated a paper entitled "Notes on *Hydroptilidæ* belonging to the European Fauna, with descriptions of new species." Mr. McLachlan made some remarks on the subject of this paper.

Dr. T. A. Chapman read a paper entitled "On some neglected points in the structure of the pupa of Heterocerous Lepidoptera, and their probable value in classification; with some associated observations on larval prolegs." Mr. Poulton, Mr. Tutt, Mr. Hampson, and Mr. Gahan took part in the discussion which ensued.

Mr. J. Cosmo-Melvill communicated a paper entitled "Description of a new species of Butterfly of the genus *Calinaga*, from Siam."

Mr. W. L. Distant communicated a paper entitled "Description of new genera and species of Neotropical *Rhynchota*."

ANNUAL MEETING.

January 18, 1893.

Frederick DuCane Godman, Esq., F.R.S., President, in the chair.

The Treasurer's Balance Sheet was read by Mr. Jenner Weir, one of the Auditors.

Mr. H. Goss, one of the Secretaries, read the following:—

Report of the Council.

During the Session 1892–1893 eleven Fellows have died, *viz.*, Mr. Henry Walter Bates, F.R.S., Professor Hermann Carl Conrad Burmeister, M.D., Mr. Edward H. Burnell, Dr. Carl August Dohrn, Mr. John T. Harris, Mr. Henry Berkeley James, Sir Richard Owen, K.C.B., D.C.L., F.R.S., Mr. Sidney T. Smith, Mr. Henry T. Stainton, F.R.S., Mr. Howard W. J. Vaughan, and Professor J. O. Westwood, M.A., the Hon. Life-President; two Fellows have resigned; and 25 new Fellows have been elected.

The number of Fellows elected during the year is above the average, but the Society is in need of a considerable increase in this respect to enable it to publish more papers, and allow more plates, and in other ways to advance its interests and promote its objects. The Council, therefore, earnestly hope that the Fellows will do their utmost to induce their friends to join the Society, and thus increase its revenue.

At the present time the Society consists of 8 Honorary Fellows, 47 Life Fellows, and 296 paying the Annual Subscription, making the total number of Fellows now on the Society's List, 351, which, after allowing for the losses by deaths and resignations, is an increase of 12 since the Annual Meeting last year.

The Transactions for the year 1892 form a volume of nearly 500 pages, containing 19 memoirs contributed by the following authors, *viz.*, Colonel Swinhoe, M.A., Mr. Frederic Enock, Mr. George T. Bethune-Baker, Mr. Frederic Merrifield, Mr. William Bateson, M.A. (2 papers), Mr. Edward

Meyrick, B.A., the Honble. Walter Rothschild, Mr. Henry Walter Bates, F.R.S., and Mr. F. DuCane Godman, F.R.S., the Rev. Alfred E. Eaton, M.A., Dr. David Sharp, M.A., F.R.S., Mr. A. G. Butler and the Honourable Walter Rothschild, Miss Lilian J. Gould, Mr. Lionel de Nicéville, Mr. Samuel H. Scudder, Mr. Charles J. Gahan, M.A., Mr. W. L. Distant, Mr. Oswald Latter, M.A., and Mr. Edward B. Poulton, M.A., F.R.S. Of these 19 papers, 13 relate to Lepidoptera (or to inquiries in which Lepidoptera were the subjects of experiment), 2 to Coleoptera, 2 to Hemiptera, 1 to Neuroptera, and 1 to Arachnida.

The memoirs above referred to are illustrated by 15 plates, of which 10 are coloured. The Society is indebted to the Honourable Walter Rothschild for the cost of Plates IV. and X.; to Mr. F. D. Godman for the cost of Plates V., VI., VII., and XII.; and to Mr. E. B. Poulton for part of the cost of his paper and part of the cost of Plates XIV. and XV.

The Proceedings, containing an account of the exhibitions and discussions at the Meetings, in addition to abstracts of several of the papers published in the Transactions, extend to over 40 pages.

The publication of a Catalogue of the Books and Pamphlets in the Society's Library has long been under consideration, and a copy of the manuscript catalogue has been prepared, some portion of which is in type, and it is expected that it may be published this year.

During the past year about 200 Books, Pamphlets, Journals, and Papers have been added to the Library; and the Meetings have been better attended than in any previous year.

The Subscriptions received for the year amount to a larger sum than in any previous year, but only one Life-Composition has been received. The sales of publications show a considerable diminution as compared with last year, not so much in current sales as in the absence of demand for long sets, which swelled the receipts last year. The amount paid for rent and office expenses is considerably in excess of last year, chiefly owing to costs of stock-taking, which was much needed. The item under books and binding is again heavy; more books have been purchased than has usually been the case, and the cost of binding is still in part due to work that had fallen into arrear.

The cost of compiling the Library Catalogue in form for printing has been transferred to 1893, as being at present unproductive.

The following is an abstract of the receipts and payments during 1892:—

Receipts.	£	s.	d.	Payments.	£	s.	d.
Balance in hand 1st January, 1892 - -	24	17	9	Rent, Office Expenses, & Salary to Assistant Librarian - - -	169	3	2
Contributions of Fellows - - -	383	8	3	Printing - - -	117	14	6
Sale of Publications -	68	2	2	Plates, &c. - - -	41	13	0
Donations - - -	25	17	6	Books, Bindings, &c. -	31	4	7
Interest on Consols -	11	9	8	Catalogue Expenses -	26	19	0
Catalogue Expenses transferred to 1893 -	26	19	0	Subscriptions in advance carried to 1893 -	15	15	0
				Balance - - -	138	5	1
	£540	14	4		£540	14	4

11, Chandos Street, Cavendish Square, W.
January 18*th*, 1893.

The Secretary having received two notices proposing to substitute the name of Prof. Raphael Meldola, F.R.S., for the name of Mr. Henry J. Elwes, contained in the lists prepared by the Council, a formal ballot took place for the election of a member of the Council and for a President. Mr. A. B. Farn, Mr. G. F. Hampson, and Mr. C. O. Waterhouse were appointed Scrutineers, and on the ballot papers being counted, it was found that Mr. H. J. Elwes had a majority of votes. According to the ballot the following Fellows constitute the Council for 1893:—Charles G. Barrett; George C. Champion, F.Z.S.; Henry John Elwes, F.L.S.; the Rev. Canon Fowler, M.A., F.L.S.; Charles J. Gahan, M.A.; Frederick D. Godman, F.R.S.; Herbert Goss, F.L.S.; Robert McLachlan, F.R.S.; Frederic Merrifield; Osbert Salvin, M.A., F.R.S.; Dr. David Sharp, M.A., F.R.S.; Colonel Charles Swinhoe, M.A., F.L.S.; and George Henry Verrall.

The following were the Officers elected :—*President*, Mr. Henry John Elwes ; *Treasurer*, Mr. R. McLachlan ; *Secretaries*, Mr. Herbert Goss and the Rev. Canon Fowler ; *Librarian*, Mr. George C. Champion.

Mr. F. D. Godman, the outgoing President, then delivered an Address, at the conclusion of which Lord Walsingham proposed a vote of thanks to Mr. Godman for his services as President during the year, and for his Address. The proposal was seconded by Mr. J. H. Leech, and carried unanimously. Mr. Godman replied.

A vote of thanks to the Treasurer, Secretaries, and Librarian was moved by Dr. Sharp, seconded by Mr. W. H. B. Fletcher, and carried unanimously. Mr. McLachlan, Mr. Goss, and Canon Fowler severally replied.

ENTOMOLOGICAL SOCIETY OF LONDON.

Balance Sheet for the Year 1892.

Receipts.	£	s.	d.	Payments.	£	s.	d.
Balance in hand, Jan. 1st, 1892 - - - -	24	17	9	Printing - - -	117	14	6
Subscriptions for 1892	296	2	0	Plates, &c. - - -	41	13	0
Do. in advance	15	15	0	Rent and Office Expenses - - -	169	3	2
Arrears - - - -	7	10	3	Books and Binding -	31	4	7
Admission Fees - -	48	6	0	Catalogue Expenses -	26	19	0
Life Composition -	15	15	0	Subscriptions in advance carried to 1893	15	15	0
Donations - - - -	25	17	6	Balance - - -	138	5	1
Sale of Publications -	68	2	2				
Interest on Investments	11	9	8				
Catalogue Expenses, transferred to 1893 by order of Council -	26	19	0				
	£540	14	4		£540	14	4

ASSETS.

Subscriptions in arrear (considered good), £5 5*s.* 0*d.*

Investments:—

Cost of £427 19*s.* 3*d.* Consols = £408 13*s.* 0*d.*

LIABILITY.

West, Newman and Co.'s Account for Part IV. of the Transactions for 1892; amount not at present ascertained, but which will probably not be less than the balance in hand.

Robert McLachlan,
Treasurer.

Audited and found correct,

Samuel Stevens.
J. Jenner Weir.
Charles G. Barrett.
Edward Saunders.
G. C. Champion.

11th January, 1893.

THE PRESIDENT'S ADDRESS.

GENTLEMEN,

SINCE the close of the past year, and since I undertook the duty of preparing the following Address, our Honorary Life-President, the venerable JOHN OBADIAH WESTWOOD, has been removed from us by death. I do not now propose to make any attempt to give a summary of the work of this eminent Entomologist, which would adequately occupy, of itself, the whole of the time at my disposal, and which must be postponed to our next Anniversary. Suffice it to say that the late Prof. Westwood was one of our original Members, and for about sixty years took an active interest in our welfare; and, after serving in various offices in connection with our administration, was unanimously elected Honorary Life-President at a Special Meeting of the Society, held on the 2nd of May, 1883. He died at Oxford on Jan. 2nd, 1893, in his 87th year, having been born on December 22nd, 1805.

Besides the loss of our Honorary Life-President, our Society has during the past year suffered severely by the deaths of two of our Honorary Fellows and of eight Ordinary Fellows, including amongst them several of great distinction.

PROFESSOR HERMANN CARL CONRAD BURMEISTER, M.D., who was elected an Honorary Member in 1875, was born at Straslund on the 15th of January, 1807, and died at Buenos Ayres on the 2nd of May last. In early life he lived at Halle, where he studied for the medical profession, and was a pupil of Nitzsch, whom he subsequently succeeded in the chair of Zoology in the University of Halle in 1842, having well qualified himself for the post by his able writings on Natural History subjects, Entomology forming no inconsiderable portion. The first volume of the 'Handbuch der Entomologie,' by which Burmeister established his fame as a patient and able writer, was published in 1832, when its author was only twenty-five years old. An English translation of this work was undertaken by Shuckard and appeared in 1836, and formed an 8vo volume of 654 pages, illustrated by thirty-two plates, relating mostly to structural and anatomical characters. Four more volumes of the 'Handbuch' were published, the last in 1847, which dealt with the systematic portion of his subject. This, however, was never completed, for its author having become involved in the politics of that stormy period (he had been elected a deputy by his fellow citizens to the short-lived National Assembly), he obtained two years' leave of absence from the university. Proceeding to Brazil, he joined Lund, the well-known Scandinavian naturalist at Lagoa Santa in the province of Minas Geraes. Here he had the misfortune to break his leg, and was carefully nursed by Lund and the late Prof. Reinhardt of Copenhagen, who happened to be there at the time. Though lame for the rest of his life, Burmeister nevertheless pursued his explorations, sending large collections to the Halle Museum. The 'Systematische Uebersicht der Thiere Brasiliens' and the 'Erläuterungen zur Fauna Brasiliens' were the outcome of this period.

In 1858 he traversed the Andes to Chili by way of Mendoza, and returned to Europe *viâ* Panama and the West Indies. During a short stay in his old home at Halle he published his 'Reise durch die La Plata-Staaten' in two volumes, which still remains a standard work on the Vertebrates of the Argentine Republic. Returning to Buenos Ayres, Burmeister devoted himself for the remainder of his life chiefly in studying and describing the wonderful fossil mammalia of the tertiary deposits of the Argentine Republic, the results being published in the 'Anales del Museo Publico de Buenos Aires,' in a series of papers illustrated by well-executed plates, prepared from the author's own drawings. During this long period Burmeister still continued his interest in Entomology, and in 1879–80 he published in his 'Description Physique de la République Argentine' two parts devoted to the Lepidoptera of his adopted country.

Dr. Carl August Dohrn, who died on the 4th of May last, at Stettin, in the 86th year of his age, was born on the 27th of June, 1806. He was elected a Member of our Society in 1855, and an Honorary Fellow in 1885. On the death of Dr. Wilhelm Schmidt, the first President of the Entomological Society of Stettin, which had been founded in 1839, Dr. Dohrn, who was then acting as secretary, was selected for the vacant post, and duly elected on the 5th of November, 1843, President of the Society, a post he held until his retirement in 1887, when he was succeeded by his eldest son, Dr. Heinrich Dohrn. Dr. Anton Dohrn, his youngest son, is well known to zoologists as the founder of the Zoological Station at Naples.

Under Dr. Dohrn's presidency the Entomological Society of Stettin flourished, and its 'Zeitung,' which has been issued with unfailing regularity, now extending to fifty-three volumes, is one of the leading entomological periodicals of the day, and is full of important memoirs, many of them written by Dohrn himself. Though sympathizing with entomologists of all branches of the science, Dohrn's work was restricted to the study of certain families of Coleoptera, the *Paussidæ* being a group of special interest to him.

Besides being eminent as an entomologist, Dohrn was an excellent linguist and musician, and a man of great intellectual acquirements.

Sir Richard Owen, K.C.B., F.R.S., whose death took place so recently, at the advanced age of 88, was born at Lancaster on the 20th of July, 1804, and died at his residence (Sheen Lodge, Richmond Park) on the 18th of December, 1892. He joined our Society as a Member more than fifty years ago, having been elected in 1841. Though so eminently distinguished for his writings, chiefly on Vertebrate Zoology, I am not aware that he paid any special attention to Entomology. One important Memoir, however, connected with the subject, especially relating to Aphidæ, was published by him in 1849, entitled "On Parthenogenesis, or the successive production of Procreating Individuals from a single ovum."

Henry Tibbats Stainton, F.R.S., who died at Lewisham on the 2nd of December last, in his 71st year, was born on the

13th of August, 1822. He joined our Society in 1848, and was one of the Secretaries in 1850 and 1851, President in 1881 and 1882, and frequently a member of the Council. During the whole of that time he was one of the most regular attendants at our meetings, until the last few months, when prevented by the illness which eventually proved fatal. Stainton's work was practically restricted to Lepidoptera, though his knowledge of other Orders of insects, and of Natural History generally, was extensive. His writings extend over a long period, commencing in 1845, and continuing almost to the day of his death. They consist not only of separate works, but also of frequent contributions to periodical literature; indeed the 'Entomologists' Intelligencer,' the 'Entomologist's Annual,' and the 'Entomologist's Monthly Magazine' were all originated, and edited conjointly with others, by him. By degrees his energies were concentrated upon the Tineidæ and Pterophoridæ of his native country and of Europe, families which he found in great confusion, and which he with others reduced to their present order. This result was mainly attained in the 'Natural History of the Tineina,' of which thirteen volumes were published between 1855 and 1873, by Stainton, with the cooperation of Zeller, Douglas, and Frey. All his writings prove him to be an exceedingly careful observer, anxious above all things to base his work upon sufficient materials, so as to avoid error and lessen the labours of posterity. In his presidential address for the year 1882, he goes so far as to recommend that no species should be described upon less than twenty to thirty specimens, and advocated an amount of self-denial in such matters, which I imagine hardly any of us are prepared to put in practice, however much we may wish it. We should all like to have such a goodly array of specimens of every new species before us, but I am afraid our wishes are seldom gratified. Anyhow, Stainton's wish shows the cautious nature of his disposition. His business habits caused him to be sought by many Societies to assist in their government. He was for a short time Secretary to the Linnean Society, and one of the Secretaries of Section D of the British Association for several years, and also of the Ray Society from 1861 to 1871, during a critical period of its history. When Mr. Van Voorst discontinued the publication of the 'Zoological Record,' in 1871, Stainton was principally instrumental in founding the Zoological Record Association, which was continued till 1886, when its indispensable publication was undertaken by the Zoological Society of London. The collections of his favourite groups amassed by Stainton are very extensive, and he also possessed a valuable entomological library, the basis of which was that of J. F. Stephens. A Catalogue of the latter was published by Stainton in 1853. His Cabinets and Library were always freely open to all who wished to consult them. For many years Stainton was a keen collector of British Lepidoptera, and he eagerly sought recruits to join him in his expeditions. The influence thus acquired over many a young naturalist was very great. One of the most useful results of this period was the publication of the 'Manual of British Butterflies and Moths,' compiled in a concise and readable style, which remains to this day the best book on the subject. Stainton was elected a Fellow of the Royal Society in 1867, and served on the Council in 1880—1882.

Henry Walter Bates, F.R.S., who died on the 16th of February last, in his sixty-eighth year, was born at Leicester on the 8th of February 1825. He joined our Society in 1861, and was elected President for the years 1869 and 1870, and again for 1878, and frequently acted as one of our Council. I do not propose to repeat here the outlines of Bates's life, which have been already given, not only in Entomological Journals, but fully in the 'Proceedings of the Royal Geographical Society' for April last, and again in the admirable Memoir, by Mr. Edward Clodd, which accompanied a new edition of the well-known 'Naturalist on the Amazons,' lately published by John Murray; but there are points in Bates's life, especially relating to his entomological work, upon which I should like to say a few words. These concern his collections made chiefly during his travels, and the work he subsequently based upon them in its various aspects. Bates's collections made during his eleven years' residence in the Valley of the Amazons contained, according to his own computation, specimens of 14,700 species, of which about 8000 were judged to be novelties. The latter statement was questioned at the time; but Bates adhered to his figures, and there is every reason to believe that his estimate was below, rather than above, the actual number; but no accurate statement on this point can now ever be arrived at, for to this day there must be numbers of Bates's discoveries, in almost all Orders of insects, stored undescribed in various museums and cabinets throughout Europe. Moreover, in a number of cases, even where the species are described, the origin of the types has not been fully and properly acknowledged. This is seen in reference to one of Bates's favourite groups, the Diurnal Lepidoptera, a large number of which were described and figured by the late W. C. Hewitson, who — acknowledging in a general way Bates's contributions to his favourite study—in a very large number of cases contented himself with giving the habitat of a species as simply Amazons, without any authority. Mr. Wilson Saunders, who also acquired a number of Bates's specimens, simply ticketed them "Amazons." This serious omission, so far as the Diurnal Lepidoptera are concerned, is to some extent remedied by Bates's own writings on this group; but he never published his notes on the numerous and important families Lycænidæ and Hesperiidæ, so that we must look elsewhere for further details on these families. His own private collection, which some years ago passed into my possession, furnishes these so far as the Lycænidæ are concerned; but the series of Hesperiidæ (the great stumbling-block to all systematists on the group) is far from complete. On the whole, therefore, it would be possible to compile a tolerably complete list of the Diurnal Lepidoptera collected by Bates during his memorable expedition. But I believe I am right in supposing that, with the exception of a few families of Coleoptera, no such list could be made of any of the other Orders of insects in which he interested himself. This of course is greatly to be regretted; but Bates's is by no means an isolated case, but rather the rule that has prevailed as regards the collections of our greatest travellers. Where, for instance, are the specimens collected by Darwin, and even by Wallace? As regards his own collections, Bates himself tells us what became of them, and the reason of their dispersal, in the following paragraph in his Preface to his 'Travels':—"It will be an occasion for regret to many naturalists to learn that a complete set of the species has nowhere been preserved, seeing that this would have formed a fair illustration of the Fauna of a region not likely to be explored again for the same purpose in our time. The limited means of a private traveller do not admit of his keeping, for a purely scientific end, a large collection. A considerable number, from many of the consignments which arrived in London from time to time, were chosen for the British Museum, so that the largest set next to my own is contained in our National Collection; but this probably comprises less than half the total number of species obtained. My very complete private collection of insects of nearly all the Orders, which was especially valuable as containing the various connecting varieties, ticketed with their exact localities for the purpose of illustrating the formation of races, does not now exist in its entirety, a few large groups having passed into private hands in different parts of Europe." His private collection of Diurnal Lepidoptera, upon which he bestowed much attention during his travels, and to which he added subsequently from every available source, passed, as I have already said, into my hands many years ago. Bates then concentrated his energies upon a close and comprehensive study of the Geodephaga, the Lamellicornia, and the Longicornia of the Coleoptera, and amassed large collections of each. These, by his own arrangement and wish, passed, at his death, into the possession of Mons. René Oberthür, of Rennes. When Mr. Salvin and I commenced an attempt to gather together our scattered knowledge of the fauna and flora of Mexico and Central America, Bates was one of our most trusted advisers in planning the work. He hesitated for some time before consenting to take an active part in it, but eventually undertook the charge of the three groups of Coleoptera in which he was an expert. Once having commenced, he persevered with characteristic energy until his task was completed. The Longicornia were begun in

November, 1879, and finished in January, 1886; the work on the Geodephaga occupied from October, 1881, to December, 1884; and that on the Lamellicornia from May, 1886, to January, 1890. During the whole of this time we were receiving large consignments of specimens from various parts of the country we were investigating, and as the new arrivals came in Bates was duly summoned to inspect the contents, and the keen interest he showed, as a novelty here and a rarity there was spied in each box as he scanned it, was always a pleasure to watch. The specimens thus acquired were duly handed over to him to work out; a complete set was then put aside, to be returned to us, and then Bates was at liberty to add what he pleased to his own collection, and I am glad to know that by this means his stores were considerably enlarged. The first set of all these collections has now been placed in the British Museum, to be eventually incorporated into the National Collection.

It has frequently been said with truth that Bates was a many-sided man, and this is especially true as regards his entomological work, for not only was he a good collector and a good observer, but also his general reasoning and his systematic work were of a very high order. This combination of qualities seems to me to be of special value at the present day, when it is the practice of some to extol certain branches of our subject, and to decry others; to exalt generalisations, and to depreciate the drier and less attractive labours of the systematist. Personally I recognise no such antagonism, for the successful collector is ever bringing forward fresh stores of material to the systematist, who again reduces that material to order, and constantly enlarges the basis upon which the generaliser constructs his theories, which without systematic work would stand upon far too narrow a foundation. Bates's generalising power is largely shown in his well-known works, and especially in that relating to the theory of mimicry. This was the outcome of constant collecting and observation, and subsequent systematic work; indeed, to the latter labour nearly the whole of the published work of the later portion of his life is devoted. Those who were acquainted with him personally, as it was my good fortune to be for upwards of a quarter of a century, well knew that the theories which interested him so keenly in the earlier part of his career to him never lost their charm, and never ceased to enliven the more purely systematic work at which he laboured so industriously. In the introductory portion of his Contributions to the Coleoptera of the Biologia Centrali-Americana, which treats of the geographical distribution of some of the orders, he constantly alludes to our imperfect knowledge of the distribution of species, and speaks with diffidence as to the general relationships of the local forms he was treating of, showing that he was keenly alive to the imperfections of our knowledge of even the better-known families of Coleoptera, and the danger of generalising on too narrow a basis. To my mind, Bates's method of work is one to be followed by everyone aiming at producing sound results, and is the same as that followed by Darwin, and by the great botanist whose admirable letters to Bates have recently been published in Mr. Clodd's memoir. Referring to his address to this Society in 1879, it will there be seen what his own views on the subject were. After alluding to the preponderance of strictly systematic entomological literature of the day, which he attributed to the prodigious influx of material from various countries constantly being opened up by the growing facilities of communication, he deprecated this class of work being confined to the mere description of species and genera, and urged the elaboration of the general results of their observations, which would throw light upon the genetic relations of forms. He goes on to say that "all our knowledge of natural affinity in biology, or the true blood-relationship of forms, has been due to the labours of systematists and 'species-describers': not always consciously, but through their endeavours, persisted in with prodigious industry and keenness, to discover characters which may enable them to classify satisfactorily the objects of their study. It has fortunately happened that the instinctive perception of truth (less clear and strong in some than in others) has been such that no classification has satisfied them, until it has become a natural one: thus without knowing it, or intending it, their labours have gradually tended to the abandonment of artificial systems and to the discovery of arrangements which express the true genetic relations of forms."

Our science will be best served when workers in its various branches regard one another as contributors, each in his special department for the welfare of the whole, not urging the superior claims of one subject in preference to another, but as mutually resting on one another, and no one being complete in itself. This is the teaching of Bates's life which may be profitably followed by us all.

Howard W. J. Vaughan, who died on the 18th of October last at the early age of forty-six, was born at Hackney on the 18th of April, 1846. By profession a solicitor, a keen lepidopterist and a frequent contributor to entomological literature, and for a time Editor of the entomological column of the journal known as 'Young England.' For a long time he specially interested himself in the *Phycidæ* and *Tortricidæ*, but subsequently he devoted his attention to varieties of British Lepidoptera generally, of which he amassed a very large collection, which was broken up in 1890. He joined our Society in 1869.

Harry Berkeley James, who died on the 22nd of July last, was born on the 9th of March, 1846, and resided for many years on the west coast of South America, both in Chili and Peru. His chief pursuit in those countries was Ornithology, and he made a very complete collection of Chilian birds, including those of the districts which formerly belonged to Southern Peru. At the time of his death he was engaged with Mr. Sclater in the preparation of a work on the birds of Chili. During his sojourn in South America he also collected specimens of several orders of insects, especially during a journey to Chanchamayo, on the eastern side of the Cordillera. I am not aware, however, that he ever published any account of his entomological captures. Mr. James was elected a Fellow of our Society in 1885.

John Thomas Harris, who died at Burton-on-Trent on the 3rd of October last, at the age of sixty-two, was a banker by profession, but a keen naturalist. In his earlier days Botany was his chief pursuit. He subsequently devoted himself chiefly to Coleoptera, of which he formed an extensive collection of British species, and was the discoverer of *Macronychus quadrituberculatus* and other species in this country. He was one of the founders of the Burton-on-Trent Natural History and Archæological Society, and one of its earlier Presidents. He was elected a Fellow of our Society in 1886.

We have also to regret the loss by death of Edward Henry Burnell, who joined our Society in 1855; and of Sidney Philip Smith, who joined in 1885.

Of entomologists, not Fellows of our Society, who have died during the past year, I may mention the following:—Henry Whitely, Jun., well known for many years as a traveller and collector, died in British Guiana on the 11th of July last. He was born at Woolwich on the 18th of June, 1844, and started on his first expedition to Japan in 1864. Here he spent a short time, and then proceeded to Peru, where he remained in the mountainous parts of the southern portion of that country for a considerable period. He left Peru by way of the Amazons, and after spending some time at Iquitos he proceeded to Pará, and thence to England. His next expedition was to British Guiana, over a considerable portion of which country he travelled, penetrating as far as the precipitous sides of Roraima. Though chiefly occupied in collecting birds, a pursuit which he followed with unflagging industry and success, he also made several large and interesting collections of Diurnal Lepidoptera. Mr. Whitely's series of butterflies from Peru was described by Mr. Herbert Druce in the 'Proceedings of the Zoological Society of London' for 1876, where it formed an important part of his List of the Diurnal Lepidoptera of that country.

Amongst British entomological collectors who were not Fellows of our Society, I may mention the names of Mr. George Haggar, of Hastings, and Mr. Francis Archer, of Liverpool, both of whom did good work in their special studies.

Of our co-workers abroad, we have lost M. l'Abbé Leon Provancher, a French Canadian, who died at Cap Rouge, Quebec, in April last, in his seventy-second year. He was Editor of the 'Naturaliste Canadien,' and author of the 'Petite Faune Entomologique du Canada.' He chiefly devoted his attention to the *Ichneumonidæ*.

The obituary notices which I have now concluded have occupied so much of the time devoted to this Address that little remains for other matter, but there is one subject of great interest to our Society upon which I should like to say something. The Catalogue of the books contained in our Library, which was commenced by our late excellent Librarian, Mr. Ferdinand Grut, has made under his successor, Mr. Champion, sufficient progress to enable me to say a few words respecting it. The manuscript is already completed, and in the printer's hands, and the number of titles of works of various kinds nearly reaches 5000. As most of our Fellows know, our Library contains a large number of pamphlets, being authors' copies of their papers printed in many of the various journals of the scientific societies in different parts of the world. One of the first questions that arose in fixing the scope of our new Catalogue, was whether or not these should all be entered under separate headings, as if they were separate, independent works. The decision that they should be so entered has more than doubled the number of titles in the Catalogue, but at the same time has, in my opinion, more than doubled its utility to our Fellows. It is of the greatest importance to the growth of our Library and the utility of our Society that our Fellows should have as free access to our books as possible, and these separate "papers" are exactly in the form that is most convenient to lend to our country Fellows for use in their own homes. We may hope, therefore, that this branch of our Library may be constantly and largely increased, for, besides the advantage already mentioned of facility of loan distribution, these pamphlets occupy a comparatively small space on our shelves, and are much more economically housed than books, which often contain matter which is not entomological, and therefore outside the studies to which we especially devote ourselves. We have only to look at the pages of the 'Zoological Record' to see how important, to a Society like ours, whose means are, alas! far too limited, concentration of subjects and economy of space become. We need only look at the volume for 1891, which, through the untiring energy of Dr. Sharp, one of our late Presidents, has now been for several months in our hands, to form some estimate of what is required of a Library that hopes to keep pace with the literature of the time. We find there that the number of separate titles belonging to the Insecta alone reached in the year 1891 the large total of 974, and the new generic names proposed for insects in the same year 765, the latter being considerably more than half the number of generic names proposed in the whole of the zoological literature of the year. And yet this large amount of literature does not nearly keep pace with the flood of new material that reaches us from all parts of the world! That the Entomological Society's Library should grow in proportion to the literature of the subject to which we devote so much of our energy is what we all wish, but a result we can hardly hope to attain. Nevertheless it is yearly of increasing importance that we should perform a definite share in gathering within the metropolis as much entomological literature as can be got together. Quite recently the Council of the Royal Society decided, after much discussion, that the Catalogue of Scientific Papers published under its auspices should in future be compiled from such periodicals only as are to be found in the libraries of the principal scientific societies in London. If this resolution is strictly adhered to, the societies in question should endeavour to see that no periodical of any importance should be omitted from one or other of their libraries, so as to render the Catalogue of Papers as complete as possible. This leads to the suggestion that some arrangement might be advantageously made between the societies themselves, so that each might take a share of maintaining certain periodicals, and that their money and space should not, as is often the case at present, be devoted to the acquisition of sets of the same periodical. A mutual arrangement of this kind would involve some kind of association between certain societies, so as to render their respective libraries accessible to their Fellows in common, and a plan to meet this might easily be devised. We have only to look at the books on our own shelves, to form a small estimate of the growth that has taken place in periodical literature during the last twenty-five years, and then look forward to what dimensions it will attain in another quarter of a century, to see that some step in this direction must necessarily be taken at no very distant date. This is merely thrown out as suggestive of a possible method of meeting a difficulty which I know occupies the thoughts of some of us, and must sooner or later be dealt with.

The Council have determined that the Catalogue of our Library, when finished, should be sold to our Fellows at a price just sufficient to cover the expense of its production, and I here express a hope that those who have not already ordered a copy will at once do so.

One other subject remains to which I wish to call your special attention. The Fellows are no doubt aware that a clause in the "Military Lands (Consolidation) Bill, 1892," introduced by the late Government as a modification of a former Bill with greater powers, still rendered it practically certain that a considerable portion of the New Forest would (if the Bill passed) be converted into a Military Rifle Range. An agitation against this clause, from all classes of naturalists throughout the Kingdom, was commenced, and petitions for its repeal were obtained, with signatures from all who are interested in preserving the New Forest intact. Our Secretary, Mr. Goss, was largely instrumental in formulating these petitions, and, at a meeting of the Council of this Society held in March last, Mr. Goss, and Mr. Elwes, a Vice-President, were appointed to represent the Society at a Government enquiry, held at Lyndhurst in April, and which lasted five days. These gentlemen attended and gave evidence; and there is every reason to believe that the action taken by this, and other Natural History Societies, had no small influence in inducing the Government to repeal the objectionable clause in the Bill referred to.

I must now thank you all for the consideration and courtesy extended to me during the two years that I have occupied this chair, and my thanks are especially due to the officers of the Society, who have rendered me all the assistance in their power. I am confident that the same consideration will be extended to my successor.

INDEX.

Where the name only of the Species or Genus is mentioned, the description will be found on the page referred to.

The Arabic Figures refer to the pages of the 'Transactions'; the Roman Numerals to the pages of the 'Proceedings.'

The same arrangement has been adopted as last year; the new genera and species, and those which have been redescribed, will be found in detail, but certain of the longer papers are arranged *generically* under their headings.

GENERAL SUBJECTS.

ARACHNIDA.

COLEOPTERA.

DIPTERA.

HEMIPTERA.

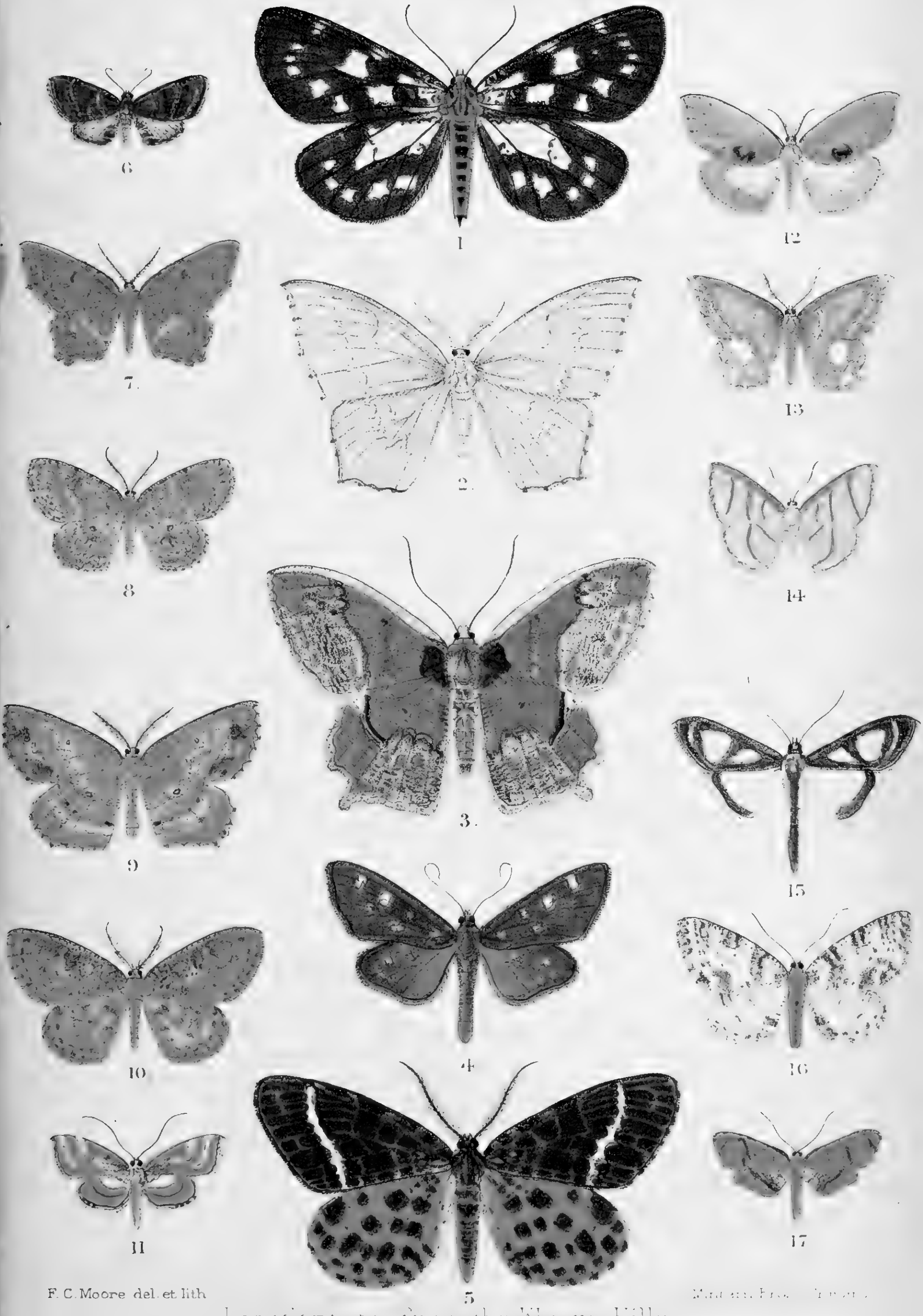
HYMENOPTERA.

LEPIDOPTERA.

NEUROPTERA.

ORTHOPTERA.

WEST, NEWMAN AND CO., PRINTERS, HATTON GARDEN, LONDON, E.C.



F. C. Moore del. et lith.

Lepidoptera from the Khasia Hills.

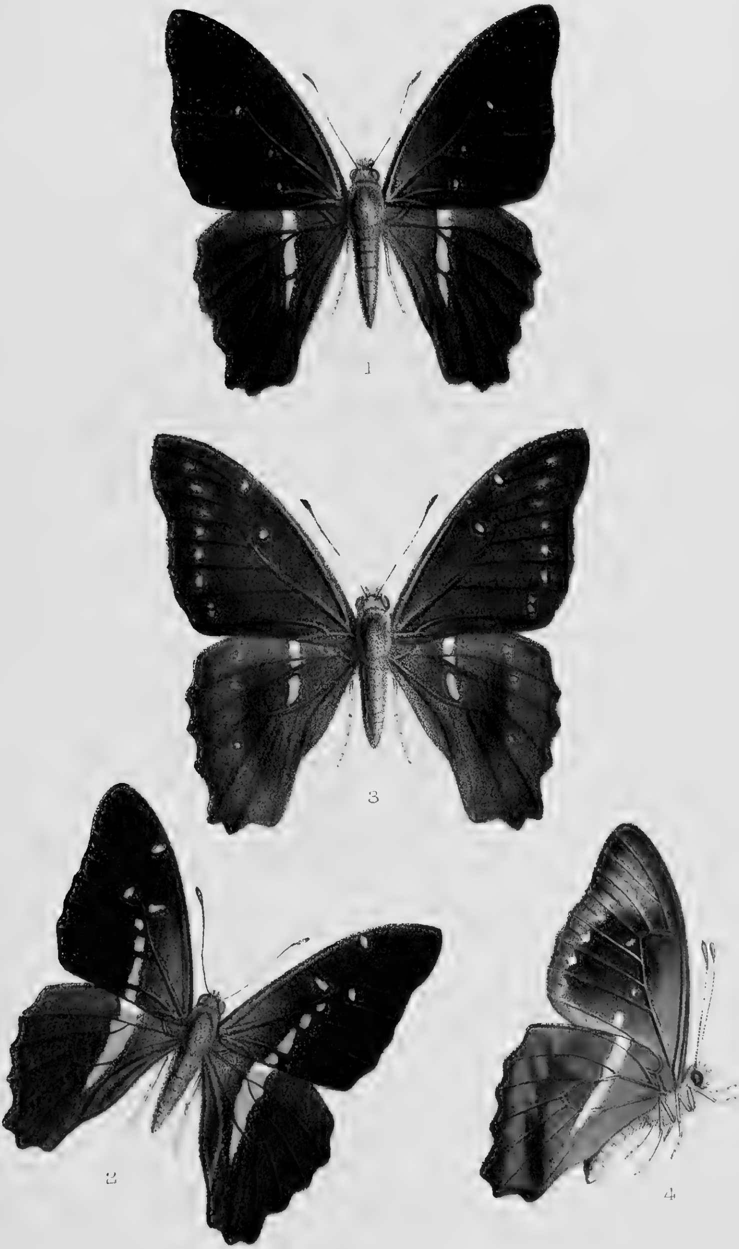
G.T.B-B. del. West, Newman Lith.

Genitalia of Species of Lycæna & Thecla.

E. Meyrick del.

West, Newman lith.

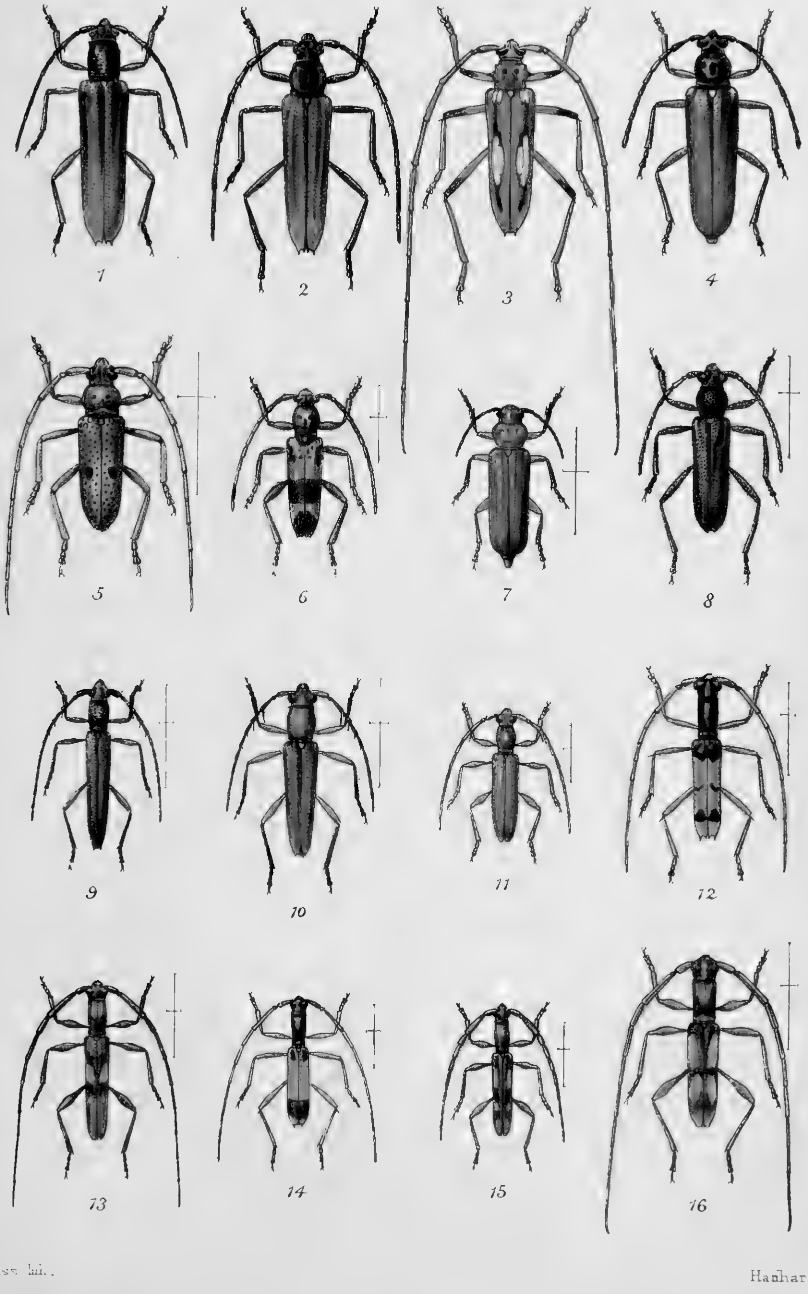
Neuration of Geometrina.



F. W. Frohawk del. et lith.

West, Newman chromo

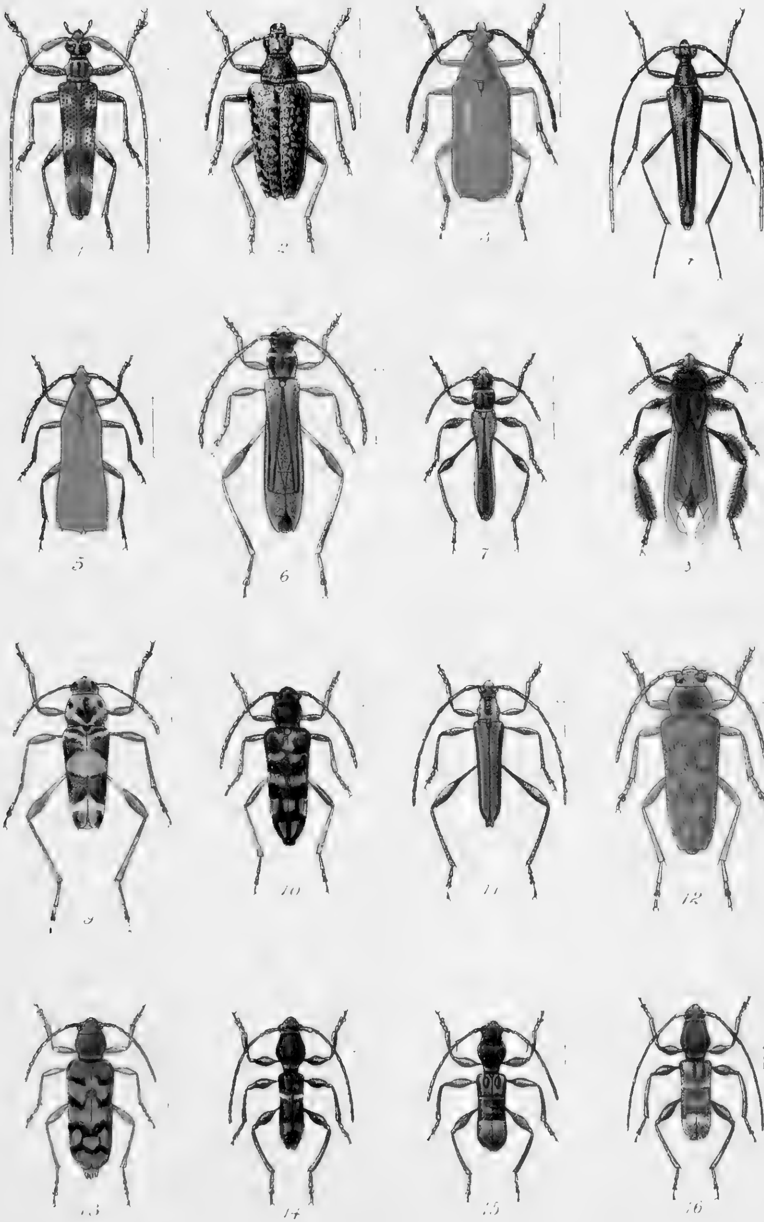
Papilio Gelon, *Boisd.*



W Purkiss lith.

Hanhart imp

New species of Longicornia from Mexico and Central America.



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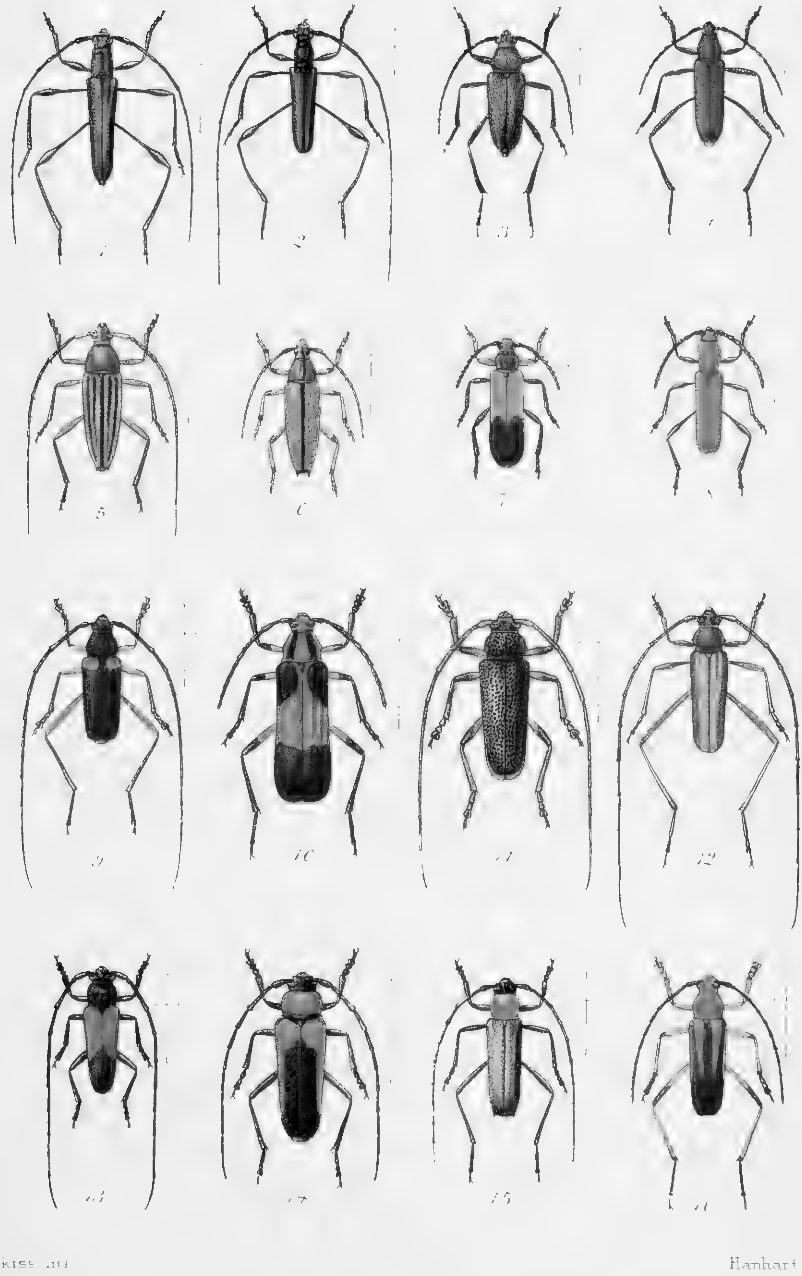
New Species of Longicornia from Mexico and Central America.



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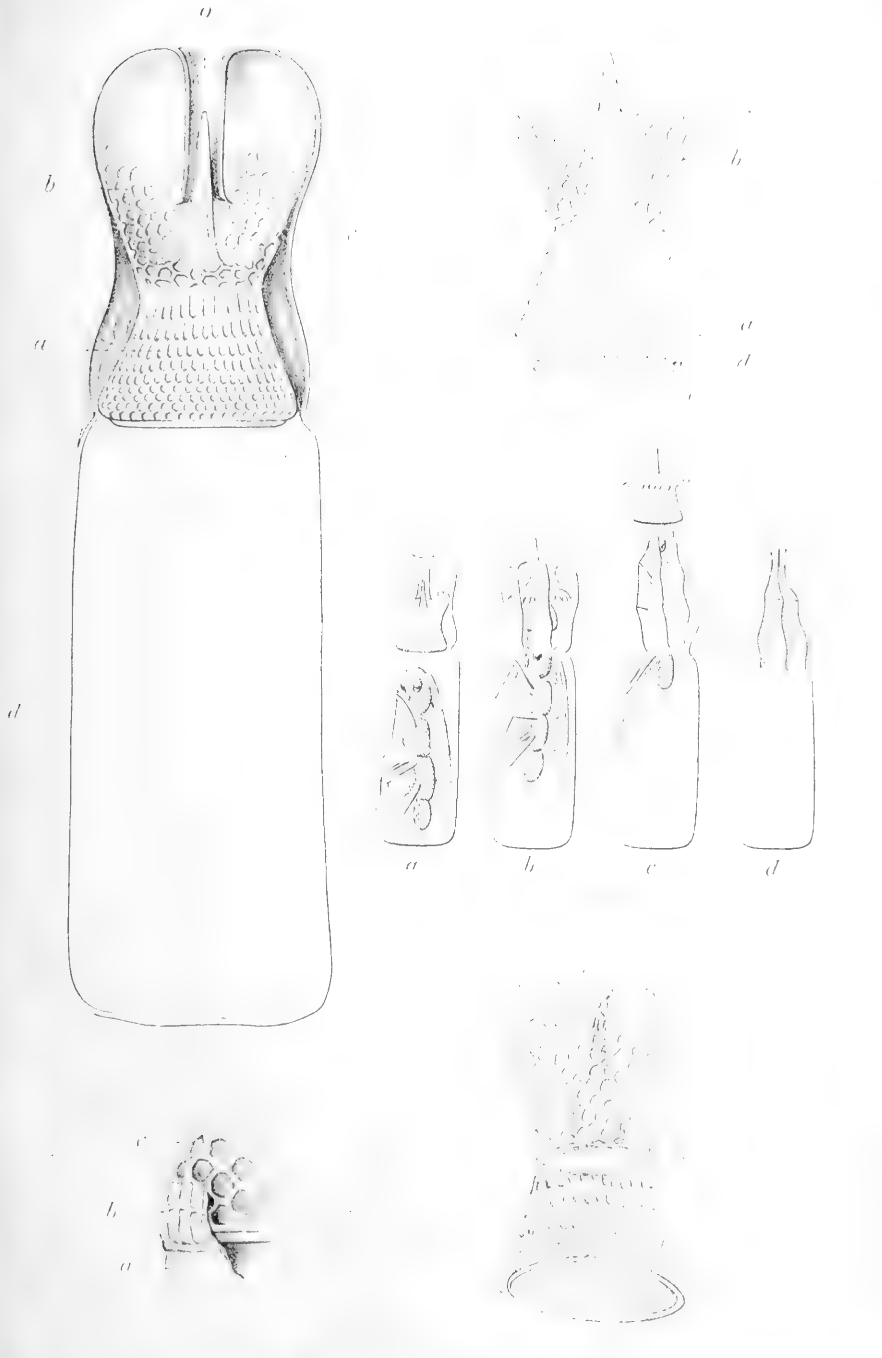
Hanhart imp.

New species of Longicornia from Mexico and Central America

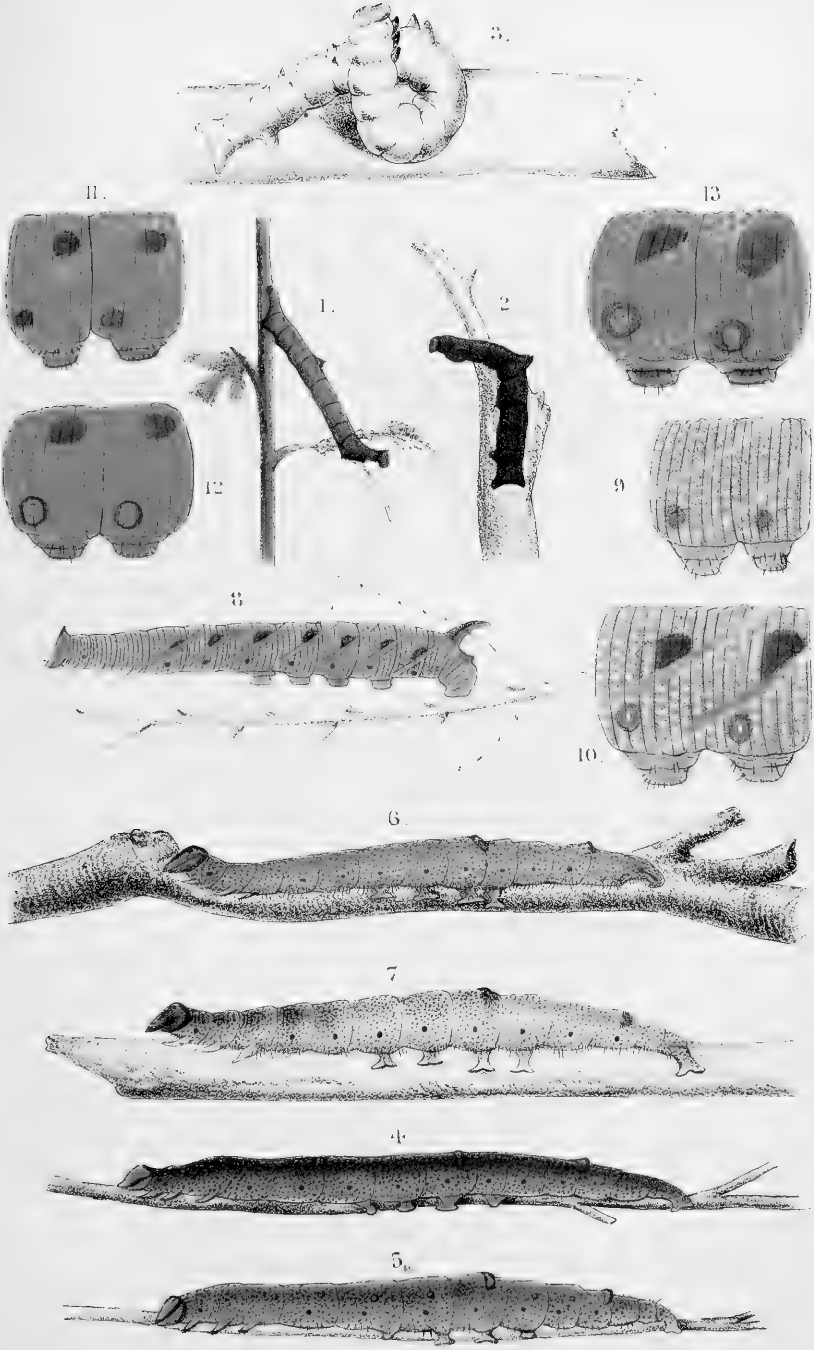


Edwin Wilson del.   Cambridge Engraving Co.

F. W. Frohawk del. et lith.

West, Newman chromo.

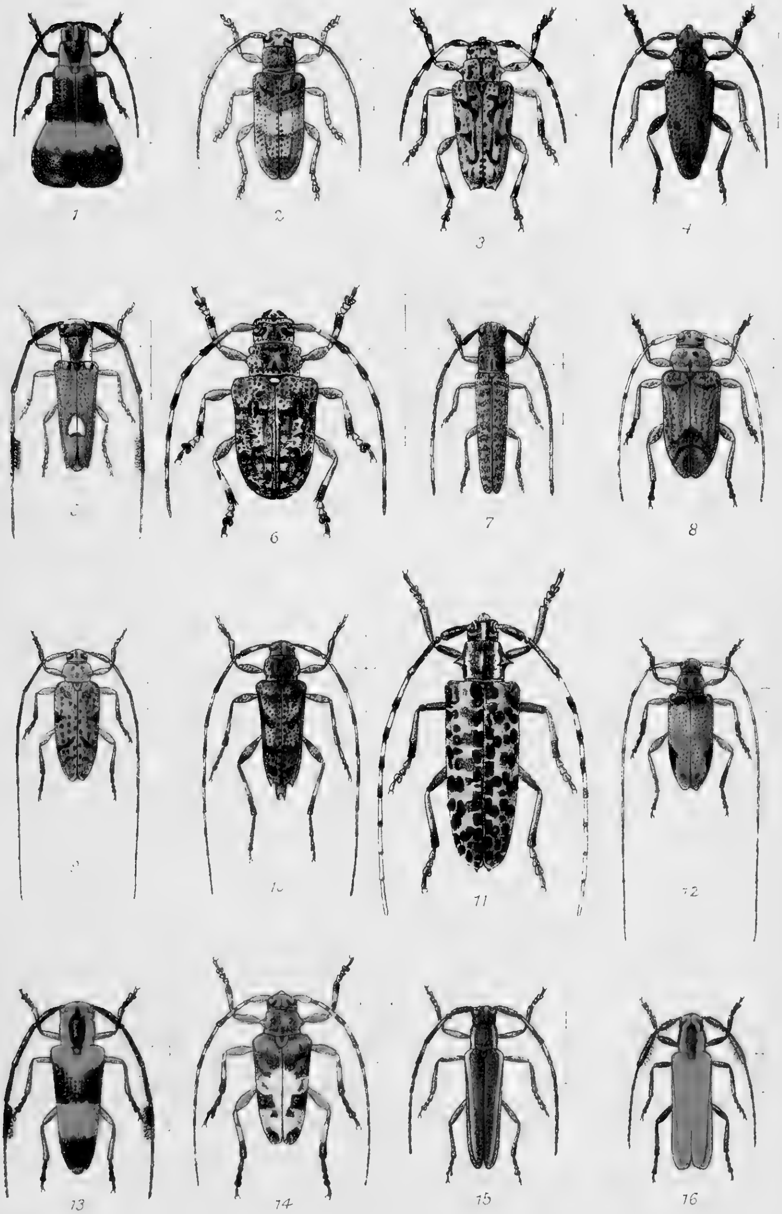
1. 1a Pseudacræa clarkii. 2. 2a. Pseudacræa poggei



Lilian J Gould del.

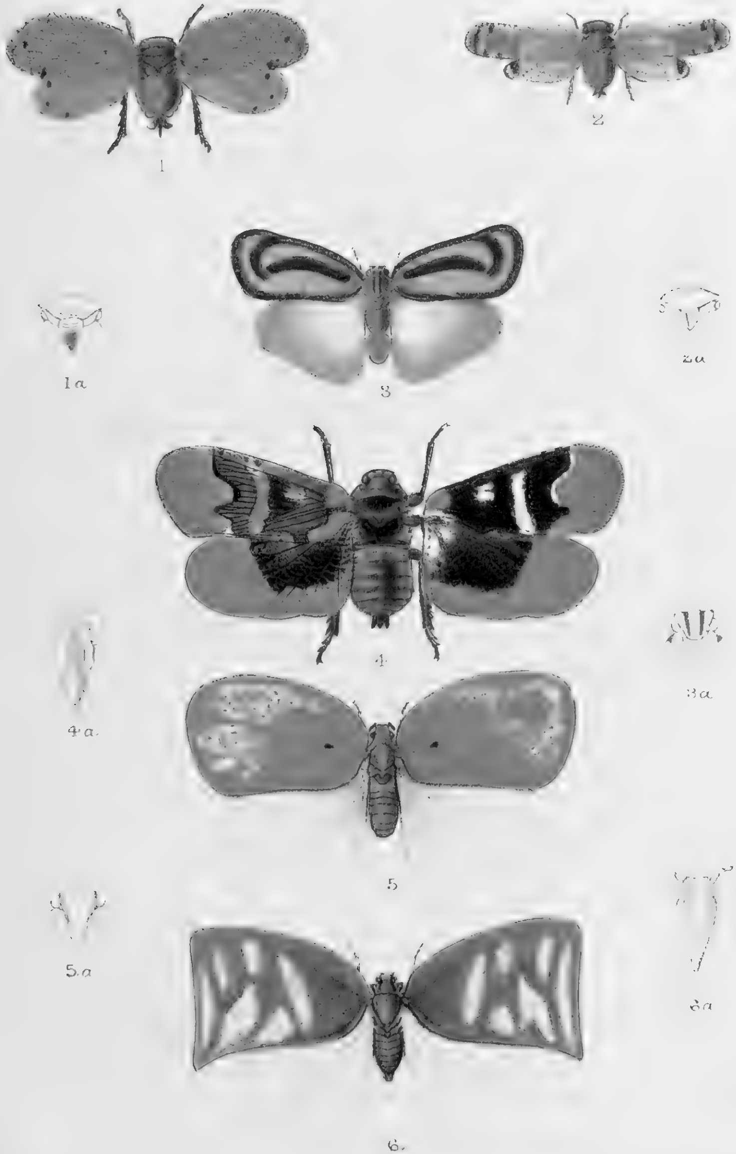
Mintern Bros. Chromo lith.

Colour relation between
Lepidopterous larvæ & their surroundings.



W. Purkiss, lith. Hanhart imp.

New species of Longicornia from Mexico and Central America.



West, Newman } chr. lith
Horace Knight }

New Species of Fulgoridæ.

J. T. Murray
Naomi Cundell } pinx.nt
E. B. Poulton

West, Newman chrom. lith.

Colour relation of larvæ of Geometræ to their surroundings

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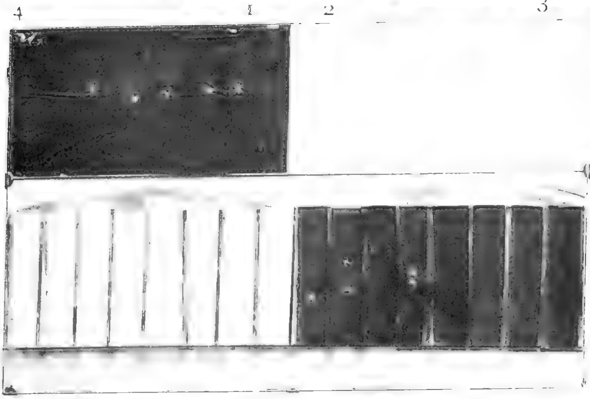

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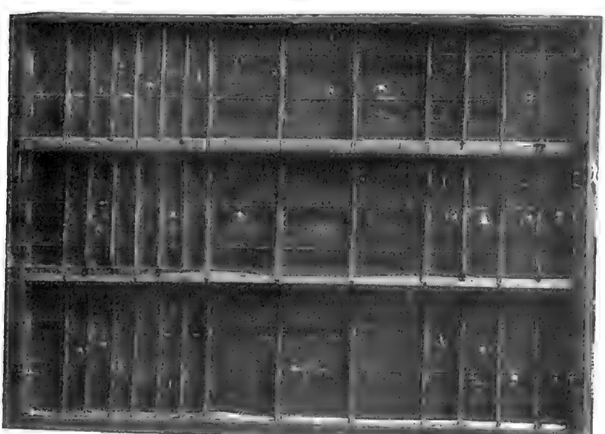

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E. B. Poulton University Press, Oxford

Experiments upon
the Colours of certain Lepidoptera