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# STUDIES on ALEURODIDAE.

Submitted by

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for the

DEGREE Ph. D., EDINBURGH UNIVERSITY.

# P A P E R  I.

## ANATOMY of some of the BRITISH ALEURODIDAE.

(Four Plates - Nos. I, IA, II. & III.)

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## INTRODUCTION.

There are some references on the study of the morphology of the Homoptera in which Cicada has been taken as a basis for the generalised structure. In the sub-order Sternorhyncha psylla has been studied, but there are hardly any references directly dealing with the Aleurodidae or any particular species except the general morphological and anatomical features described by Quaintance and Baker(1913) in their "Classification of the Aleurodidae,Part I.". No one has studied the structure of any of the British species.

In the following pages I have described in detail the morphology of all the stages, and some of the anatomical features of A.brassicae, and compared with that three or four other species whose life history has been studied. I propose to discuss here the morphological features of some of the British species. In all I came across 15 species all of which belong to sub-family Aleurodinae.

Egg : All eggs are stalked but the attachment of the stalk is not of the same type in all. In some it is central, in others it is lateral and in some it is far towards one side and always to the convex side (Pl.V.Fig.3 and Pl.XIII.Figs.1 and 5). The shape and size of the egg differs in different species. The usual shape is oval and pointed at one end, and generally curved on one side. The maximum size is

.38 mm. x .18 mm. Eggs are laid in circles, semi-circles and in some cases scattered. Colour is greenish yellow, yellow or whitish yellow.

Larvae and Pupae have been described in detail in Paper III. and hence I do not repeat the same. But one thing may be mentioned that the larvae of all the species are nearly of the same shape and structure while the pupae differ considerably in all aspects and especially in the form and structure of the vasiform orifice.

## A D U L T .

Eyes : In general two kinds of compound eyes are found (1) divided and (2) not divided or reniform. Some species like A.brassicae, A.proletella, A.rubi, A.lonicerae and A.fragariae have upper and lower divisions of the eyes quite separate (Pl.I Figs.1 & 2). T.sonchi and T.vaporariorum (Pl.I Fig.3) have divided eyes, but the division is not wide as in the above species and one of the lenses comes very nearly to touch the other division. The reniform structure in the undivided eye is formed by the two divisions of the eye being joined by the lenses touching one another like a bridge. In 'rubicola' (Pl.I Fig.5) the bridge is formed by one lens, in phillyreae (Pl.I Fig.6) and immaculata by three or four lenses, in quercus, chittendeni and azaleae by two (Pl.I Fig.4).

In /

In divided eyes there is a great difference in the size of the lenses of the upper and lower divisions, but the difference is not so marked in the case of species with undivided eyes and more so in the last two species in which it becomes hardly recognisable. The position of the ocellus (Pl.I Fig.3) is always anterior to and nearly touching the upper division of the eye and is not strikingly different in different species. There are about 60 lenses in the upper division of the eye and 50 in the lower. The diameter of the bigger lenses varies from .006 mm. to .010 mm., while of the smaller ones from .003 mm. to .004 mm. The maximum diameter of the ocellus is .018 mm.

Antenna : In general, the form of the antenna is the same in all species. The length varies in different species (see Paper III.). The seventh segment is not always the smallest as Quaintance and Baker say, but very often the fourth is found to be the smallest. The pit sensoria are 3 on the 3rd segment, one on the fifth and one on the seventh (Pl.V. Fig.12).

Rostrum : (Pl.I Fig.8). The structure is the same in all the species, though the length varies in different species. It is comparatively longer in species with immaculate wings than in the spotted ones.

Legs /

Legs : Length varies in different species, but the general structure is the same. The number of spines found on the tibia varies from species to species. One thing that is peculiar is, that the tarsal joints of the middle legs are invariably the smallest of the three, while all other parts are proportionately intermediate.

At the junction of the tarsus with the claws are three small sclerites centrally placed in a row (Pl.II Fig.7). These are kept in position by muscular attachments on both the sides to the claws and are fixed in the hollow of the distal end of the tarsus. The function of these sclerites appears to be to facilitate the movement of the claws and even the paronychium. In Orthoptera there are found two such sclerites and Snodgrass(1928) has named them 'the planta and the unguitractor plate'(and the part is called the pretarsus) and the pad-like structure which follows these two sclerites is called the 'aerolium'. In the Aleurodidae to the three sclerites above referred to is attached distally the paronychium which is apparently helped in movement by them. The paronychium which is hairy and blade-like has been called 'pulvillus' (Pl.II Fig.7). This appears to be a misnomer. Quaintance and Baker in their "Classification of the Aleurodidae Part I." on page/

page 14 remark that the Psyllidae have a prominent bilobed pulvillus, but in Aleurodidae it is undivided and single. The pulvillus is usually a bilobed structure and has its origin always near the claws. The empodium is a single structure and originates in the centre. It can also exist without the pulvillus as can be seen from the leg of a grasshopper where the padlike empodium is called the aerolium. So I am inclined to homologise the paronychium to and to call it an empodium, rather than pulvillus.

Wings : The size differs from species to species, but the structure and venation do not differ much; except that in some species the wings are spotted and in some they are immaculate.

Abdomen: Hargreaves(1915) describes in his paper that there are six segments visible in a female dorsally and the waxplates originate from the second. From the figure given by him it appears that he has not taken into consideration the peduncle. The latter (the attachment between the thorax and the abdomen) is nothing but the first abdominal segment rather differently formed. It can not be called the intersegmental membrane between the abdomen and the thorax, because the postnotum of the meta-thorax forms generally the intersegmental membrane between the thorax and the abdomen and that postnotum is well developed. So there/

there can not be a second intersegmental membrane. Further the peduncle appears to have definite tergum, sternum and pleurae and has thus definite structure of a segment(Pl.II Fig.1). Accordingly the waxplates begin on the 3rd segment. In all dorsally eight segments can be made out very clearly in the females.

This work was done under the guidance of Dr.C.B. Williams and my thanks are greatly due to him for all the help I received from him.

## METHOD and TECHNIQUE.

To study the internal structures, adults and larvae were dissected in 5% salt solution; sometimes before dissection, to remove the wax from the specimens; they were washed with ether. Of the various killing and fixing agents Carnoy's Fluid always gave good results. The formula is as follows:-

Absolute alcohol - 6 parts.
Chloroform - 3 "
Glacial acetic acid- 1 part.

For staining purposes Haematoxylin(Delafield) and Eosin were used. For skeletal structures and mounting the larval stages, specimens were boiled in 10% caustic potash for about a quarter of an hour or sometimes kept over night in cold caustic solution and washed thoroughly before examination. In making permanent preparation for the microscope, the general method /

method followed was :-

(1) Boil in caustic potash.
(2) Wash in distilled water.
(3) Place in Acetic acid.
(4) Stain while in Acetic acid by adding a few drops of fuchsin.
(5) Wash in a bath of 30% alcohol.
(6) Dehydrate by taking the preparation through 50%, 70% and 90% up to absolute alcohol.
(7) Clear in Xylol, cedar oil or clove oil.
(8) Mount in Canada Balsam.

Figures were drawn from permanent preparations by means of camera lucida.

For studying the tracheal system of the larva De Faure's mounting medium was made use of as recommended by Dr.A.D.Imms in the Bull.Ent.Res.XX.1929. It contains :-

(1) Gum Arabic - 30 gr.
(2) Chloral Hydrate - 50 "
(3) Glycerine - 20 cc.
(4) Distilled Water - 50 cc.
(5) Chloral Hydrate of Cocaine - 50 cc.

This has found very useful in mounting larvae, but not for winged adults as the fluid contains distilled water and air bubbles are liable to be enclosed in the wings as soon as the cover slip is placed. Moreover as the specimens cannot be pressed for fear of breaking the tracheal system these bubbles are difficult to get rid of.

In order to study the internal structures, microtome /

microtome sections were taken which were stained with Haematoxylin(Delafield) superimposed by Eosin.

The systems or structures which could not be dissected completely were dissected out in parts and thus the complete structures were studied.

## EXTERNAL ANATOMY of A. brassicae.

(Pl.V. Figs.1 to 12).

Egg : Elongate, oval in shape, more or less curved on one side, with a definite tip and a small stalk on the other side, nearly attached in the middle. When freshly laid they are shining pale yellow with the orange bodies (the pseudovitellus or mycetoma) prominently seen towards the stalk side. The colour after 5 to 7 days changes to brown and then dark brown, The egg then becomes opaque. The size of the egg without the stalk is at an average .32 mm. long x .14 mm. broad. The measurements of 15 eggs are as follows:-

| | | | | | |
|---|---|---|---|---|---|
| | mm. mm. | | mm. mm. | | mm. mm. |
| (1) | .30 x .15 | (6) | .33 x .15 | (11) | .30 x .13 |
| (2) | .30 x .15 | (7) | .30 x .16 | (12) | .33 x .15 |
| (3) | .31 x .15 | (8) | .33 x .15 | (13) | .31 x .15 |
| (4) | .35 x .13 | (9) | .33 x .13 | (14) | .33 x .15 |
| (5) | .36 x .15 | (10) | .33 x .15 | (15) | .31 x .15 |

The eggs are twice long as broad. The length of the stalk is .023 mm. and the measurement with the stalk /

stalk is .34 x .14 mm. The maximum dimension of the egg is .38 mm. x .16 mm. The egg when laid is covered with white powdery meal, and after the incubation period hatching takes place by a longitudinal crack.

Larva, I instar : The larva as it is seen coming out of the egg-shell is pale white, but when it completely emerges it is pale yellow. Size .33 mm. x .16 mm., that is nearly the size of the egg. Shape elongate more or less oval. If examined soon after emergence the abdominal segments can be clearly seen, but not so the thoracic ones. A central dorsal prominence extending from the abdominal segments downwards to the vasiform orifice is noticed. There is a rim-like narrow margin from which 16 pairs of small hairs come out, of which one anterior pair and two posterior pairs are prominent and long.

After emrgence the larva is active for 3 days and is in search of a suitable spot. Wax is secreted and the minute particles accumulate and become attached to the marginal hairs and the larva appears to be moving through some floury material. After the larva has settled the colour darkens slightly and becomes brownish yellow and all over the margin a white waxy fringe is formed. The larva becomes convex dorsally.

Antennae: Comparatively long, slender, and setaceous. It is pale yellow in colour and consists of /

of three segments. The basal segment is stout, short and broad at the base. The 2nd segment is longer than the 1st and has a spine in the middle. The third and the last segment is the longest and ends in a fine point. It has a spine towards the distal third.

Rostrum : It is a very short, lobed structure situated between the front pair of legs. Two pairs of stylets corresponding to the mandibles and maxillae are seen in the rostrum.

Legs : All the three pairs of legs consist of 5 segments. The coxa is small, stout and ring-like. It has one spine on the inner side. The first and the last pair have their coxae rather further apart than those of middle legs. The trochanter is small. The femur is the longest segment. The tibia has one spine in the middle. The tarsus is small and two-jointed. It has one spine on the 1st segment.

Vasiform orifice : It is more sub-circular than sub-cordate. The flap-like operculum and the lingula are very prominent in the larvae on leaves. The vasiform orifice is nearer to the caudal margin and is comparatively larger in size than in later instars. The dorsum of the larva is smooth and devoid of any hairs or spines.

II. instar : Size .53 mm. x .33 mm. Shape more or less oval. Marginal fringe of wax broader and thicker /

thicker than in the previous instar. Colour of living larvae oily yellow, translucent, but when older a little brownish. The thoracic segments are not still so very clearly seen as the abdominal ones with the median abdominal ridge. Dorsum smooth, vasiform orifice sub-cordate, the lingula prominently seen with the two spines at the distal end. Marginal hairs, seen in the first instar when it was active, have disappeared except the two pairs to the caudal end and one pair to the cephalic end.

III. instar : Size .7 mm. x .5 mm. varying up to .83 mm. x .58 mm. More or less oval in shape; sometimes the caudal end narrowed into a tail. In freshly moulted specimens colour is pale yellow, changing to oily yellow and later turning brownish. Dorsum smooth and shining. The marginal fringe of wax sometimes present, sometimes not clearly seen. The thoracic segments still not as clearly seen as those on the abdomen where there is a central prominent ridge. Margin in mounted specimens crenulate and with a pair of spines at the caudal end. Antennae extremely atrophied. Legs as blunt processes. Eyes appear as small red spots and the rostrum as a lobed structure reaching the middle of the thorax.

IV. instar or Pupa : Size 1.46 mm. x .85 mm. Shape more or less oval, colour in freshly moulted specimens /

specimens pale yellow. In translucent specimens the outline of the developing adult can be clearly seen bordered by a white line. The colour after some time changes to deep yellow and then brown. The chitin then hardens. Later it becomes covered with dirty white waxy meal. The dorsum shows the segmental rings on the abdomen and also on the thorax. The abdominal ridge in the advanced stage disappears. The flat larva becomes convex in shape. The thick narrow marginal fringe of wax fastens the pupa to the surface of the leaf. Sometimes the pupa is yellowish brown and sometimes dark brown. The vasiform orifice is prominently yellow with the lingula protruding, the latter with two spines at the tip. The dorsum of the pupa is apparently smooth, but in specimens prepared in potash there are seen small tubercles - 2 pairs one on each side of the rostrum, and one or two pairs on the thoracic segments. There is also a pair of spines(one on each side) towards the anterior border of the vasiform orifice. The latter has a rectangular operculum and a spathulate and setose lingula. The margin is crenulate with a pair of long spines at the caudal margin. The vasiform orifice is subcordate in shape with the caudal border prominently notched.

The /

The Adult - Female :-

Length 1.4 mm. General colour of the body yellow and black mixed or comparatively more black than yellow. Immediately on emergence from the pupa the insect is quite soft, delicate, shining and pale yellow in colour. The black colour begins to develop on the body after about 5 hours. It develops first on the thorax and then it appears on the ventral side of the abdomen and then on the dorsal side. The spots on the wings are the last to appear and in some cases they do not develop till the next day.

Head and its Appendages.
(Pl.IA. Fig.1).

Head : It is more or less triangular in shape, broadened between the antennae, becoming narrower and flat towards the rostrum. It is carried in such a way that its anterior surface is slanting ventro-caudal. The vertex is rounded and is divided by a median longitudinal suture. The region in front of this suture known as the frons(Fr.) is bounded by a frontal suture(F.S.) on either side giving rise to strong internal ridges. The Frons anteriorly merges into clypeus(cl.) and it is at the corners of the fronto-clypeal junction (which is very indistinct) that the front arms of the tentorium are seen to join internally. On either side of the frons(in the genal area/

can you find a better term than the American ventro caudal

area) is placed an antenna(Ant.) in the antennal socket(Ant.S.). The Compound eyes(C.E.) are placed laterally to the antennae and occupy a large amount of space in the genal area.

Antenna : (Pl.V.Figs.11 & 12 and Pl.VII.Figs.9,10 & 11).

Long, filiform, pale yellow in colour with the terminal segments pale brownish. It consists of seven segments. First segment is small, round and cup-shaped. Second segment is sub-pyriform in shape, very broad at the tip with an excavation to receive the third. On the body of this segment there are about 7 or 8 short and stout spines. The third segment is the longest. At the base it is narrow, broadening to nearly half the length. It is constricted slightly in the middle and again broadens towards the tip. The fourth segment is the shortest of the last five. V., VI. and VII. are nearly sub-equal. The last segment terminates in a bristle. There are three sensoria on the third segment, one on the fifth, and one on the seventh. The sensoria under high magnification and in section appear like small circular pits, in the centre of each of which is seen a papilla encircled by a bunch of small hairs. All the last five segments possess annular rings from which small bristles project. In sections the nerves inside the antennae are very clearly seen. The total length is .516 mm.

can be confusing.

Eyes /

Eyes : Each compound eye is completely divided into two parts by a strip-like projection of chitin. The whole eye all round and the chitinous projection is hairy. The upper part of the eye is bright red or reddish brown in colour and consists of small round facets arranged in rows. The diameter of these facets varies from .0066 mm. to .010 mm. each. The lower part of the eye is more brownish in colour and consists of larger facets, the diameter of which varies from .01 to .013 mm. each. The facets or the ommatidia are so arranged that they appear to be hexagonal in shape and in stained specimens there is always one unstained facet surrounded by six stained ones (Pl.I Fig.2). In sections the wall of the stained lenses is seen thicker than that of the unstained ones. In his recent researches in the study of the Aleurodid eyes, Dr.Eltringham has not come to any definite conclusion regarding the difference in the ommatidia. The upper part of the eye is rectangular in shape and stands on one angle in the middle of the lower portion which is semi-circular in shape. Anteriorly to the upper portion of the eye almost touching it in the middle is placed a single ocellus, elliptical in shape and having the diameter of .017 mm. In stained specimens it is pale yellow in colour and not easily noticeable. The occular sclerite surrounding the eye is /

is strongly developed on the ventral side.

Mouthparts (Pl.IA. Figs.1,2 & 3).

The mouthparts consist of (1) clypeus (2) labrum or the upper lip, (3) 2 pairs of setae and (4) labium or the lower lip.

Clypo-labrum : To the distal end of the frons is the clypeus(Cl.) which further merges into labrum, and so the whole broad trapezium-shaped portion after the frons is called the clypo-labrum. Below this is a triangular pointed sclerite which may be called the labrum(Lbr.). This has been called by Quaintance and Baker(1913) the epipharynx. The inner floor of this part can be rightly called epipharynx as it forms part of the endoskeleton. By the side of the clypeus laterally are two sclerites which are known as the clypeal sclerites or the lorae(Lo.). The clypo-labral portion and the labrum cover about one third of the labium.

Setae : Behind the labrum are situated two pairs of setae, one pair being anterior to the other. The anterior pair are the mandibles and the posterior pair the maxillary setae(Md.and Mx.). Each seta consists of a hollow conical expanded basal portion and a long slender portion terminating in a point which constitutes /

constitutes the piercing stylet(Sty.). The basal portions of the setae are contained within the head, but the long piercing stylets pass out through the buccal cavity and become lodged in a groove on the anterior face of the labium which they traverse to the tip. The mandibular setae are free throughout their entire length and are somewhat stouter in build than the maxillary ones. The latter as they pass out in the buccal cavity each approaches the median line until they become closely applied one to the other so as to form a single piercing organ. However, the union is of mere juxtaposition as they can be easily separated except at the tip where they are more firmly joined. By joining the grooves of the two setae form a tube for suction. The basal portions of the maxillary setae, and possibly also of the mandibles, are attached to the chitinous walls of the head by rods known as the maxillary levers(Mx.L.).

Labium (Fig.2) : The labium is inserted in the base of the head on what is known as the projection of the thorax. It consists of three joints, is bent strongly caudad and appears to be grooved through its length. At the base the groove(R.g.) is wide, but more centrally it becomes narrower. The first or the proximal(I.Seg.) is much the longest, and narrow and posteriorly has a chitinous rod(C.A.) attached to/

to it. The 2nd segment(II.Seg.) is thicker and shorter. The 3rd segment(III.Seg.) is longer than the second, heavily chitinised and tapering towards the tip. At the extremity of the distal joint the walls of the fold close almost completely over, but the rest of the length the groove is open. All the segments are covered with small setae and especially the tip of the third or the distal segment. Behind the head there is a short, distinct neck which is attached to the thorax by the sclerotised membrane.

Thorax. (Pl.I.A. Figs.4 to 8).

It is the broadest part of the body. The prothorax and metathorax are comparatively smaller and the meso-thoracic region is the largest. In the whole of the insect body the thoracic region both ventrally and dorsally is the darkest.

Pro-thorax(P.T.) : It is the smallest segment of the thorax. The notum is dark in colour and collar-like in form. Its anterior border has three semi-circular notches - the middle one being the largest and the two side ones being small. The tergum or notum is narrowed mesally but widens, is rounded and also extends laterally downwards till it approaches the pleuron. In the tergal region the parts - prescutum, scutum, scutellum - are not separated. The posterior border of the notum overlaps the/

the anterior border of the prescutum of the meso-thorax.(Taylor(1918) says that it scarcely overlaps the mesothorax). The pleuron of the prothorax is much reduced and closely attached to the notum. The episternum and the epimeron are not distinguishable. The sternal region consists of only one small sclerite in the centre the posterior border of which extends to both the coxal bases.

Meso-thorax(M.T.) : The notal region is sub-divided into several parts (1) prescutum(P.S.), (2) scutum(Sc.), (3) scutellum(Scl.) and the post-scutellum or post-notum(P.N.).

Two distinct longitudinal sutures which approach behind in the middle of the tergum mark out a portion nearly sub-cordate in form which is known as the pre-scutum. Posteriorly and at each side is an ill-defined region forming the major part of the tergum which is and known as the scutum. On both sides of the prescutum and anteriorly to the scutum there are two lobed structures which are the pre-alares(P.a.). They connect the notum with the pleuron anterior to the wing. A broken suture nearly parallel with the posterior margin of the notum demarks the scutellum. The posterior border of the latter is produced on either side to a point which connects with the anal margin of the wing. Just before this point embedded in the membrane is a small triangular plate articulating with/

withthe basis of the anal veins. The post-notum consists of the middle sub-cordate piece and the post-notal plates, one on each side.

The meso-pleuron is marked by a pleural suture extending from the wing basis to the articulation of the coxa. The suture starts from the lower pre-alare lobe in a diagonal direction dividing the pleuron into the triangular episternum(E.S.) and an irregular shaped epimeron(E.M.). Above the epimeron at the base of the wing occur two plates known as the sub-alares which support the anal region of the wing. The sternum consists of two oval sclerites jointed together at the base. It is the furca-sternite(F.S.) laterally from which are given out two furcae having a common stalk.

Meta-thorax(Me.T.) : In the notal region the prescutum is but a very narrow band and is concealed under the postnotum of the meso-thorax. The scutum is arched in the middle to receive the conical post-notum of the meso-thorax. The scutellum is a small ill-defined region. The posterior margin extends on both sides bearing the axillary cord which is continuous with the anal margin of the wing. The post-scutellum is a plate of half the size of the scutum, stretching parallel to the scutellum. The metathorax bends rapidly downwards posteriorly.

The pleural suture is distinct, dividing the pleural/

pleural region into episternum and epimeron. The suture extends over the entire coxa marking off the vera-coxa(V.C.) and the meron. The coxa is apparently fused with the pleuron.

The sternum consists of one crescent-shaped sclerite called the furca sternite. Laterally two small furcal processes and a plate(Fig.8) placed vertically are given out.

In live specimens the whole of the thorax is a mixture of black and yellow. On the meso-tergum the dark patch is seen on the pre-alare, part of the scutum on both sides and to some extent on the pre-scutum, in such a way that it assumes the form of a crescent or more exactly a horse-shoe, the two arms facing the meta-thorax. Signoret in his "Essai Monographic sur les Aleurodes" describes the form as 'fer a cheval'. The black mark on the meta-thorax is also of the same form, but it faces the one on the meso-thorax. The meso-post-notal portion sometimes has only its borders dark. The post-scutellum of both the thoraces are yellow and the pleurae are spotted black and yellow. The sternites are black and the intersegmental membranes yellow.

Wings : There are two pairs of wings which are rounded on the outer side. They appear white because with the powdery wax which covers them, but immediately on /

on hatching they are pale, translucent yellow and delicate. The veins in the wings are of the same colour. As soon as dark colour develops on the body, the veins(especially Rs) assume the dark tinge and also the black spots begin to develop. The anterior or the meso-thoracic pair is larger and the posterior or the meta-thoracic pair is smaller, the former is 1.8 mm. x .75 mm. and the latter is 1.4 mm. x .64 mm. Expanded wings cover 3 mm.(Pl.VI. Fig.5).

Wing Venation : In freshly emerged specimens (Text Fig.1,Paper III.) we find in the forewing - (1) costa, (2) $R_1$ (3) Rs, (4) spur of media and (5) cubitus. (According to Miss Patch sub-costa is suggested by a faint line). But after the wing hardens only (1) costa, (2) Rs and (3) cubitus persist - $R_1$ and median spur disappear. Even the cubitus is not so prominent, but is only suggested by a faint line. The Rs is bent twice, once in the middle from where the $R_1$ is seen to emerge and again towards the end. At each of the bends a black patch is seen to develop soon after the vein Rs darkens. These patches appear as irregular patterns of dark lines. In the hind wing only one vein is present and that is the Rs centrally situated. It has one dark area in the centre.

Wings are attached to the meso and meta notum respectively by the notal processes and supported from /

from underneath by the pleural processes. In between the veins there occur sclerites known as the axillary sclerites. In the front wing there are two small axillary sclerites(Ax.Scl.) above the anal vein, while in the hind wing there is only one sclerite.

Compared with the size of the insect the wings appear to be large. In the sitting posture they are held like a flat roof and the hind wings are hidden under the front ones. The wing borders are orange coloured and beaded. These beads are blunt teeth-like projections from which small hairs are seen to issue. These beads are about 16 to 17 in .1 mm. The hind wings have on the anterior border near the base six or seven small hairs.

Legs : They are long, thin and spotted with black except at the joints. The coxa(Co.) of the prothorax is large. The distance between these coxae is greater than the other two pairs. The middle coxae are a bit thinner. The hind ones are very close to each other and are large. The trochanters(Tr.) are small and more or less yellow. Femura(Fe.) proportionately thin and long. Tibia(Ti.) are very thin and long with a double row of small spines which are more numerous on the hind ones. Tarsi(Tar.) are two-jointed, the first of which is the longer. To the distal end are attached two strong claws(Clw.) which enclose between /

between a hairy, blade-like empodium or the paronychium(Pa.) the homology of which has been discussed in the introduction(Pl.II.Figs.4 to 7).

Abdomen (Pl.II. Figs.1 and 2).

It is spindle-shaped, thick in the middle and tapering both ways. It is attached to the thorax by a pedunculer attachment which I have already in the introduction shown ~~xx~~ to be the first segment. The 2nd segment is comparatively small dorsally, but has a larger sternite on the dorsum of which there are chitinous rods. The 3rd and 4th segments are, comparatively, the largest. Then the further segments get smaller till the last one which is large and has a peculiar structure. There are in all 8 segments. The waxplates are situated ventrally on the 3rd and 4th segments and cover an area .33 mm. x .25 mm. As Hargreaves(1914) has not taken into consideration the peduncle he says that waxplates are on the 2nd and 3rd segments. On the tergites there are black stripes commencing from the 4th segment, and the stripes get deeper and bigger posteriorly till the last segment is black ventrally and dorsally. Dorsally in the middle of the last segment is the vasiform orifice. Behind the orifice the 8th tergite is folded(C.F.) transversely on itself and to the end is /

is attached the basal sclerite(B.Scle.) which supports the dorsally-situated genital valves.

Genitalia (Fig.2) : These consist of three pairs of valves which according to their position may be referred to as the ventral, dorsal and inner valves. The ventral valves(V.V.) which are homologous with the coxites of the 8th abdominal sternum, occupy a ventro-lateral position. They are deeply concave on their inner surface. Behind and dorsal to the ventral valves are situated the dorsal pair of valves(D.V.). The latter consist of a pair of chitinous rod-like thickenings which terminate distally into a pair of pointed processes. The region between the dorsal valves is occupied by a thin membrane, as the intra-valvular membrane(I.V.M.). The inner pair of valves (I.V.) are situated in the distal region of the intra valvular membrane (between the dorsal valves). They consist of a pair of rod-like thickenings lying in the intravalvular membrane and being slightly free at their distal end. The dorsal and ventral valves show a few hairs scattered at their outer surfaces. Much discussion has been going on about the homology of the dorsal valves(Imms 1931), but all seem to agree upon their origin from the 9th abdominal sternum. The dorsal and ventral valves are very pointed and together form what is known as the ovipositor(Ov.).

Adult /

Adult - Male : Generally more slender. Length 1.65 mm. with claspers. Forewing 1.45 mm. and hind wing 1.16 mm. Abdomen strongly pedunculate. The 2nd segment is rather larger. The succeeding segments smaller and tapering. The last segment is collar-like, strongly chitinous and dark in colour. To the distal end of this are attached the claspers. In the male 9 segments can be made out very clearly. The last segment is .15 mm. long and the length of the claspers is .16 mm. The latter are deeply forked at the tips which possess some hairs. The abdomen has four pairs of waxplates placed ventrally and beginning from the 3rd segment. The area occupied by the waxplates is .27 mm. x .13 mm. The antenna measures .588 mm. The legs are similar in structure.

Genitalia (Pl.VII.Fig.1 & Pl.II.Fig.3).

They consist of a pair of claspers and the medially situated penis or aedeagus. Claspers(Cla.) - otherwise known as Parameres - were considered by many authors as separate processes, but George(1929) says that he regards them not as distinct entities but as processes of the aedeagus(Ae.) and as such the aedeagus or the penis is the representative of the endopodite of the ninth segment. If comparison is to be made, the claspers and the aedeagus correspond to the inner pair of valves of the female.

A. lonicerae.

(Pl. VIII.)

Egg : Elliptical in shape, colour whitish, size .25 mm. x .08 mm. without the stalk which is .03 mm., standing erect; base broad and tapering towards the tip.

I. instar : Shape as that of A.brassicae and structure also the same. Size .35 mm. x .16 mm. Colour olive yellow.

II. instar : Size .5 mm. x .3 mm. Colour olive yellow. Shape as in that of A.brassicae.

III. instar : Size varying from .61 mm. to .70 mm. x .45 to .50 mm. Shape and structure the same as in A.brassicae.

IV. instar : Size 1.05 mm. x .73 mm. Shape, structure and habits as in A.brassicae.

Two kinds of Pupae have been found - one having the dorsum apparently smooth and the other with six pairs of spines on the dorsum. The position of these spines is as follows:- one pair by the side of the base of the rostrum; second, third and the fourth on each of thoracic segments respectively; the fifth on the first abdominal segment and sixth to the sides of the anterior border of the vasiform orifice. The hairy and smooth pupae are found respectively on hairy /

hairy and smooth leaves. The adults which hatch out from the two pupae are identical. The colour of the pupa is olive yellow. In some of the specimens the sub-marginal area is broader and striated.

Adult ♀ : In general similar in structure to A.brassicae except that the forewings have only one V-shaped black mark on the 2nd flexure in Rs. The thorax, head and other parts are dark coloured as in A.brassicae except that in A.brassicae the meso and meta-thoraces have horse-shoe shaped black marks, while in this the meso-thorax or meso-notum is completely dark excepting sometimes the triangular post-notum. The bars on the dorsum of the abdomen in A. brassicae are not so dark. The adult is smaller in size measuring 1.33 mm. Forewing 1.8 mm. x .72 mm. The rest of the structure is similar to that in A. brassicae. Antenna is .479 mm.

In this species there are also specimens which are quite yellow, without any dark colour on the body except one black mark on the wings. But there is no difference in the general structure.

Male : similar to the female except that it is comparatively smaller.

T. sonchi /

T. sonchi.

(Pl.X. Figs.1 to 8).

Egg : Size .25 mm. x .07 mm. Colour greenish yellow. Broadened towards the tip. Shape sub-elliptical; standing erect on stalk.

I. instar : More resembling the larva of T.vaporariorum; colour greenish yellow; size .283 x .16 mm.; shape, structure and habits like that of A.brassicae. Vasiform orifice sub-cordate in shape; the caudal end slightly notched. Anterior border of the orifice deeply arched. Lingula spathulate and the tip has a large number of hairs.

Pupa : Size varying from .75 to .82 mm. x .50 to .62 mm. Shape oval at the surface. Opaque, greenish or yellowish waxy in colour, raised on a palisade of wax. Dorsum smooth. The margin all round has white, shining waxy rods varying in number from 40 to 45 pairs, one caudal and one cephalic pair being the longest. Vasiform orifice sub-cordate and yellow in colour. Lingula spathulate possessing a pair of spines at the tip. A deep furrow from the vasiform orifice to the caudal margin. Margin of the case crenulate under the waxy rods.

Adult ♀ : Size 1.3 mm. to 1.4 mm. Colour lemon/

lemon yellow in general and more so on the thorax. The antennal tips brown. The body structure is the same as in A.brassicae. The second segment of the abdomen on the dorsum has a dark border and the last segment is dark in colour ventrally. Wings white, spotless. Rostrum long reaching the middle of the abdomen, black at the tip.

Adult ♂ : Similar to the female except that it is slender and small. Abdomen strongly pedunculate. The last segment of the abdomen collar-like, dark in colour. The claspers are also dark in colour, The tip of the latter is not forked.

## INTERNAL ANATOMY.

Reproductive System : This can be traced in two ways, (1) by dissecting the abdomen ventrally by cutting open at the waxplates, or (2) by separating and pulling out the last abdominal segment. This latter is more easily done in the case of males where it is collar-like, but the normal position of the organs getsdisturbed. In the case of females it is always better to take the specimens which are not gravid because all the ovarioles discharge the eggs in the act of dissection.

Male /

## Male Reproductive System of A. brassicae.

(Pl.III. Fig.4).

It lies ventrally in the last part of the abdomen and consists of the following parts:- (1) Testes(Te.) (2) Genital ducts- (a) Vasa deferentia(V.d.), (b) Vasiculae seminalis(V.s.), (3) Accessory glands(A.g.), (4) Intromittent organ aedeagus or penis(Ae.).

The testes(Te.) are paired bodies more or less round. Each testis has a slight constriction towards the distal end with a definite neck. The colour is dull yellow. To the posterior end behind the neck is attached a narrow canal which is Vas deferens(V.d.). It is very short and of pale yellow colour. This becomes enlarged along its course to form a sac or vesicle. The two vesiculae(V.S.) open in a common passage which leads to the intromittent or the copulatory organ. At this point of junction of the two vesiculae is seen a pair of glands known as Accessory glands(A.g.) which are transluscent, elliptical bodies one on each side situated in between the vesiculae. The colour of the vesiculae is deep yellow with a slight dark tinge. The copulatory organ is narrow at the base but enlarges rapidly and then tapers down in a thin point.

Exactly the same kind of structure is found in the /

the species A.proletella and A.lonicerae. In the other three species T.sonchi, T.vaporariorum and A.quercus there is a great difference in the various parts of the system. I give below the differentiation (Pl.III. Fig.3) :-

(1) Testes are globular bodies with a definite tip. The colour of these is whitish yellow with no neck-like constriction.

(2) Vasa deferentia : These are very long tubes as compared with the short ones in A.brassicae. On account of their length they are coiled.

(3) Vesiculae seminalis : These are distinctly smaller in size than the large sacs in A.brassicae. The colour of these sacs is pale yellow.

(4) The Accessory Glands are much larger than in A.brassicae.

## Female Reproductive System of A. brassicae.

(Pl.I Fig.9).

This consists of the following parts :-
(1) Ovaries, (2) Genital Ducts, (3) Spermatheca or Receptaculum seminalis.

(1) Ovaries (O) : Are paired more or less compact bodies lying in the body cavity of the abdomen on /

on either side of the alimentary canal. Each ovary is composed of five egg tubes or ovarioles which open in the oviducts. The ovary is of the acrotrophic type, where the epithilial layer grows inward in such a manner as to enclose each oocyte in a sac. In the ovarioles, or the ovarian tubes(O.t.), of this type of the ovary the third zone - the Vitellarium - constitutes the major portion of and contains the developing eggs and the nutrition cells when present. The other two zones - the germarium and the terminal filament - are not well developed. The eggs(Pl.I Fig.9) inside the ovarioles are found in different stages of development, the fully developed ones being deep yellow with the chorion having prominent vacuoles. In double stained specimens each egg shows the lining tissue and the nuclei very clearly. That part of the egg (Pl.I Fig.10) inside the body which is fully developed is deep red at the point of attachment of the stalk. The stalk of the egg inside the abdomen is always transparent, clear white, and directed posteriorly so that when the eggs are laid, the stalk comes out first and the egg is permanently fixed in the plant tissue by embedding the stalk. The number of fully developed eggs at one time in the abdomen is 12 or 13.

Genital /

Genital ducts or Oviducts(O.d.) are paired canals leading from the ovaries and combining to form a common passage. Into the latter opens a globular, flask-shaped organ, with a long duct. This is Receptaculum seminalis(R.s.) It is a thinly chitinised structure and has walls pale yellow in colour.

The eggs when fully developed assume orange yellow colour and hence the colour of the abdomen of a gravid female changes to orange on account of the developed eggs inside. The common passage of the oviducts ends in the external genitalia which have been already described before.

The female reproductive system practically is the same in all the other five species - A.proletella, A.lonicerae, T.sonchi, T.vaporariorum and A.quercus.

## DIGESTIVE SYSTEM of A. brassicae.

(Pl.III. Fig.2).

The alimentary canal in an insect with sucking mouth-parts or which feed on liquid food is generally longer than in those with biting mouth-parts or which feed on solid food. This holds good in all Homoptera and also in the Aleurodidae. The length of the canal in the latter if straightened measures about /

about 2 mm., while the length of the insect body varies from 1.3 to 1.5 mm. Therefore, the alimentary canal has to be convoluted or coiled.

The Digestive System consists of the three principal divisions - (1) Fore intestine(F.i.), (2) Mid intestine(M.i.) and (3) Hind intestine(H.i.).

(1) Fore intestine:- It is made up of three parts - (i) Pharynx(Ph.), (ii) Oesophagus(Oe.) and (iii) Crop(Cp.). If we trace up the canal of the rostrum the broad portion in the head is the Pharynx which is very well developed. This narrows down in to a thin tube called Oesophagus which passes from the hinder region of the head into the fore part of the thorax. At this point is found a pair of small kidney-shaped bodies, which are the salivary glands(S.g.). The Oesophagus leads into a capacious flask-shaped sac called the crop, which occupies a large part of the meta-thorax. The crop narrows down and joins the next division - Mid intestine - in the abdomen.

(2) Mid intestine : This is also known as the stomach or the mid gut. It is this part which is coiled and loop-like. Just after the attachment of the crop to the Mid intestine are two sac-like diverticula which are known as the enteric or gastric caecae(Cae.). The Mid intestine is coiled over itself and is attached to or near to the caecae by some /

some thread-like tubules which may be the malpighian tubes. The loop is thick in the middle and greatly decreases in size to the point when it joins the hind intestine.

(3) Hind intestine : This is also divided into three parts - (i) Small intestine(S.i.), (ii) Colon(Co.) and (iii) Rectum(R.). The first part is not very long and narrows posteriorly. The colon is thin-walled, long and coiled, and it broadens into the last part, the Rectum, which is large in size and oval sac-like in form. It terminates in the anus. The whole system is situated dorsally in the body and the anus opens dorsally in the peculiar structure called the vasiform orifice which is found on the last segment. The opening of the anus(A.) lies dorsal to the lingula and is protected by the flap or the lid-like covering - the operculum(Op.). The lingula(Li.) is strap-like in form and grooved. It is hairy all over and hence the liquid excreta as it is thrown out is directed by means of the channel in the lingula. If we watch the pupae or the larvae, we see that the liquid excreted accumulates in the form of a drop and then by a slight jerk of the lingula it is thrown away.

The alimentary system is similar in the other species examined except that the rectum in sonchi, vaporariorum and quercus is more spindle-shaped.

In /

In the larvae of all the species examined, the digestive system is the same as in the adults. In the adults, on account of the construction between the thorax and abdomen, the thin connection between the crop and the mid gut often gets broken, but that difficulty never arises in the dissection of the larvae.

## TRACHEAL SYSTEM .

(Pl.III. Fig.1).

Larval : There are four pairs of spiracles(Sp.) present in the body of the larvae. The position of these is as follows:- One pair is situated between the bases of the 1st and 2nd pair of legs, second pair lies between the 2nd and 3rd pair of legs, third pair lies below the base of the 3rd pair of legs and the fourth pair lies on either side of the vasiform orifice. The first and the fourth pair are comparatively larger and the middle two smaller. The three pairs of spiracles 1st, 2nd and 4th can easily be seen, but the 3rd pair is very difficult to make out.

Mainly the tracheal system consists of ventral trunks(V.T.), dorsal girdles(D.g.) and tracheal folds. The ventral trunks run centrally on either side from the anterior to the posterior spiracles. There are two dorsal girdles first connecting with each other the /

the first pair of spiracles and the second connecting with the second pair of spiracles. Besides there are branches given out from the posterior or anal pair, one going to the sides and the other going upwards parallel to the ventral trunks in the middle. Again there are various branches and sub-branches given out from these trunks and ramifying in the cephalic, thoracic and abdominal areas.

The tracheal or breathing folds are the passages between the outside air and the spiracles. The necessity of these organs is evident when it is noted that the spiracles open ventrally and the body of the larva is cemented to the leaf, so there must be some arrangement for the access of air. The breathing folds are three in number - a latero-thoracic pair or the anterior pair and one posterior or caudal. Anterior tracheal folds are situated on each side of the thorax communicating with the 1st pair of thoracic spiracles. The body wall is transversely folded, the fold extending along the sides of the thorax and part of the abdomen. This allows for the access of air to the thoracic and first abdominal spiracles. The caudal fold extends from the vasiform orifice caudad to the margin and forming a Y-shaped structure extending to the posterior thoracic pair of spiracles.

The /

The ventral trunks are stouter and those dorsal are thinner. The tracheal system in the early larvae remains the same in the main parts and the only difference that is seen is that the ramification of branching is far less and the tracheal folds are not well developed in the first instars.

Adult : The tracheal system in the adult appears to be more complicated at least in the thorax. There exist four pairs of spiracles - two in the thorax and two in the abdomen. In the former the first pair(Pl.I Fig.11) is situated in between the pro-thorax and meso-thorax. The exact position is in the intersegmental membrane just anterior to the first pre-alar lobe. This pair is the largest and is seen situated on a slight protuberance. The second pair is situated in between the border of the meso-epimeron and the meta-sternum. It is smaller than the first, deep set and not easily noticeable. The third pair, or the 1st abdominal one, is situated ventrally on the 2nd segment far anterior to the wax-plates. The fourth or the last pair(Pl.I Fig.12) is situated laterally on the 8th segment, both in the female as well as male, on each side of the vasiform orifice.

As regards the tracheal trunls, two main trunks are /

are seen in the abdomen running ventrally, joining the two abdominal pairs of spiracles, and a large number of small and finer branches ramifies from near the spiracles. The part in the thorax(and the finer branches) seems to be complicated and has not been clearly made out .

The spiracles appear to be quite simple and are round holes surrounded by a slightly chitinised rim known as the peritreme. Of the four pairs, the pair in the pro-thorax is the largest and the one near the vasiform orifice is the smallest. The diameter of the pro-thoracic and meso-thoracic spiracles are .008 mm. x .01 mm. and .005 mm. x .008 mm. respectively, and that of the caudal pair .004 mm. x .006 mm. The latter appears to be surrounded by a ring of hairs projecting like rays bent inwardly.

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## Abbreviations explained.

A. = Anus.

A.g. = Accessory gland.

A.T-P. = Arms of the tentorial pits.

Ab. = Abdomen.

Ab.S. = Abdominal segment.

Ae. = Aedeagus.

An.V. = Anal vein.

Ant. = Antenna.

Ant.S. = Antennal socket.

Ax.Scl. = Axillary sclerite.

B.Scle. = Basal sclerite.

C. = Costa.

Ca. = Caecum.

C.A. = Chitinous attachment.

C.E. = Compound Eye.

C.F. = Chitinous fold.

C.P. = Chitinous process.

C.T. = Chitinous thickening.

Cl. = Clypeus.

Cla. = Clasper.

Clw. = Claw.

Co. = Coxa.

Cp. = Crop.

Col. = Colon.

Cu. = Cubitus.

D.g. = Dorsal girdle.

D.v. = Dorsal valve

E. = Egg.

E.m. = Epimeron.

EP.Su. = Epicranial suture.

E.St. = Episternum.

Fe. = Femur.

F.I. = Fore intestine.

Fl. = Flexure.

Fr. = Frons.

F.R. = Frontal ridge.

F.S. = Frontal suture.

F.St. = Furca sternite.

Gen. = Genitalia.

H.I. = Hind intestine.

I.V. = Inner valve.

I.V.M. = Intra-valvular membrane.

L. = Larva.

Lb. = Labium.

Lbr. = Labrum.

L.F. = Large facets.

Li. = Lingula.

Lo. = Lorae.

M. = Median.

M.I. = Mid intestine

M.St. = Meso-sternum.
M.t. = Meta-thorax.
Md. = Mandible.
Mer. = Meron.
Me.St. = Metasternum.
Me.t. = Metathorax.
Mx. = Maxilla.
Mx.L. = Maxillary lever.
O. = Ovary.
Oc. = Ocellus.
Oes. = Oesophagus.
Op. = Operculum.
O.t. = Ovarian tubes.
O.d. = Oviducts.
Ov. = Ovipositor.
P. = Pupa.
P.a. = Prealares.
Pa. = Paronychium.
Ph. = Pharynx.
Pl. = Pluron.
Pl.pr. = Plural process.
P.N. = Post Notum.
P.Sc. = Prescutum.
P.St. = Prosternum.
P.T. = Pro thorax.

R. = Rectum.
Ro. = Rostrum.
Rs. = Radial sector.
R.g. = Rostral groove.
R.S. = Receptaculum seminalis.
Sk. = Stalk.
Sc. = Scutum.
Scl. = Scutellum.
Sen. = Sensorium.
Set. = Setae.
Seg. = Segment.
S.F. = Small facets.
S.g. = Salivary glands.
S.I. = Small intestine.
Sp. = Spiracle.
Spr. = Spermatheca.
Sty. = Stylet.
Tar. = Tarsus.
Te. = Testis.
Ter. = Tergum.
Ti. = Tibia.
Tr. = Trochanter.
V. = Vein.
V.d. = Vas deferens.
V.S. = Vesicula seminalis.

V.P. = Ventral plate.

V.t. = Ventral trunk.

V.c. = Vera coxa.

V.o. = Vasiform orifice.

V.V. = Ventral valve.

W. = Wing.

W.P. = Wax plate.

W.A. = Wing attachment.

# PAPER II.

## BIOLOGY of some of the BRITISH ALEURODIDAE.

(One Plate - No.IV.)

BIBL. UNIV. EDINBURGEN

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## INTRODUCTION.

Of the twenty-one British species only very few have been found on plants economically important, and considering the damage done by them I think only two are harmful pests - (1) A.brassicae and (2) T.vaporariorum. The former attacks plants of the cabbage tribe and the latter is a cosmopolitan pest attacking the greenhouse plants. Both are multibrooded and can be bred in plant house throughout the year. I obtained one colony of 20 specimens of A.brassicae in March 1930 which has since then been going on increasing in number (Pl.IV. Figs.2 and 3). The activity decreases in winter, and on very cold days they are reluctant to move from their places. Still it is not true hibernation. The flies go on feeding and move away on bright sunny days. Also the flies living on plants in the cages, die for want of food, if the plants are dead.

As regards the alternate food-plants, there do not appear to be very many except in the case of the green-house species and some of the species appear to be specialised for particular host-plants.

I have repeatedly reared and traced the life-history of four species - (1) A.brassicae, (2) A.proletella, (3) A.lonicerae and (4) T.sonchi. Except A.lonicerae, which I found in the Comely Bank nursery here, the rest were from south of England. T.sonchi

passed /

passed through one generation only but afterwards could not be reared.

As to the biological study, the only species that has been previously worked out fully is T.vaporariorum. Its life-history and habits have been studied by Hargreaves(1915) and again by Lloyd(1922) particularly from the economic side. Sex-ratio and parthenogenesis were studied by Williams(1917) and Schrader (1926), and Thomsen(1925) verified the same experiments. Lastly Speyer(1927) studied the parasites. Apart from this species, the biology of the other British species has not been worked out.

The Homoptera belongs to a class of insects known as Exopterygote or the Hemi-metabola in which there exists incomplete metamorphosis. But there are certain groups in this class like the Aleurodidae and the males of the Coccidae which exhibit a well defined tendency towards the Holometabolous condition. The sequence of events in the development of stages in the life of the Aleurodidae is as follows:-

From the egg hatches out a larva which is quite dissimilar to the parent. It is not called a nymph but a larva of the 'oligopod' type, Imms(1931). It is active for some time and then settles down at one place, feeds, grows and moults. Then follow two more fixed, but actively feeding stages. These grow and moult, and then comes the fourth instar which is said to/

to be equivalent to the pupal stage of a holometabolous insect. Let us first see what is meant by a Pupa and consider whether those conditions hold good here. A pupa is the term applied to the resting inactive instar in all holometabolous insects, during which stage the insect is incapable of feeding and is externally quiescent. In the Aleurodidae after the third moult, the larva of the fourth instar is flat and thin. The upper cuticle is so translucent that the white outline of the future adult inside can be clearly seen from outside. Evidently this is not the resting stage as it is seen to feed and drops of liquid excretion are passed out of the vasiform orifice and are shaken off intermittently by the lingula. This stage also grows in thickness and becomes convex in form. The cuticle hardens and the adult inside gets loosened from the cuticle. The development of various parts of the body goes on inside. The wings begin to develop from the internal buds and after the full growth is complete the adult breaks open the upper cuticle and emerges. From the time when the cuticle hardens and the internal development begins, the instar appears to be in a resting condition and not to feed. This latter part of this stage (fourth instar) can be said to be the Pupal stage, as it behaves like a Pupa defined above. The only type of pupa it can be compared with is the Coarctate/

Coarctate type. But/also in the latter a very thin pupal skin is seen to exist under the hard outer cuticle after the emergence of the adult, i.e. there is a true pupal skin in the puparium, while here there is found no moult or skin in between the upper cuticle and the adult skin as has been ascertained by dissecting numbers of pupae at different periods during development. In the sections taken by Hargreaves, he also found only two skins, one forming the outer cuticle and the other forming the adult skin. At no other period does this instar behave like a pupa and at the latter part this stage may be called a Rudimentary pupa (as Dr. Imms has named it in his Text-book of Entomology, p.188).

This work was done under the guidance of Dr. C.B.Williams and my sincere thanks are due to him for all the help received from him, and especially for the trouble he took in securing the live specimens from the fields and the woods.

## METHOD and TECHNIQUE.

In order to provide a continuous supply of specimens for study, I had infested cabbage plants with A.brassicae, Chilidonium majus and Sonchus sp. with A. proletella; Honeysuckle with A.loniceraе,; Fuschia with T. vaporariorum and Sonchus sp. for T. sonchi; and all these were growing well in the greenhouse with the flies established on them. All the /

the stages beginning from the eggs to the adults were obtained and thus I was able to trace the complete life-history. So far as possible these were checked in the field. For the study of longevity, egg-laying capacity and parthenogenesis, freshly emerged and unfertilised females were removed to plants kept in wire-netting cages or to branches enclosed in broad mouthed glass jars inverted and supported on a retort stand. The mouth was closed by cotton wool to prevent the escape of the fly, but at the same time to allow aeration in the jar and thus to provide more or less natural conditions.

To study parasitism, parasites soon after emergence were taken in small tubes to the greenhouses and liberated in wire netting cages which enclosed branches of plants having larvae on them (see Plate IV.)

## LIFE-HISTORY and HABITS.

### (1) A. brassicae.

Egg-laying: After the manner of Aleurodids, this species has generally the habit of laying eggs in circles or semi-circles, but some flies lay irregularly, laying two or three eggs at one place and then moving to another place without any apparent external disturbance. At many places the female seems to have settled for some time, but afterwards has moved to another place without laying any eggs. Such places can be easily marked /

marked out by the white powder sticking there, being brushed from the abdomen. The places chosen for egg-laying are always on the underside of leaves, in the pockets between the veins and near the mid-rib. In circles the eggs are usually in single rows but rarely I have seen them in double rows. They are always laid with the tip towards the centre. The method (as has been described by many authors) is due to the fact that the female sits at one place with the rostrum imbedded in the tissue and this serves as a pivot & she thus moves round and round and lays one by one; the radius of the circle being the distance from the rostrum of the female to the tip of the abdomen. Eggs freshly laid are covered with powdery meal. The stalks are imbedded into the leaf tissue and as a result the eggs are difficult to remove. For egg-laying generally tender leaves are preferred, but still I have seen eggs laid on older leaves and rarely on the upper side. Naturally these eggs on the older leaves frequently cannot survive as the leaves drop before the flies are mature. The number of eggs in a semi-circle varies from 3 or 4 to 25 or 28. Eggs develop on leaves cut off from the plants, but the period of hatching extends. The colour of such eggs also deepens, the shell becomes harder and there is a greater percentage of death while hatching.

Development /

Development and Hatching: Eggs freshly laid are sulphur yellow and shining. The orange bodies can be very distinctly seen through the shell. From day to day the orange bodies appear to change position, sometimes appearing at the bottom, sometimes in the middle and sometimes at the other end - evidently caused by the movement of the larva inside. On the sixth or seventh day the colour of the eggs becomes brown and two or three days later the larva inside begins to be formed. Six or seven days before hatching, the red eyes of the larva inside can be clearly seen through the shell, and three or four days before hatching a longitudinal crease on the egg shell, more usually often in the middle, is noticed. It is on the line of this crease that the rent in the egg-shell appears, through which the larva emerges. First the cephalic portion emerges. As the larva pushes itself from inside, the rent becomes larger to facilitate the complete eclosion. The egg is laid perpendicular to the leaf surface but soon after it bends down and lies horizontally. The delicate larva can thus get a foothold on the leaf and easily extricate the rest of the body. In the few cases where the eggs are standing erect on stalks, the hatching larva has to bend out till it gets hold of the leaf and under these circumstances larvae have been observed to die if /

(what does cephalic portion emerge? Is it the head? Does the thorax not come out first?

if they fail to get any foothold. Similarly I have seen many larvae dead half in and half out of the shell without any apparent cause. The percentage of deaths in hatching is higher in the case of eggs on dry leaves than in those on living plants. The time required for complete eclosion of the larva from the egg-shell differs in different larvae. I have observed them to take 45, 55, 65 and even 90 minutes, and when a longer time was required the part of the body of the larva outside the egg used to secrete wax particles. If hatching was effected earlier, the wax did not appear till later.

Incubation: The period of incubation has varied from thirteen to twenty-one days. The longer time was required in March and April and the period was shortened as the hot weather set in.

The larva after emergence is active and moves in search of a suitable place and then settles by fixing its rostrum inside the leaf tissue and begins to grow.

Larval habits: After fixation at one place the larvae grow from a flat thin form to one which is convex above and when this stage is reached moulting takes place. Colour, size and wax production differ from instar to instar.

Moulting: The moulting begins from the cephalic end. The upper skin bursts at the cephalic end and the larva wriggles out and the skin or the moult rolls backwards /

backwards. (The movement of the larva can be seen when the last end-part moults). The larva never removes the rostrum, and if forced to do so it dies as it is unable to fix it in again. The moult (cast skin) may lie by the side of the larva or may remain on the back of the larva for some time. The operation of moulting may take as long as even half an hour.

II. instar - same habit as the first. It is larger and the marginal fringe of wax is a little broader.

III. instar - same as in second but slightly larger and changes to the IV. instar or the Pupa.

The Pupa: In the early stage, that is immediately after moulting of the third instar, it is thin, flat and translucent. The formation of the adult insect inside can be seen indistinctly along the boundaries of the head, thoracic and abdominal segments. Then as it grows the cuticle above becomes hard, the flat size changes to convex. The waxy secretion is seen as a thick narrow fringe, fastening the case to the leaf. White waxy meal is seen scattered over the body. The growth and development goes on. The compound, divided eyes take the place of simple eye spots, and the vasiform orifice can be prominently marked. In the early stage of growth the lingula is seen to be very active and constantly moving to throw off /

off the accumulating excretion. In the later stage it is not so active and many times the honey dew hardens into a ball, apparently closing the vasiform orifice.

Hatching or Emergence: When full growth is completed the skin begins to crack by the movement of the insect inside. There is first a vertical or longitudinal median crack on the thorax. The thorax of the insect is pushed up first and the rent extends backwards to the junction of thorax and abdomen and then laterally on each side and assumes the form of an inverted T. As the emergence progresses the head comes out and the insect pushes itself standing erect. The wing-folds emerge in the crumpled condition and the legs are moved continuously to help wriggling out and lastly the abdomen comes out. When the insect fully emerges, it rests for about five to ten minutes during which period the wings are unfolded and straightened, and then perambulates slowly here and there.

Adult: Immediately on emerging the colour is yellow, but after two to three hours the dark colour begins to appear on different parts of the body. Even before the development of colour, i.e. within a period of two hours, wax begins to appear on the ventral abdominal wax plates which become shiny. The adult actively moves after three hours.

Mating /

Mating: It is always the male that goes in search of the female and not vice versa. The male as it comes near the mate, feels with the antennae and tries to come as near as possible abreast on the left side of the female. Then it begins to move its wings and passes them under those of the female. Then after coming very close it moves its hind portion of the body and feels the hind part of the female. If the latter is ready for pairing it moves its hind portion of the abdomen and ultimately the copulatory organs join. The hind part of the female is held tightly in between the claspers of the male, then the fluttering of the wings and the movement of the body goes on. If the female does not want the male, she remains passive, then the male goes to another female. The copulations I have seen did not last for more than ten minutes. Leaving that female, the male began searching for other females. Before mating the eggs are always developed inside the body and the orange colour of the eggs inside the ovary can be seen from outside.

Photo-tropism: The flies seem to be positively photo-tropic and negatively geotropic. If the flies are enclosed in a glass jar in a mass of leaves, they will always congregate on the exposed parts which are turned towards the light. If they are liberated they will /

will run to the glass panes of the windows. In cages they are always seen crowding on the part towards the light. Bewteen sunlight and electric light in a room they are more attracted by the yellow electric light. This is in accordance with the observations of Lloyd (1921) that yellow light is preferred by the flies to any other kind.

Feeding: The adults evidently feed, as can be seen from the observation that the flies kept without any food material to feed on succumb in three days, while on a semi-dry material they eke out their subsistence for five to seven days. If they are provided fresh material they live for a long time. If starved for some time and then allowed on to plants, they feed and live on. While the fly is on a plant, it can be seen fixing its rostrum into the plant tissue and sitting at one place for a considerable length of time - even three to four days.

Longevity: Immediately on emergence an adult female of A. brassicae was enclosed in a glass jar with a branch of the plant to feed on. The fly survived in the cage for 91 days. In the case of T. vaporariorum one female lived for 95 days. During these periods they were normally feeding and laying. Males were always shortlived.

Egg-laying Capacity: The number of eggs laid varied /

varied in different species. In brassicae I have observed that the number laid by one female varied from 56 to 68. In vaporariorum the number of eggs laid by one female was 108. Egg-laying is not started immediately after emergence, but generally there is an interval of one week or ten days before the female begins to lay. The number of eggs fully developed inside the body at one time is 10 to 12. In spring the life-history takes a longer time than in summer. Egg-laying is very prolific in summer, but as the cold weather sets in egg-laying is retarded. The reason is that the development of the ovaries is stopped. I dissected a large number of females and the eggs were not at all developed in the ovarioles during colder months.

Food-plants: There appear to be specific host plants for particular species. In A. brassicae the insects have greatest affinity for cabbage plants and they will not lay on Chilidonium or green-house plants like Tomato, Fuschia, &c. But they have been found breeding on cruciferous weeds, such as shepherd's spur.

Broods: This species appears to be multibrooded and can be reared continuously if adequate supply of food plants is maintained. I received about 20 females from the south of England in March 1930 and since then they have been breeding continuously. In October the plants /

plants had withered and so I planted new plants. As soon as plants were brought in, even before planting, the insects had flown to them from the original plants.

Resistance to cold temperature. - The flies seem to be very resistent to low temperature, the only effect on them being that their activity becomes less, their breeding is stopped, but their feeding goes on. The lowest temperature in the greenhouse where the plants have been kept was -1°C. but this was not constant. In order to see, therefore, as to how far the flies can stand continuous cold temperature and if they were affected, was it due to the temperature or the lack of food, I experimented as follows:-

(1) Two lots of 10 flies each were kept at +1°C. in a refrigerator in two glass-topped boxes. All the flies were dead on the 4th day. No feeding was arranged for.

(2) Two lots of 10 flies each were kept at +1°C. with a fresh leaf of cabbage inside the boxes for 5 days. In one 7 flies were living and in the other six. All the living flies died after 3 days from the time they were taken out. The leaves had withered.

(3) Two lots of 10 flies each were kept at -1°C. for 8 and 15 days respectively with sufficient quantity of food. The flies were quite happy in both the cases.

This shows that it is not so much the cold but the lack of food that kills the flies and they can stand -1°C. temperature for a fortnight.

## Duration of various stages.

Eggs: Yellow when laid; they turn brown after four days and hatch in about 16 to 25 days from deposition. Mean of 8 cases :-

25, 23, 24, 22, 16, 17, 18, 19 = 20.5 days.

I. instar: Active for 3 or 4 days.

Mean of 8 cases - period 10 to 16 days:-

14, 15, 15, 12, 12, 13, 16, 10 = 13.5 days.

II. instar: Inactive - period 8 to 13 days.

Mean of 8 cases :-

11, 12, 13, 10, 9, 8, 8, 9 = 10 days.

III. instar: Inactive - period 5 to 10 days.

Mean of 8 cases :-

10, 9, 8, 10, 8, 8, 6, 5 = 8 days.

IV. instar: Inactive - period 10 to 20 days.

Mean of 8 cases :-

20, 20, 17, 15, 14, 13, 11, 10 = 15 days.

## Summary of Duration of the various stages.

| | Mean period. |
|---|---|
| Egg ..... | 20.5 days |
| I. instar ... | 13.5 |
| II.instar ... | 10 |
| III.instar ... | 8 |
| IV. instar ... | 15 |
| | 67 days |

The life-history in -

March - April (temperature 52-58°F.) took 73 days, and

August - September ( " 62-68°F.) " 53 days.

Life-histories.

| Egg laid. | Hatch. | Moult I. | Moult II. | Moult III. | Imago. |
|---|---|---|---|---|---|
| 20.3.30 | 13.4.30 | 25.4.30 | 6.5.30 | 15.5.30 | 5.6.30 |
| 20.3.30 | 13.4.30 | 24.4.30 | 7.5.30 | 15.5.30 | 30.5.30 |
| 20.3.30 | 13.4.30 | 26.4.30 | 5.5.30 | 15.5.30 | 9.6.30 |
| 13.6.30 | 30.6.30 | 11.7.30 | 19.7.30 | 25.7.30 | 5.8.30 |
| 10.7.30 | 26.7.30 | 13.8.30 | 20.8.30 | 25.8.30 | 5.9.30 |

(2) A. proletella.

Rearing of this species was begun on 28th of June 1930 with the specimens from Letchworth, Hertfordshire. This species has the same habits as A. brassicae. Not only that, but they are extremely alike and may be only biological races. This species or race refuses to lay on the cabbage and cruciferous plants, while it readily lays on other weeds, as mentioned below, and settles on Fuschia and Honeysuckle.

Food plants: (1) Chelidonium, (2) Veronica sp., (3) Sonchus sp.

Sonchus of Compositae & Veronica of Scrophulariaceae & Chelidonium of Papaveraceae

Duration /

Duration of various stages.

Eggs: When laid yellow, turn brown after 3 or 4 days and hatched in 12 to 17 days.

Mean of 6 cases :-

12, 13, 14, 15, 16, 17 = 14.5 days.

I. instar: 5 to 7 days. Mean of 6 cases:-

6, 6, 5, 7, 7, 6 = 6 days.

II. instar: 4 to 7 days. Mean of 6 cases:-

4, 5, 6, 7, 6, 5 = 5.5 days.

III. instar: 4 to 6 days. Mean of 6 cases:-

5, 6, 7, 4, 5, 6 = 5.5 days.

IV. instar: 12 to 15 days. Mean of 6 cases :-

12, 13, 15, 14, 15, 13 = 13.7 days.

Summary of Duration of Various stages.

| | Mean period. | |
|---|---|---|
| Egg ..... | 14.5 | days |
| I. instar ... | 6.1 | |
| II.instar ... | 5.5 | |
| III.instar... | 5.5 | |
| IV. instar... | 13.7 | |
| | 45.3 | days |

The rearing was done in summer and hence the number of days required for completion was less as compared to A. brassicae in March - April.

Life /

Life-histories.

| Egg laid. | Hatch.. | Moult I. | Moult II. | Moult III. | Imago |
|---|---|---|---|---|---|
| 29.6.30 | 10.7.30 | 16.7.30 | 22.7.30 | 27.7.30 | 9.8.30 |
| 30.6.30 | 12.7.30 | 18.7.30 | 25.7.30 | 31.7.30 | 12.8.30 |
| 13.7.30 | 27.7.30 | 5.8.30 | 11.8.30 | 16.8.30 | 27.8.30 |
| 13.7.30 | 28.7.30 | 6.8.30 | 12.8.30 | 18.8.30 | 1.9.30 |
| 15.7.30 | 27.7.30 | 7.8.30 | 13.8.30 | 20.8.30 | 4.9.30 |

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(3) A. lonicerae.

Egg-laying: The usual habit in this species is to lay eggs singly and only very rarely in semi-circles or circles. The eggs are white in colour, standing erect and on account of the broad base and tapering end appear as white spots. One more peculiarity with these flies is that they seem to prefer comparatively older leaves to tender ones as against A. brassicae which lays on more tender leaves. If a plant is examined, the oldest pupae or a larger number of pupal skins will be found on the lower leaves.

Hatching: Similar to that of A. brassicae. The larvae are similar to those of A. brassicae in form and structure, except that these are more olive than yellow. Larval habits and growth as in A. brassicae. One thing noticeable at the time of moulting is that the moulted larva has got a drop of liquid on its body /

body for some time - evidently the liquid has come there from the previous turgid stage. This occurs in all the first three stages. Wax is present in the first two or three stages, but not so much in the last. Pupae are olive coloured at first, afterwards the chitin becomes hard and assumes an ashy-white colour. Male pupae are smaller and narrower in the anterior part than the female ones. Emergence and habits of adults same as in the previous species.

Food plants: Honeysuckle (Lonicera sp.).

Duration of various stages.

Eggs: Freshly laid whitish, turn brown after 4 days and hatch in 14 to 16 days. Mean of 5 cases:-

14, 15, 16, 14, 16 = 15 days.

I. instar: active for 3 or 4 days. Period 7 to 10 days.
Mean of 5 cases :-

8, 10, 9, 7, 8 = 8.4 days.

II. instar: inactive - period 5 to 9 days.
Mean of 5 cases :-

5, 5, 6, 8, 9 = 6.6 days.

III. instar: inactive - period 4 to 7 days.
Mean of 5 cases :-

7, 5, 7, 4, 6, = 5.8 days.

IV. instar: inactive - period 13 to 22 days.
Mean of 5 cases :-

13, 14, 15, 18, 22, = 16.4 days.

Summary /

Summary of Duration of various stages.

| | Mean period. |
|---|---|
| Egg ..... | 15 days |
| I. instar ... | 8.4 |
| II.instar ... | 6.6 |
| III.instar ... | 5.8 |
| IV. instar ... | 16.4 |
| | 42.2 days |

Minimum days required were 35.

Life-histories.

| Egg laid. | Hatch | Moult I. | Moult II. | Moult III. | Imago |
|---|---|---|---|---|---|
| 19.6.30 | 3.7.30 | 11.7.30 | 16.7.30 | 23.7.30 | 4.8.30 |
| 10.7.30 | 24.7.30 | 3.8.30 | 7.8.30 | 12.8.30 | 26.8.30 |
| 11.7.30 | 27.7.30. | 5.8.30 | 12.8.30 | 18.8.30 | 31.8.30 |
| 11.7.30 | 27.7.30 | 6.8.30 | 12.8.30 | 19.8.30 | 4.9.30 |

There is a great variation in the life-histories traced from eggs laid on the same date.

(4) T. sonchi.

Egg-laying: Same habit as is found in T.vaporariorum. The eggs are either laid in circles, semi-circles and sometimes also scattered. Greenish yellow, standing erect on stalk.

Hatching and growth: As in other species. Larval habits similar; moulting and growth also same up to the III. instar. From that stage a box-like nature /

nature of the pupa begins to be seen. The marginal waxy rods make their appearance to some extent in the III. instar. But they develop fully in the IV.instar.

Food plants: I received the species from Ferndown, Dorset, where it was found on Sonchus sp. (Sowthistle). I reared it in the laboratory on Chelidonium but I was not able to rear it beyond one generation.

Life-history.

| Egg laid. | Hatch | Moult I. | Moult II. | Moult III. | Adult. |
|---|---|---|---|---|---|
| | 28.8.30 | 3.9.30 | 9.9.30 | 15.9.30 | 2.10.30 |

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General Explanatory

## WAX - PRODUCTION.

The secretion of wax is a very commonplace phenomenon in many of the Homoptera and is particularly noticeable in all the families of Sternorhyncha. (Define) Wax is secreted by special structures known as wax-glands, wax-cells and wax-pores. The arrangement, position and structure of these may differ in different families. The secretion of wax is found in the larval as well as in the adult stages. In the family Aleurodidae, wax-secretion is profuse in the adults of all the species, but not found to the same extent in the larvae. Generally three types of wax pores are found /

found in the larvae of Aleurodidae - (1) Simple, (2) Agglomerate and (3) Compound. In the sub-family - Aleurodinae - simple wax pores only are found, while in the sub-family Aleurodicinae, all three kinds of wax-producing structures are found in the different Genera. For example, in the genus "Dialeurodicus" the dorsal pores are simple, but in one of the species "lahilli" agglomerate pores are present, and in the genus "Aleurodicus" the wax-pores found are of the "compound" type. It would not be out of place here to describe in short the structure of simple and compound waxpores.

Simple waxpores are circular holes of small or large size varying in diameter from .017 mm. to .027 mm. These exist in greater numbers in those species which secrete a large quantity of wax. In compound pores the holes have a chitinous ring surrounding them and a definite elevated cup-like structure. Within the cup the pores are arranged in a ring and are produced into more or less elevated rods or tubes.

The British species under study all belong to the sub-family Aleurodinae and so have only simple pores in the larvae. The British species A.aceris, A.azalaeae, A.immaculata, A.phillyreae, T.sonchi and T.vaporariorum secrete a large amount of wax and the last two produce the most. The secretion of wax is less /

less in the earlier stages and more profuse in the last instars or the pupae. Wax secreted by the 1st instar before settling is meal-like, the nature of which changes after some days and a thick fringe is formed. In A.aceris the dorsum of the pupa is covered over by waxy strands especially so on the abdomen. In A.immaculata and A.phillyreae, and also in A.azaleae, T.sonchi and T.vaporariorum the lateral wax-secretion is in the form of a palisade on which the pupa case is elevated. In the case of the first two the dorsum is covered over by the flocculent waxy material secreted by the hollow chitinous processes on the dorsum. In A.azaleae there is no marginal or dorsal secretion. In T.sonchi there is only marginal secretion in the form of glassy rods of wax secreted by the sub-marginal row of papillae. In T.vaporariorum in addition to the marginal secretion as in T.sonchi there is also secretion on the dorsum in the form of waxy rods. In other species the pupal cases are attached to the leaf surface by a marginal fringe of wax.

In the Adults there are chitinous plates, which are placed ventrally on the abdominal segments and are known as waxplates. These may be comparable to the waxplates in honey bees. There are two pairs of these plates in the female placed on the 3rd and 4th segments /

segments respectively and four pairs in the male on the 3rd, 4th, 5th and 6th segments (Pl.IV. Fig.5). These waxplates appear like thick pads and are oily yellow in appearance. They are separated by a median line in the centre of the abdomen but extend considerably outwards on both sides so that they can be very clearly seen laterally as they are bounded by a black line. In the female both the plates appear to be equal in dimensions, but in the male the first one is bigger and the succeeding ones gradually reduced in size. When viewed under the microscope these present an appearance of plates possessing minute holes arranged in regular rows (Pl.IV. Fig.6). When highly magnified (1200 times under the oil-immersion lens) these holes appear like cells in a honey comb. These are the minute circular pores through which wax comes out or is forced out in small minute particles or threads. In thin microtome sections taken through these wax-glands, there is seen a single layer of secreting cells with large nuclei which contain vacuoles (Pl.IV.Fig.7). There are numerous granules in these vacuoles which are found in a large number towards the outer side.

A careful examination of these plates in a male of T.vaporariorum, under a very high magnification, shows that each of the last three plates contains 40 rows of 90 cells each at an average; the first one has

50 /

50 rows as it is larger. Thus the total number of pores of one side comes to 3600 x 3 = 10,800 plus 50 x 90 = 4,500 = 15,300, or approximately 15,500, and both the sides together will bring the number to 31,000. Each side on the abdomen the space occupied (longitudinally) is .3 mm. In the female there are only two pairs of plates which are rather broader and occupy space to the extent of .23 mm. each side. Each of the plates contains pores in rows of 63 x 95 and 60 x 95 cells respectively. The total number of pores on one side thus comes to 11,685 or nearly 12,000. It is not understood why the number of pores is less in females.

Freshly hatched specimens are perfectly free from any wax particles soon after emergence. The waxplates, not being at work, cannot be marked out very clearly.

I give below my observation on a specimen for about 5 hours from its emergence. It was a male. It extricated itself with great difficulty from the pupal case which operation took it about an hour. This was at 10 a.m. In the first two hours no wax was seen being secreted but only the waxplates assumed an oily olive appearance. Then one of the plates (on the left side) was seen covered with white floccu-lent material which soon after drying became white. The insect (which was under a binocular) was actively moving /

moving its legs first of one side and then of the other. In that way the legs actually brushed off the wax accumulated on the plate and by dashing the legs here and there it distributed the wax or the meal all over the body. As the plates on the left side were active, the left side of the body was covered with wax, first the abdomen and its end, then the underside of the wings and then the front part of the body. Gradually all the plates began to secrete wax which was being spread all over the body. All the plates were in full action by 3 p.m., i.e. 5 hours after emergence.

The structure of the meal or the wax secreted is very peculiar. It is in the form of spiral threads as if forced out through small holes, but under abnormal conditions, or if the meal is not constantly removed by the brushes on legs, it assumes the form of long threads appearing like silken combs or tufts. While observing the eclosion of flies from the pupae, I have seen several specimens with three-fourths of their body out and struggling hard to extricate the last part of the body. The insect is standing erect and dashing its legs in the air and with wings in the unexpanded condition. The waxplates are active and the wax begins to appear on the body. As no brushing off is possible in that condition, the wax goes on accumulating and a very thick brush-like layer is formed.

Under /

Under the microscope these appear like bunches of long threads with one end curved. I have also observed cases of partial emergence wherein the flies have died after the upper part of the body - head and thorax - having come out and the abdomen remaining inside the pupal case. In such cases I have found after pulling out the abdomen that it was full of waxy brushes, proving thereby that the waxplates were actively secreting wax even if the abdomen was enclosed in the pupal covering.

## PARTHENOGENESIS.

Out of the species under study parthenogenesis has been established in T.vaporariorum by Hargreave, Williams and Schrader. I again confirmed it in that species and established it in other three species. In all I studied parthenogenesis in the following species :-

(1) A.brassicae
(2) A.proletella.
(3) A.lonicerae.
(4) T.vaporariorum.

In all the cases the females immediately on emergence were isolated to avoid fertilization and kept in separate cages. T.vaporariorum and A.lonicerae were liberated on a small branch under a glass jar which was supported on a retort stand and the mouth of which was closed with cotton wool to prevent escape and to give as natural a condition as was possible.

The /

The flies did quite well in these conditions. They always took about a week's time, and in one case 12 days before laying. In all cases all the eggs laid have hatched, proving thereby that these can breed parthenogenetically.

As regards the sexes obtained from the rearings, I have been able to get only males in all the species. The number of eggs reared has been different but the result was the same in all the cases.

A. brassicae - 4 eggs - 4 males - (repeated with the same result.

A. proletella - 28 eggs - 28 males.

A. loniceræ - 6 eggs - 6 males.

T. vaporariorum - 108 eggs - 18 males (the remaining pupae and larvae could not be reared as the branch was withered).

## PARASITES and PREDATORS.

During my study I did not come across any parasite prevalent in Edinburgh. The parasite that I studied was brought along with specimens of A. brassicae sent from Devonshire. It was a species of Encarsia (Hymenoptera - Chalcidae). Three weeks after the arrival of the Pupae and Adults of A. brassicae from the south of England the parasites began to emerge. They were all females. As I did not want the Brassicae under rearing to be infected, I removed the parasites to a greenhouse and liberated them in a wire /

wire netting cage (Pl.IV,Fig.4),which enclosed a branch having the larvae of T.vaporariorum, with a view to seeing them established. The cages were opened after 3 weeks and examination of the nymphs showed the presence of larvae of parasites. The nymphs could at once be recognised by the dark spots on the thorax and the general darkened appearance.

The description of the chalcid parasites is as follows:-

Head dark brown, thorax black with yellow sides, abdomen uniformly shining yellow with a conspicuous ovipositor. To the posterior end two long tubercles bearing three long hairs. Antennae 8-jointed .5 mm. long, light brown, legs brownish yellow, wings opalescent covered with short hairs and fringed with long hairs; expanse 1.5 mm.

Habits: The parasites seem to prefer 3rd and early 4th instars for oviposition. Late pupae not attacked. Exit holes in all the 40 specimens examined by me were anterior in the thorax. The exit holes of parasites are neatly cut round holes against the cracks in the pupal skin owing to the emergence of white flies. The emergence of the parasite takes about an hour from the start to the finish. When the parasite is ready to emerge, it makes a small hole and then enlarges it by actually eating the sides round /

round and round. It is extremely interesting to watch the operation and to note the movements of the fly every time throwing the cut portion. When the sides are nearly finished, it tries to push its head through. If it could not do so it again begins to cut the sides and to enlarge it. This is repeated until it succeeds in thrusting its head out. The parasite emerges either ventrally or dorsally. First the head comes out, then the antennae, then the thorax and legs. As the legs come out they are greatly helpful in wriggling the whole body out. If the parasite emerges ventrally, it find great difficulty and takes a longer time. After complete emergence is effected, it comes out exhausted and taking rest after a few seconds begins to expand its wings. When the wings are fully stretched it begins its perambulation.

Predators: As to the predators I did not come across any in Edinburgh. On the Chelidonium leaves I got only one Coccinelid grub feeding on the larvae of A.proletella.

In the nurseries I got a Fungus which was responsible for the death of a considerable number of larvae of T.vaporariorum.

On the leaves of Honeysuckle and in greenhouse plants I found that spinning mites were indirectly harmful to many young larvae which used to get entangled and died in the silken threads secreted by them.

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# PAPER III.

## CONTRIBUTION to the KNOWLEDGE of SYSTEMATICS of SOME of the BRITISH ALEURODIDAE.

(Ten Plates - Nos. V. to XIV.)

EX BRIT. UNIV. EDINBURGH

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Genus /

## INTRODUCTION.

On examining the literature so far published on this family, it will be seen that very little work has been done with regard to the systematics of the British species as compared to that done in other parts of the world and especially in America. Out of 34 species recorded in the whole of Europe 21 species have been found in Great Britain. Out of these 21 species I have obtained live specimens of all stages of six, live adults only of one, dry specimens (with prepared slides) of all stages of four, prepared slides of adults of two and dry specimens of pupae of two. Thus I have had an opportunity of studying 15 species in all. Of the remaining six, I was able to examine, without touching, the adults of three and of the last three I have no knowledge beyond the references in literature. From whatever information and knowledge I could get, I have described them and attempted the classification. Considering the schemes of classification that have been put forward, none is so comprehensive as that of Quaintance & Baker(1913) which has served and will serve as the basis for all. In the past, classification has been largely based on pupal characters, but I think that the characters afforded by the pupae alone are not sufficient and that along with them the adult characters must also be taken into consideration. I may even remark here that /

that for assigning a genus or a group of genera the characters afforded by the adults are not only helpful, but essential, and the study of internal structures - particularly the male genital system - will confirm the differentiation. For distinguishing one genus from the other in any group and for assigning the proper places for the species, the form of the vasiform orifice, the shape and dorsum of the pupa, and other characters as the shape of the eyes, are also helpful. The vasiform orifice of the adult is not as characteristic as that of the pupa and need not be taken into consideration.

All the species under study have wings having either one or two flexures in the Radial sector of the forewing, and those with two flexures have either one or two spots. I have not come across any specimens having one flexure and being spotted, or having two flexures and immaculate wings.

In the British species there are two pairs of species which are exactly similar in appearance and general characters, so much so that it is extremely difficult to differentiate between them. These are first A. brassicae and A. proletella, and secondly A. lonicerae and A. rubi. As to the latter pair, I am not in a position to say anything definite as I was not able to examine the live specimens of A. rubi, so /

so I restrict my remarks to the first two.

Structurally these two do not differ in the least (though they do differ in measurements of the different parts of the body), but they differ considerably in their habits. This kind of resemblance can only be explained by considering them as 'biological races' of one and the same species. Thorpe(1930) in his book 'Biological races in Insects and allied Groups' defines as follows:- "a biological race may be said to exist where the individuals of a species can be divided into groups usually isolated to some extent by Food-preference occurring in the same locality and shows definite difference in Biology". He further remarks that in order to establish fully the existence of a biological race in a plant feeding insect it is necessary to show that :-

(1) The larvae of each form have a well marked preference for the food plant of a particular race.

(2) The adults have a preference for egg-laying on this plant.

(3) There is a definite tendency for members of the same race to mate together rather than individuals of another race.

He further adds that the host-selection principle, as it has been called, has a close bearing on this subject in that it suggests a method whereby a large class of biological races has been brought into being.

All /

All these conditions given above are satisfied in the species under discussion. A. brassicae has restricted itself to cabbage and other plants of the cabbage tribe, while A. proletella refuses to breed on the same, but readily lays eggs on Chilidonium major and other plants. If the adults of both be side by side, there is no tendency whatever to mate. I have come across statements that A. proletella is found on cabbage and a solitary reference that A. brassicae is found on Chilidonium, but I think that because of the extreme similarity one species has been mistaken for the other. The measurements of A. brassicae are quite different and never agree with those of A. proletella even though the averages are compared.* I therefore say that A. brassicae and A. proletella may be the biological races of one and the same species. The same may be said about A. lonicerae and A. rubi which also greatly resemble each other.

My thanks are greatly due to Dr. C. B. Williams under whose guidance the work was carried on. His help was invaluable in so far as he allowed me the use of his slides from his collection and lent me all the literature he had on the subject.

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* In contradiction to this the measurements in T. vaporariorum taken by me have exactly agreed with those of Hargreaves taken some 15 years ago.

## HISTORICAL.

While the bibliography of the family is very extensive the earlier writings are of comparatively little importance from a systematic standpoint. Prior to Latreille, the insects were referred by writers to such genera as Tinea, Phalena, Chermes &c. The genus Aleyrodes was established by Latreille and was placed with Apididae to which family, or to the Coccidae, it was subsequently referred by various writers until 1840.

Westwood in modern classification Vol.II, p.442, in 1840, in reviewing the genus, established the family **Aleu**rodidae, the then single genus Aleyrodes constituting the type genus.

Signoret gave the comprehensive revision of the family in 1867 in his "Essai Monographique sur la Aleurodes" in which 23 species were treated, six being described as new. This valuable paper has constituted the principal basis for subsequent workers.

In 1892 the genus Aleurodicus was erected by Douglas for a species described as 'anonae' by Morgan.

Maskell in 1896 catalogued the species of the world, giving descriptions of 22 new species, bringing the number up to 66, four belonging to Aleurodicus. The American species were treated by Quaintance in 1900 in his "Contribution toward a Monograph of the American Aleurodidae", 52 being listed/

listed 18 of which were new. In 1902 Cockerell catalogued 98 species of the world according to the Geographical distribution and proposed several new subgenera.

In 1907 a catalogue of the species of the world by G. W. Kirkaldy was published with description of six new species by Jacob Kotinsky. Also in 1907 Albert Tullgren established a new genus Aleurochiton with Aleyrodes aceris Geoffroy as type, presenting also detailed descriptions of Aleyrodes proletella Linne , A. brassicae Walker, A.fragariae Walker, and Aleurichiton aceris Geoffroy. In 1908 Qaintance wrote the historical account of the family under Homoptera in the Genera Insectorum and catalogued the world species, giving the sub-families and the genera with their geographical distribution. The total number of species recorded by him was 156.

In 1913 Quaintance and Baker published a classification and description of the known species of Aleurodidae, especially dealing in detail with American ones. They dealt with the morphology and discussed about the relationship of the family. In 1914 in the second part of the above they reviewed the classification of the sub-family Aleurodinae as the genus Aleurodes contained a cosmopolitan collection of species and formulated a new classification of the whole sub-family/

family. In 1917 Harrison erected a new genus Tetralicia with 'ericae' - a new British species - as the type and gave the description of the adults and the larvae. In 1920 Baker and Moles published a note on a new species on Azalea in the Proceedings of the Entomological Society, Washington, XXII, 5. In 1928 Laing described one new species found on Rhododendron and put it under the genus Dialeurodes.

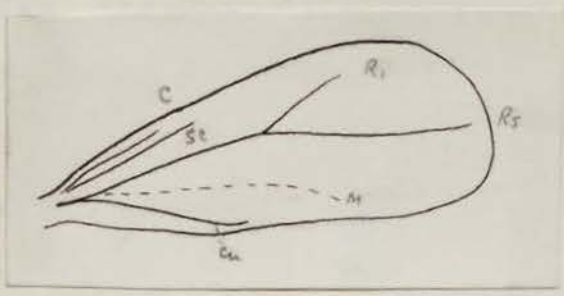
Since 1919 various authors have published descriptions of species found in different parts of the world but none of them refer to European species.

FAMILY CHARACTERS and RELATIONSHIP.

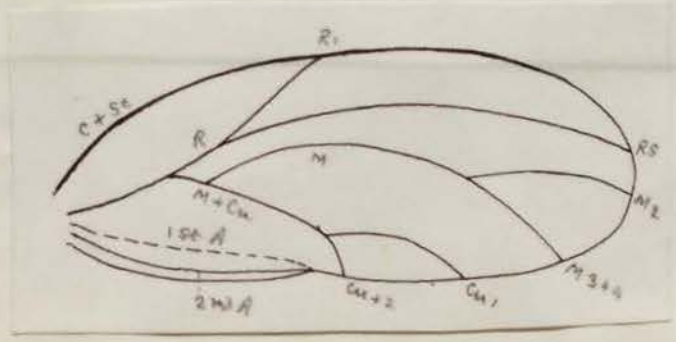
The family Aleurodidae belongs to the group Sternorhyncha(Phytoptheris) of the order Homoptera. This group contains in all four families - (1) Psyllidae, (2) Aleurodidae, (3) Aphididae and (4) Coccidae. Looking to the characters of all these with the intention of fixing the proper position and relationship of the family Aleurodidae, it will be seen that this family has some characteristics in common with each of the remaining three families. In the early stages, the Aleurodidae resembles the Coccidae as the first four instars appear scale-like (and resemble the stages of the genus Lecanium) and in the phenomenon of the adults hatching out from the pupae, in winged form. It resembles the Aphididae and Coccidae in the production /

production of wax by means of special wax-glands, in the secretion of the honey dew by the special apparatus - Lingula and operculum - and in the structure of the antennae having sensoria. The Aleurodidae resemble the Psyllidae in many characteristics such as (1) wing venation, (2) genitalia, (3) mouthparts, (4) legs, and lastly (5) antennae. The best homology is found in wing venation and legs.

Comparing the wing-venation of a Psyllid and an Aleurodid (especially species belonging to the sub-family "Udamoselinae" and the genus "Dialeurodicus" of the sub-family Aleurodicinae) it is clearly seen that the ancestor of the Aleurodidae has had a wing-form and venation very similar to the Psyllid type. In a Psyllid wing all the veins-costa, sub-costa, Radius, Radial sector, median, and cubitus are present.




1. Wing of an Aleurodid.




2. Wing of a Psyllid.

The last four veins are clearly visible in Udamoselis and one can trace the whole venation. In Aleurodidae, the reduction of veins seems to be the rule, and in the genus 'Neomaskellia' only one vein is present.

If we examine the female and male genitalia, the resemblance is more clear. The ovipositors in these two families are remarkably alike and the claspers are present in both the families, with the median copulatory organ. The similarity of the legs and especially of the claws and the paronychium convincingly prove the close relationship. The tarsi in both are two-jointed and the claws are also two with a pulvillus or paronychium centrally situated. In the Aphididae the pulvillus is wanting in almost all species and the Coccidae possess only one claw. Sensoria are situated on the antenna of a psyllid as in Aleurodidae, the only difference being that the number of antennal segments is greater in the former. Judging therefore from all the characters, it is clear that instead of the family Aleurodidae being considered as a link between Aphididae and Coccidae it is more related to Psyllidae and may be said to be an off-shoot of the same.

Family Characters :- Small to minute insects, measuring little over one mm. in the adult stage, the immature stages scale-like, the adult stages winged in both the sexes, active, covered with powdery /

powdery or meal like waxy material secreted from wax-plates situated ventrally on the abdomen. In the adults the head is convex rounded anteriorly, eyes reniform or completely divided into an upper and a lower division, the facets in the upper division being smaller and those in the lower part being larger in size. Anteriorly to the upper division is placed an ocellus on each side. Base of antennae near the eyes in sockets. Each antenna consists of seven segments, the first is broad and cup-shaped, the second is large, more or less sub-pyriform, the third and the following ones are slender and numerously ringed and possessing small hairs. Rostrum made up of three joints. Thoracic segments equally distinct; Prothorax the smallest. Each sex with two pairs of wings, rounded distally and with a beaded border all round with some hairs coming out from these beads. Legs large and slender, with dimerous tarsi and two claws with a median process called paronychium. Abdomen somewhat peduncu-late (especially in males), rounded, tapering or ovoid in females ending in a conical ovipositor. The abdo-men in males more slender, ending in a forcipate geni-talia composed of two valves, and centrally between them is placed the copulatory organ. On the dorsum of the last segment of the abdomen of each sex is the so-called vasiform orifice, comprising the orifice, the /

the operculum and the lingula. General colour yellow with some dusky markings.

The immature stages elliptical, oval or rounded in shape, quiescent except in the first larval stage, occurring mostly on the underside of leaves of plants, firmly attached to the surface by the sucking mouth-parts. In earlier stages mostly flat, in the last scale-like stage becoming more convex and in some species raised on a palisade all round of white wax. In some species the different forms are covered with wax-tubes or chitinous hollow processes, in others waxy secretion from marginal wax tubes. A distinctly Aleurodid character in the larval and pupal stages is the presence, on the dorsum of the last abdominal segment, of a rounded ovoid or sub-cordate opening the "vasi-form orifice" consisting, as in the adult, of the orifice, the operculum and the lingula. These are of different shapes in different species and may differ considerably from the adult form of the same species.

Eggs elliptical, often curved, attached firmly to the leaf with a short stalk; laid, when the female has not been disturbed, in an arc of a circle, rarely in an almost complete circle.

NOTE /

NOTE on CLASSIFICATION and CHARACTERS considered for GENERA and SPECIES.

The family Aleurodidae has been divided into three sub-families - I. Udamoselinae, II. Aleurodinae, and III. Aleurodicinae, the characters taken as basis for the same being :-

(1) The wing venation.

(2) The nature of the paronychium.

(3) The presence or absence of compound wax pores in the pupae.

All the British species which are under study here belong to the sub-family Aleurodinae. I therefore confine my attention to that sub-family only.

This sub-family, prior to 1902, was divided into three genera. In the members of this sub-family the media of the forewing is lost, but the cubitus is retained as a distinct vein in most genera. The radial sector forms the main vein of the wing and radius$_1$ may or may not be present. No compound pores are present in the pupa case and the paronychium is broad and hairy.

Genera of the Aleurodinae.

(1) Forewing with radius$_1$, radial sector and cubitus present ..... Aleurochiton.

(2) Forewing with only radial sector and cubitus present ..... Aleyrodes.

(3) Forewing with only radial sector present ..... ... Neomaskellia.

In his paper on "The Classification of the Aleurodidae" Cockerell(1902) remarked that the genus Aleyrodes /

Aleyrodes as at present(1902) understood was cosmopolitan and proposed some new genera. Quaintance and Baker in 1914 reclassified the whole sub-family into seventeen genera, but in doing so more reliance was placed on the characters presented by the pupae, but they remarked that the classification as thus proposed did not differ much from that based on characters obtained in the adults. They further added that a classification based on the characters in the adults would not be possible for many years to come owing to the fact that in so many species only pupal stages were available, but at the same time implying that such a classification would be welcome when possible. An attempt therefore is made in the following pages to frame a classification both of the British genera and species by taking into consideration the characters afforded by the adults supplemented by the pupal characters.

The characters considered in the classification are :-

Adult Characters.

(1) Wing venation.
(2) Flexures in the Radial sector of the Forewing.
(3) Spots on the above flexures.
(4) Claspers of the male forked or not.
(5) Eyes divided or not divided.
(6) Antenna.
(7) Internal structure.
(8) Paronychium and its shape.

## Pupal Characters.

(9) Shape of the pupa.
(10) Pupa hairy or otherwise.
(11) Characteristic vasiform orifice of the pupa.
(12) Wax-secretion.

It might not be out of place here to discuss the above characters with a view to make it clear as to how they have been interpreted to show the differentiation.

(1) Wing-venation: The absence or presence of Radius$_1$ will at once differentiate Aleurochiton from the rest. In the genus Aleyrodes in some species a trace of median is seen and in some species like rubicola, phillyrea, &c., the cubitus is more pronounced than that in others.

(2) Flexures in Rs of the forewing: This character is very useful in separating the species as in some Rs is distinctly bent twice, once in the middle and once towards the end (Pl.VI.Fig.2 &6), while in some it is only bent once in the middle. This character has been found associated with the spots on the wing.

(3) Spots on the forewing: Dusky spots or maculations (either one or two) are found at the places of flexures in the Rs in some species. They are observable in living and dead specimens and persistent even in prepared slides of the same. There are, however, some species which are perfectly immaculate, these are invariably with one flexure in Rs. The spots thus /

thus afford a good basis for classification.

(4) Claspers of male : In some of the species the claspers are forked at the tip and in some they are not. The forked nature in A.brassicae, A.proletella &c. is quite different from that found in "quercus". The forked nature of the claspers is associated with poly-broodedness and spotted wings.

(5) Eyes divided or not : In some of the species the eyes are completely divided(Pl.I. Fig.1) and in some they are not, i.e. the lenses from two divisions touch one another giving the whole eye a constricted or reniform appearance. The form of the eyes helps in separating closely allied species.

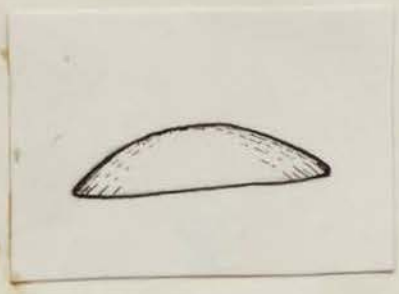
(6) Antennae: In all the species under study, except those belonging to the genus Tetralicia, the third segment is the longest. The fourth may be shorter or longer than the seventh and is not a very sure character for identification except in comparing the average lengths in different species. The relative lengths of the joints do differ on the average in different species and so may serve as a confirmatory character.

(7) Internal structure : On examining the internal structures of the adults it is seen that the male genital system differs strikingly in various genera though the other system may be very similar. For /

For example, the male genital system of A.brassicae, A.proletella and A.lonicerae is quite different from that in T.sonchi and T.vaporariorum and also from "quercus". Rubicola, phillyrea and immaculata belong to different genera and this decision arrived at by studying other characters would have been supplemented by the study of internal structures had I had living specimens of the above species.

(8) Paronychium : The genus Aleurochiton can be recognised by the thick, pad-like paronychium, while in the other genera of British species it is thin and blade-like.

(9) Shape of the pupa: Generally considered, in the species under study, there are two kinds of shapes of the pupae, one touching the surface of the leaf and convex in form above and the other box-like in appearance raised on a palisade of wax.



Convex.

Boxlike.

(10) Pupa with or without processes: The dorsum of the pupa may possess hairs, waxen tubes or rods or chitinous hollow processes, or may be smooth, i.e. devoid /

devoid of these structures. This character is greatly helpful in grouping the different allied species.

(11) Vasiform orifice of the pupa: This is one of the most important and dependable characters as it at once distinguishes very closely one species from the other and even sometimes the earlier stages from the later ones. In the pupae of the species under study, three or four kinds of shapes are met with - (i) Sub-cordate, (ii) Sub-circular or cup-shaped, (iii) V-shaped, and (iv) Sub.rectangular. The operculum does not show the same differentiation, but the lingula and especially the caudal end or the tip is helpful in distinguishing the different species by its form whether it is spathulate, rounded or with or without lobes. As regards the orifices it is important to note whether the anterior border is straight and the caudal end notched or not.

(12) Wax-secretion: In the adult of all species under study there is not so much difference in the wax secretion as is seen in the pupae. In the pupae simple (not compound) pores are found in all the British species, but in some species (e.g. vaporariorum, sonchi, phillyrea, immaculata, aceris &c.) there is more wax-secretion than the others. Of course this directly correlates with the presence of extra wax-secreting structures such as the sub-marginal row of papillae in the first two species and the hollow chitinous processes in the third and fourth species.

Classification /

## Classification of the British Aleurodidae.

The British species so far known are :-

(1) aceris (Geoffroy).
(2) avellanae (Signoret)
(3) azeleae (Baker and Moles)
(4) bagnalli (Harrison)
(5) brassicae (Walker)
(6) carpini (Koch)
(7) chittendoni (Laing)
(8) ericae (Harrison)
(9) fragariae (Walker)
(10) immaculata (heager)
(11) lonicerae (Walker)
(12) phillyrae (Haliday)
(13) proletella (Linneus)
(14) quercus (Signoret)
(15) ribium (Douglas)
(16) rubi (Signoret)
(17) rubicola (Douglas)
(18) sonchi (Kotinsky)
(19) spiraeae (Douglas)
(20) vaccinii (Kunow)
(21) vaporariorum (Westwood).

Table /

Table of Characters present in different Species.

| Name of the Species. | Wing Venation | Flexures in Radial sector of Forewing | Spots on the Flexures | Eyes divided or not | Wax Secretion | Antenna | Tips of Claspers of the Male |
|---|---|---|---|---|---|---|---|
| aceris | R,Rs,Cu | | | Reniform | considerable | 3rd joint longest | not forked at the tip |
| *carpini | Rs, Cu | one | no spots | - | - | - | - |
| brassicae | Rs, Cu | two | two | divided | slight | " | forked |
| erica | Rs | one | no spots | slightly reniform | none | " | not forked |
| fragariae | Rs,Cu,M | two | one | divided | slight | " | forked |
| immaculata | Rs,Cu | one | none | not divided | considerable | " | not forked |
| phillyrea | " | " | " | " | " | " | " |
| lonicerae | " | two | one | divided | slight | " | forked |
| proletella | " | " | two | " | " | " | " |

* Not seen.

| Pupa, hairy, smooth, with waxen rods or chitinous processes | Vasiform orifice of the pupa | Shape of the pupa | Male genital system. Internal Structure. | Paronychium |
|---|---|---|---|---|
| waxy crust on the dorsum | sub-rectangular | arched oval | | spathulate |
| - | - | - | - | Blade-like |
| dorsum smooth | sub-cordate | convex, touching leaf surface | (1) round testes<br>(2) short vasa deferens<br>(3) small accessory glands | " |
| dorsum with some spiny hair | rounded sub-cordate | flat, elongate, elliptical | not known | not known |
| dorsum with 3 pairs of spines | sub-cordate | convex, touching leaf surface | not known | Blade-like |
| dorsum with hollow chitinous processes | sub-circular | box-like, elevated on a palisade of wax | " | " |
| " | " | " | " | " |
| dorsum smooth or having 6 pairs of spines | sub-cordate | convex, touching leaf surface | as in A. brassicae | " |
| dorsum smooth | " | " | " | " |

Table of Characters present in different Species .

| Name of the Species | Wing Venation | Flexures in Radial sector of Forewing | Spots on the Flexures | Eyes divided or not | Wax Secretion | Antenna | Tips of Claspers of the Male |
|---|---|---|---|---|---|---|---|
| quercus | Rs, Cu | one | none | not divided | | | slightly forked |
| * ribium | " | " | " | " | slight | 3rd joint longest | not forked |
| rubicola | " | " | " | " | " | " | " |
| rubi | " | two | one | divided | " | " | forked |
| * spiraeae | " | " | " | " | " | " | " |
| sonchi | " | one | none | " | considerable | " | not forked |
| vaporariorum | " | " | " | " | " | " | " |
| chittendeni | " | " | " | not divided | none | " | " |
| azaleae | " | " | " | divided | considerable | " | " |

* Not seen.

| Pupa, hairy, smooth, with waxen rods or chitinous processes | Vasiform orifice of the pupa | Shape of the pupa | Male genital system. Internal Structure. | Paronychium |
|---|---|---|---|---|
| | | | (1) globular round testes<br>(2) long vasa deferens<br>(3) large accessory glands | Blade-like |
| dorsum smooth | | flat, slightly convex touching the surface | | " |
| " | triangular | " | | " |
| dorsum with 3 pairs of spines | | | | " |
| dorsum margin with waxen rods | sub-cordate | box-like, elevated on a palisade of wax | as in quercus | " |
| dorsum and margin with waxen rods | " | " | " | " |
| dorsum smooth | sub-circular | convex, touching the surface | | " |
| dorsum with 2 small spines | sub-cordate | box-like, elevated on a palisade of wax | | " |

Quaintance and Baker(1914) in their classification of the Aleurodidae, Part II. which deals with the sub-family Aleurodinae, placed some of the British species under certain genera and the rest, in the absence of any information, were kept aside as unplaced species. Their classification was as follows:-

| | |
|---|---|
| Aleyrodes..... | (1) brassicae. |
| | (2) fragariae. |
| | (3) lonicerae. |
| | (4) proletella. |
| | (5) quercus. |
| | (6) rubi. |
| | (7) rubicola. |
| | (8) spiraeae. |
| Aleurochiton... | (1) aceris. |
| Asterochiton (Trialeurodes)..... | (1) immaculata. |
| | (2) phillyrae. |
| | (3) sonchi. |
| | (4) vaporariorum. |
| Unplaced Species ..... | (1) avellanae. |
| | (2) carpini. |
| | (3) vaccinii. |

Comparing their classification and the characters given for the different genera with the characters of the different species as given in the previous table, it will be clearly seen that the species-quercus, ribia, rubicola under the genus Aleyrodes, and phillyrea and immaculata under the genus Trialeurodes - were wrongly placed. Quercus, ribia/

ribia and rubicola are species having immaculate wings and having only one flexure in the Radial sector of the forewing. Hence they cannot go under the genus Aleyrodes with proletella as type. Similarly phillyrea and immaculata cannot be placed under the genus Trialeurodes because the four important characters, namely (1) vasiform orifice sub-cordate, (2) the tip of the lingula lobed, (3) a furrow from the vasiform orifice to the caudal margin of the case, and (4) submarginal row of papillae, are not present in these two species. So, taking into consideration all the known characters of the British species and following the generic classification of Quaintance and Baker as far as possible, I classify these twenty-one species as follows :-

| Genus. | Species. |
|---|---|
| Aleurochiton..... | (1) aceris. |
| Aleyrodes..... | (1) brassicae, (2) fragariae, (3) lonicerae, (4) rubi, (5) proletella, (6) spiraeae. |
| Dialeurodes..... | (1) chittendeni. |
| Neo-aleuroplatus... | (1) immaculata, (2) phillyrae |
| Neo-Bemisia..... | (1) ribium, (2) rubicola. |
| Tetralicia..... | (1) ericae, (2) vaccinii |
| Trialeurodes..... | (1) sonchi, (2) vaporariorum. |
| Unplaced ..... | (1) avellanae, (2) bagnalli, (3) carpini, (4) quercus, (5) azaleae. |

It /

It might be possible to include immaculata and phillyreae in the genus Trialeurodes of Quaintance and Baker ( 1914) by extending its characteristics, but they have really nothing in common with the other species of the genus except the box-like pupae. I have examined the characters of the adults of carpini and quercus and those of the adult and pupae in the case of rubicola and to some extent ribia. The latter two species resemble each other closely, but do not seem to fit in any of the known genera of Aleurodinae. Harrison( 1917) describes carpini, avellanae and bagnalli as belonging to the genus Asterochiton, but in the absence of any full reliable description of the species I have put them under the list of unplaced species. The species ericae and vaccinii he has put under the genus Tetralicia which he himself erected as a new genus, and hence I have kept the genus as such. The species chittendeni has been described by Laing(1928) in the genus Dialeurodes, though he says he is not sure about the general relationship. I have kept it as such.

or full enough

Genera of the British Aleurodidae.

I. Forewing of adult with Radius 1 present as a distinct vein ..... Aleurochiton.

II. Forewing of adult without Radius 1 .

A. Forewing with two flexures in Rs, and dark spots on them, male claspers deeply forked at the tip.

(1) Vasiform orifice sub-cordate with cephalic margin straight ..... Aleyrodes.

B. Forewing with one flexure in Rs, wings immaculate, male claspers not deeply forked at the tip.

(1) Pupa case papery, without any wax secretion, vasiform orifice small and roundly sub-cordate, operculum almost fitting the orifice ..... Dialeurodes.

(2) Pupa case box-like, elevated on a palisade of wax.

(a) Dorsum of the pupa and margin with waxen rods, vasiform orifice sub-cordate, Lingula with lobed tip, sub-marginal area with a row of papillae..... .... Trialeurodes.

(b) Dorsum of the pupa and margin without any waxen rods, vasiform orifice sub-cordate, Lingula spathulate, without any row of papillae in the sub-marginal area ..... (sp. azaleae)

(c) Dorsum of the pupa with hollow chitinous processes, vasiform orifice roundly sub-cordate or sub-circular, Lingula distally knobbed and included within the orifice.. ..... Neoaleurotulus.

(3) Pupa case flat or slightly convex.

(a) Pupa case yellowish brown, with a large sub-marginal area, vasiform triangular, with the caudal area of the orifice with folds, slightly marginal wax-fringe.... ..... Neo Bemisia.

(b) Pupa case black, elliptical, without any marginal wax secretion, vasiform orifice sub-circular, operculum filling the orifice ..... Tetralicia.

List /

## List of European and British Species with their Host Plants and Known Distribution.

| | Name of the Species. | Food Plant. | Locality. |
|---|---|---|---|
| (1) | aceris (Geoffroy) | (1) Acer plantanoides (Sycamore) (2) Acer compestris (Maple) | England, France, Germany, Austria-Hungary. |
| (2) | avellanae (Signoret) | (1) Corylus avellanae (Hazel) | England, France. |
| (3) | bagnalli (Harrison) | (1) Fagus sylvatica (Beech) | England. |
| (4) | brassicae (Walker) | (1) Brassica oleracea (Cabbage) | England, France, Germany, Austria. |
| (5) | capreae (Signoret) | (1) Salix caprae (Willow) | France. |
| (6) | carpini (Koch) | (1) Carpinus betulus (Hornbeam) | England, France, Germany, Austria. |
| (7) | complanatum (Baeransprung) | (1) Acer plantanoides (Sycamore) | Germany. |
| (8) | couchyliformes (Signoret) | | |
| (9) | dubia (Heager) | (1) Fraxinus excelsior (Ash) | Austria, Germany. |
| (10) | ericae (Harrison) | (1) Erica tetralix (Cross-leaved Heather) | England. |
| (11) | euphorbia (Loew) | (1) Euphorbia peplus (Petty Spurge) | Austria. |
| (12) | filicum (Goeldi) | (1) Asplenium lueidum (2) Oleandra articulata (3) Pyrola rotundifolia (Round-leaved Winter Green) (4) Pteris quadriaurita (Bracken) (5) " quadriolata (Bracken) | Originally Brazil Introduced in England. |
| (13) | fragariae (Walker) | (1) Fragaria (Strawberry) | England, France. |

| | Name of the Species. | Food Plant. | Locality. |
|---|---|---|---|
| (14) | fraxini (Signoret) | (1)Fraxinus excelsior (Ash) | France. |
| (15) | immaculata (Heager) | (1)Hedera helix (Ivy) | England, France Italy, Austria, Germany. |
| (16) | jelineki (Frauenfeld) | (1)Arbutus unedo (Strawberry tree)<br>(2)Viburnum linus | |
| (17) | lacerdae (Signoret) | (1)Anona sylvatica | Brazil. |
| (18) | lauri (Walker) | (1)Laurus nobilis | Greece. |
| (19) | lonicerae (Walker) | (1)Campanula tracheliodes (Nettle-leaved Bell-flower)<br>(2)Impatiens nolitangere (Yellow Balsam)<br>(3)Lonicera periclymentum (Common Honeysuckle)<br>(4)Salvia glutinosa (Sage) | England, France, Germany, Austria. |
| (20) | phillyreae (Haliday) | (1)Corylus avellanae*? (Hazel)<br>(2)Fraxinus excelsior (Ash)<br>(3)Phillyreae latifolia<br>(4) " media<br>(5)Pyrus<br>(6)Mespilus(Medlar)<br>(7)Rhamnus alaternus (Hawthorn) | England, Ireland, France, Germany, Austria Hungary, Italy. |
| (21) | preanthis (Schrauk) | (1)Sonchus oleratus (Sow-thistle) | Germany. |
| (22) | proletella (Linne) | (1)Quercus robur*?<br>(2)Brassicae olerac<br>(3)Chilidonium majus<br>(4)Sonchus oleraceas (Sow-thistle) | England, France, Germany, Austria, Switzerland, Hungary. |
| (23) | quercus (Signoret) | (1)Quercus pedunculate (Oak) | England, France. |
| (24) | ribium (Douglas) | (1)Ribes nigrum (Black Currant)<br>(2)Rubrum | England. |

(25) /

| | Name of the Species. | Food Plant. | Locality. |
|---|---|---|---|
| (25) | rubi (Signoret) | (1)Rubus fructosus (Blackberry) | France. |
| (26) | rubicola (Douglas) | (1)Rubus (Blackberry) | England. |
| (27) | spiraeae (Douglas) | (1)Spiraea ulmaria (Meadow Sweet) | England. |
| (28) | sonchi (Kotinsky) | (1)Sonchus oleraceus (Sow-thistle) | England. |
| (29) | tabaci (Gennadios) | (1)Nicotiana tabacum (Tobacco) | |
| (30) | vaccinii (Kunow) | (1)Vaccinum uliginosum (Mt.Blackberry)<br>(2) " myrmillus (Blackberry) | England,<br>Germany. |
| (31) | vaporariorum (Westwood) | Greenhouse plants- very many. (Sometimes out of doors in the summer). | England, France, Austria, Pennsylvania, Connecticut, Massachusets, Illinois, Indiana, Hawaiian Islands. |
| (32) | xylostei (Westhoff) | (1)Lonicera Xylosteum (Fly-Honeysuckle) | Germany, Westphalia. |
| (33) | chittendeni (Laing) | (1)Rhododendron | England. |
| (34) | azaleae (Baker and Moles) | (1)Loiseleuria procumbens (Azalea) | England. |

Key /

## K e y and Description of the British Aleurodidae.

### GENUS ALEUROCHITON (Tullgren).

Forewing with Radius 1, radial sector, and cubitus retained; vertex rounded; antennae of seven segments of which the third is the longest; claspers of male of medium length and thickness; paronychium very long and hairy. Pupa case with no compound pores, but the dorsum crowded with simple ones. Lingula of vasiform orifice short, setose, and included orifice surrounded by a differentiated area.

Species coming under this genus :-

Aleurochiton aceris (Tullgren).

(Plate XI. , Fig.7-11).

Aleurodes aceris (Signoret) 1865, A.S.E.F.(4) VIII. p. 394.
" " (Douglas) 1886, Ent.Mo.Mag.XXIV.p.108.

Characters:- Paronychium in adult spathulate, vasiform orifice of the pupa case large and sub-rectangular in outline.

Pupa :- (described from a dry specimen and a microscope slide).

Size 1.83 mm. x 1.5 mm., shape oval, slightly sinuate at the posterior margin under the vasiform orifice and wavy at the anterior margin. It is narrowed in the front part from the thoracic segments upwards and broader downwards towards the hind part - the breadth varies from 1.25 to 1.5 mm. The whole dorsum is covered with wax crust with blank spaces.

The/

The margin all over is covered with wax small rim-like in form. The cephalic area is practically free excepting the central ridge. There are three pockets bare of wax on the thorax and five pockets on the abdomen towards the margin. Median ridge has got small bare spaces on the abdominal segments. Practically each segment has got a waxy crust. There are fine rents in the waxy crust, one in the middle of the body transversely separating the abdominal part from the thorax and two longitudinal ones - one on each side of the median line - from the head to the anterior margin of the vasiform orifice. Colour of the pupa after the wax is removed is brown. Margin crenulate with large blunt teeth. Teeth measuring 9 to 10 in .1 mm. The dorsum shows the three thoracic and the abdominal 5 to 6 segmental constrictions. By changing the focus of the microscope there appears to be a crenulated or wavy area in the sub-margin. Dorsum covered all over by small round wax pores situated in pairs. Vasiform orifice situated within the curved last abdominal constriction, sub-rectangular in form. The anterior margin faint but straight, operculum flap-like & transversely rectangular, lingula hardly visible caudad the operculum. The caudal portion of the vasiform orifice with an irregular pattern of lines having angular margins. By changing the focus finger-like processes are seen above the lower border. From the vasiform orifice/

orifice to the caudal margin of the case there is a furrow of wavy lines.

Adults :- not seen.

Habitat :- England (Swallowship Wood near Hexam, Northumberland; Gunnergate, N.Yorks.)
France, Germany, Austria, Hungary.

GENUS DIALEURODES (Cockerell).

(Plate XIII. , Fig. 5-11).

Pupa case variable in size, elliptic to subcircular in outline; colour usually yellowish, varying in some species brownish; margin of case toothed, the wax tubes irregular in outline and but little developed, sub-marginal area not separated from dorsal disk; dorsum without papillae or pores; tracheal folds evident, in some species very conspicuous, terminating on margin of case in a pore, the folds often showing dotlike, linear or polygonal markings; wax-secretion absent or very scant. Vasiform orifice relatively small, transversely oval or sub-circular, with or without comb of teeth on inner lateral and caudal margins; operculum large, mostly filling the orifice and obscuring the lingula.

Adult with one flexure in radial sector of forewing and no trace of media. Antennae of seven segments, segment vii. not distinctly shorter than iv, vi, and v, but usually longer than these. Sexes about equal in size, the claspers of male with a few prominent spines.

The /

The species found attacking Rhododendron in Wisley has been partly described by Mr.Laing and temporarily put under this genus, naming it as - "Dialeurodes chittendeni". The chief difference lies in the following characters :-

This species possesses no tracheal folds, the dorsum with a series of papillae, and the lingula visible caudad the operculum.

I add as follows to the description given by Mr. Laing which appears in the Ent. Mo. Magazine, October 1928.

Egg (described from dry specimen) - size .233 mm. long without stalk, stalk .02 mm. shape elliptical, curved considerably on one side; the outer side convex; broad and curved bottom, with a prominent tip. Stalk attached to the convex side and not in the centre of the bottom. Colour yellowish brown;standing erect on stalk, not laid in a circle or a semi-circle but scattered.

Early larva (dry specimens) - .45 mm. x .3 mm.; shape broadly elliptical or oval; colour pale yellow with practically no wax-secretion, papery in structure. Margin entire, crenulate, marginal teeth 27 to 30 in .1 mm. sub-marginal area broader, paler in colour and striated, of nearly the same breadth except at the caudal end. Dorsum devoid of any hairs, spines, or the papillae present in the sub-marginal area in the/

the pupa. Two red spots representing the eyes. The vasiform orifice similar to that in the pupa. Lingula visible caudad of the operculum. There are two cerei to the caudal margin. A pair of small spines, one on each side of the cerei, and a pair of spines to the cephalic margin are noticed.

Larva III instar - size 1.16 x .85 mm., shape more or less oval, sinuate at the caudal margin under the vasiform orifice. Margin entire, minutely crenulate, showing the tracheal combs in the thorax, opposite to the 1st pair of legs, sub-marginal area very broad, .066 mm. in breadth, pale, wax-like in colour, striated. Three pairs of legs blunt, and two red spots cephalad representing eyes are clearly visible, colour pale yellow, papery in structure. The vasiform orifice as in the pupa, roundly sub-cordate or sub-circular; operculum transversely elliptical, almost clouding the lingula. A furrow of two lines made up of crescent shaped marks from the lower margin of the vasiform orifice to the caudal margin of the pupa case; flat without any wax-secretion and any series of papillae-like structures in the sub-marginal area.

Adult ♀ - Wings immaculate, forewing with one flexure in the middle of Radial sector - a trace of median is visible. Forewing 1.53 mm. x .575 mm., hind wing 1.13 x .58. Eyes not divided, strongly reniform /

reniform, the two divisions joined by three facets, the facets of the lower division appear to be slightly bigger. Wing border orange in colour, beaded; beads or knobs 17 to 18 in .1 mm.

Antenna. I. segment .033 mm., II. segment .073 mm., III. the longest .133 mm., IV. .03 mm., V. .033 mm. VI. .04 mm. and VII. .033 mm. The last five segments imbricate, the third segment possessing three sensoria, fifth one and the last has one and besides a terminal bristle. Total length is .375 mm.

♀ Legs. Hind femur .30 mm., hind tibia .43 mm., hind tarsal joints, I. .133 mm. and II. .093 mm. Middle femur .22 mm., middle tibia .30 mm., middle tarsal joints, I. .106 mm. and II. .083 mm. First femur .2 mm., first tibia .25 mm., first tarsal joints I. .100 mm. and II. .083 mm. Total lengths - I. .633 mm., II. .709 mm., III. .956 mm.

♂ Legs. Hind femur .24 mm., hind tibia .373 mm., hind tarsus I. .116 mm. and II. .083 mm.; middle femur .20 mm., middle tibia .266 mm., middle tarsal joints, I. .093 mm., II. .066 mm.; first femur ,173 mm. first tibia .223 mm., first tarsal joints, I. .093 mm. and II. .073 mm. Total lengths, I. .562 mm., II. .625 mm., III. .812 mm.

## Genus ALEYRODES (Latreille).

Pupa case small to medium in size, elliptical in outline, colour usually yellowish or brownish, margin of case toothed, wax tubes poorly developed, sub-marginal area not separated from dorsal disk, no well developed papillae or pores. Tracheal folds not discernible. Wax secretion usually absent. Vasiform orifice sub-cordate, the operculum about half filling the orifice. Lingula included within the orifice but visible caudad of the operculum. The distal extremity setose and armed with a pair of spines.

Adults with two flexures in Radial sector in the forewing and media with a very short spur; forewing usually with faint patches of dusky colouration on flexures of Radial sector. Antennae of seven segments of which the third is the longest, the distal ones being sub-equal; segments imbricated. Sexes nearly equal in size. Claspers of males forked and with a few spines. (Quaintance & Baker's classification).

### Table of British species of Aleyrodes.

I. Adults with two dark spots - one on each of the two flexures in Rs of the forewing.

II. Adults with one dark spot on the 2nd flexure in Rs of the forewing.

I./

I. Adults with two dark spots on the forewing -

Pupa case yellow or dark brown, eilliptical or oval, convex 1.46 mm. x .85 mm., a short fringe of wax round the margin. Vasiform orifice broadly ovate or sub-cordate, generally notched at the caudal extremity ..... brassicae.

Pupa case often yellow, elliptical or oval, convex 1.12 mm. x .75 mm., a short fringe of waxy threads all round the margin. Vasiform orifice broadly ovate or sub-cordate, not notched at the caudal extremity ..... proletella.

II. Adults with one dark spot on the forewing -

Pupa case shining olive or dusky white in colour, elliptical, convex 1.07 mm. x .73 mm. in size, marginal area broad and striated, very thin fringe of wax all round. Vasiform orifice broadly ovate, very prominently notched at the caudal extremity. Dorsum possessing in all 6 pairs of spines ..... lonicerae.

Other species which come under this group are - rubi, fragariae and spiraeae, but in the absence of any information about them a detailed description cannot be given.

Description /

## Description of British Species.

### A. brassicae (Walker).

(Described from actual specimens and slides).

(Pl.V. Figs.1-12 Pl.VI. Figs.1-4).

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A.brassicae (Walker) 1852. List.Hom.Brit.Mus.p.1092.
Trail Dist.Gardening I. p.229.
" " (Signoret) 1868. A.S.E.France(4)VIII.p.380.
" " (Douglas) 1895. Ent.Mo.Mag.XXXI.pp.68,97.
" " (Sharp) 1901. Cam.Nat.Hist.VI.p.592.

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Egg - shape elliptical, curved on the inner side. Size .25 mm. x .085 mm. with stalk. Stalk,measuring .033 mm., attached nearly at the centre of the base, tip pointed. Colour greenish yellow when freshly laid, turning brown after a week.

1st Larva : Size .35 mm. x .16 mm.,over twice as long as broad; shape oval elliptical; marginal area crenulate, sub-marginal area very narrow. The just hatched larva is pale yellow and flat having a ridge-like prominence in the middle of the abdominal portion of the body. Case tightly fitting to the leaf surface. Active with legs functional before settling. 16 pairs of hairs along the margin. Dorsum smooth, devoid of any spines or hairs. After settling the colour turns more brownish. Of the 16 pairs of spines three pairs cephalad and three pairs caudad /

caudad are very prominent; the long hairs cephalad measure .083 mm. and the short ones .027 mm. The long ones caudad are .046 mm. and short ones .027 mm. in length. After settling down these three pairs of hairs - cephalad and caudal - only persist and the others fall off. When the larva is moving in search of a suitable place to settle, wax particles are seen attached to the marginal hairs. On settling a narrow wax fringe is noticed all round the margin, and the body of the larva becomes dome-like or convex. The mycetoma is clearly seen in the hind part of the body. The abdominal segmental constrictions can be distinguished but not so the thoracic ones. Eyes as two red spots divided into two parts, the upper part being smaller and the lower being larger. The vasiform orifice more or less semi-circular in shape and is comparatively bigger in size compared to that of the pupa. It measures .04 mm. x .037 mm., operculum .02 mm. x .03 mm., and the lingula .017 mm. caudad of the operculum. Lingula is spathulate and from its tip two hairs emanate.

Pupa : Size 1.46 mm. x .846 mm. Male pupae are smaller in size and with the thoracic portion more narrowed down cephalad. Shape more or less oval, broader towards the hind portion and rounded, narrowed about one-third towards the front part of the case.

A /

A small constriction is seen at the line of the first thoracic segment and a similar one at the line of the second. Case dome-like or convex. Margin narrow, dentate, the teeth of the margin short, blunt - not very deep dentition. Teeth 17 to 18 in .1 mm. Margin of the case crenulated, sub-marginal area of uniform breadth all round except in front part of the head and hind part of the case under the vasiform orifice. Wax pores not clearly seen, pupa case apparently smooth, devoid of any spines, except under high magnification and in stained specimens in which two pairs of small spines on each side of the rostrum are noticed; waxy meal scattered all over the body and waxy fringe all over the margin. Pupa case tightly fitting to the leaf surface, colour pinkish yellow or dark brown. Eyes in advanced specimens clearly divided. Legs and partially developed antennae can be seen in staind specimens. Vasiform orifice broadly ovate nearly as broad as long, measuring .056 mm. x .063 mm. Operculum semi-circular leaving about 1/6th clear space on both sides, measuring about ,05 x .02 mm. Lingula measuring .02 mm. caudad of the operculum - included within the orifice, strap-like, broadly spathulate. Margin crenulate, tip with two long setae. The bottom of the orifice notched inside, the border of the operculum and the lingula imbricate and /

and setose. Surface of the lingula finely hairy all over. There are two small tubercles having hairs one on each side of anterior border of the vasiform orifice.

Adult ♀ : Length 1.4 to 1.6 mm. Forewing 1.5 to 1.8 mm. x .66 to .78 mm. Hind 1.16 x .68 mm. Costal border beaded orange colour; from the beads arise 3 or 4 small hairs; beads are 15 in .1 mm. The forewing with Rs and cubitus. There are two flexures in the Rs and two maculations one on each on these flexures. In freshly emerged specimens spurs are seen at these flexures. The wings are held roof-like over the body. The body, excepting the head and some portion of the abdomen, is dark coloured. The head is rounded between the eyes and tapering with a groove between the antennae. Vertex and head also rather brownish. The rostrum brownish especially dark at the tip. It is not so long as that of T.vaporariorum and reaches the 2nd segment of the thorax. The thorax as a whole is bluish dark. Prothorax almost collar-like, notched at two or three places posteriorly and partly covered over by the mesothorax. The latter is the largest of the three segments and anteriorly the border possesses three prominences which are triangular in shape and dark in colour. These three black spots, one in the centre and two on the sides, together /

together present a horse-shoe shaped appearance. The metathorax is small and has a similar horse-shoe shaped black mark on it, but in the opposite direction to the mark on the mesothorax. The abdomen is pedunculate. 1st segment rounded at the sides, small and flat. The 2nd segment is small and has two black streaks on the dorsal side. The 3rd and 4th segments are the broadest, the remaining segments taper down. The shape of the abdomen is thus oval. Dorsally from the 4th segment posteriorly one pair of dark stripes is seen on each segment . These stripes become progressively larger and the last segment has a big dark area in the centre of which is situated the vasiform orifice which is brownish. The genitalia are made up of 3 pairs of valves. Eyes completely divided by a hairy chitinous area. The upper portion of the eye is smaller in size, reddish brown in colour and has smaller facets. The lower portion rather darker in colour and with larger facets. The smaller facets are more or less rounded while the larger ones are more hexagonal. In stained specimens one facet is pale in colour and is surrounded by even more darkly stained facets. Ocelli are placed anterior to the upper eye just touching it.

Antenna : Total length .516 mm. 1st segment short, round and cup-shaped, measures .033 mm. and is in /

in length only one-third of the second. The latter is sub-pyriform with a notch at the top to receive the third and is .088 mm. long. It is setose and has two stout spines on each side towards the upper part. The third joint is the longest measuring .161 mm., narrowed in the middle and thickened at both ends. The lower end tapers in a point, the upper side broadly attached to the fourth. It has three sensoria, one of them being situated at the tip and the remaining posteriorly one on each side. The fourth joint is .05 mm. and the shortest. The fifth is .070 mm. and longer than the last two. The sixth is .055 mm. slightly longer than the fourth and smaller than the last. The last segment is .059 mm. It is spathulate but rounded and ends in a terminal bristle. The fifth and the seventh segments each has a sensorium. All the segments except the first two are imbricate.

Vasiform orifice : Nearly circular, measuring .06 x .08 mm. The operculum .033 x .05 mm. broader than long, slightly curved in the middle, roof-like and setose towards the caudal border and all over the surface. Lingula triangular caudad the operculum but further down straplike, caudal end of the same is notched on both sides and at these places there is one projecting hair. Lingula thickly pilose. The portion of the lingula caudad the operculum is .05 mm.

There /

There is clear space in the orifice round about the operculum.

Legs : Hind femur is .290 mm. and a little more than half as long as the tibia. Hind tibia is .525 mm. and nearly double the total length of both the tarsal joints combined. The 1st hind tarsal joint is .159 mm. and 2nd joint is .116 mm. Middle femur is .270 mm. and is nearly three-fourths of the middle tibia. The latter is .367 mm. The middle tarsa are .219 mm., 1st joint being .123 mm. and 2nd joint .096 mm. First femur .251 mm. and is nearly three-fourths of the tibia. First tibia is .326 mm. First tarsal joints, 1st joint is .135 mm. and 2nd joint .106 mm. The total lengths are - 1st Leg .818 mm., 2nd Leg .856 mm., 3rd Leg 1.098mm.

Adult ♂ : Narrower than the female; length 1.65 mm. including the claspers. Forewing 1.46 mm. x .66 mm., hind wing 1.16 x .66 mm. Body characters similar to that of the ♀ except that the abdomen is very much pedunculate and tapering up to the claspers. The ninth segment to which the claspers are attached is collar-like, having a darkish tinge in colour and also highly chitinised. The black stripes on the abdomen as in ♀ . The claspers are forked at the tips, penis thin, pointed and reaching half the length of the claspers. When seen laterally it is curved.

Antenna : First segment is small, cup-shaped.

It /

It is .03 mm. Second is sub-pyriform and more than double in length of the first. The third is the longest and nearly sub-equal in length to the combined length of the last three segments except the last. The fourth is nearly equal in length to the sixth and longer than the seventh. It is .068 mm. The fifth is the longest of the last four segments, it is .08 mm. Sixth is sub-equal to the fourth and is .066 mm. The last is the smallest of the last four, it is .055 mm. The total length of the Antenna is .588 mm. It is longer than that of the ♀ .

Habitat : England - Dorset(Glanvilles Wootton), Suffolk(Coddenham), Herefordshire, Hampshire(Brockenhurst), Surrey(Camberley), Cambridge, Devonshire, Dorset(Ferndown), Somerset(Blue Anchor).

France, Germany, Austria.

Food plants : Brassica oleracea, Cruciferous weeds, like Shepherd's Spur &c. = a purse purse (Capsella bursa-pastoris)

Parasite : Encarsia sp.

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## A.brassicae (Walk.) and A.proletella (Linn).

### A comparison.

These two species are so exactly similar in appearance in all the stages that it has been difficult to differentiate one from the other, by any particular morphological characteristics. Douglas in the Entomological Monthly Magazine of March 1895 (p.68) has given some points of difference by which he says these species can be distinguished and I wish to discuss them here. Signoret in his monograph says that without the study of the larvae it would have been impossible for him to decide if they were distinct. On the other hand Westwood says that proletella is found on cabbage, evidently deeming brassicae to be the same, and Walker himself adds to his description of brassicae the query that it may be a variety of proletella, and others have practically said that it is so.

The points of difference given by Douglas are as follows :-

| | A.brassicae. | A.proletella. |
|---|---|---|
| Adult: | (1) Head is narrower and triangular, more produced on the thorax and nearly as long as wide. | (1) Head is broader and in front has the form of a crescent. |
| | (2) Out of the two spots the median is divided into two parts - one on the median nervure and the other furcating from it towards the anterior margin; the 2nd or the terminal spot also furcates, one branch going upwards and the other downwards. | (2) One of the two spots is at the end of the median nervure and the other transverse in the middle of the wing where the nervure is deflexed is more or less fascia-form. |

| | A. brassicae. | A. proletella. |
|---|---|---|
| Newly born Larva. | More elongated; on the segments of the body no hairs; only two long ones towards the extremity. | Oval, with a border of hairs all round, 34 to 36, of which 4 are important at the extremity of the abdomen. |
| Advanced Larva: | Oval, convex, pale, greenish yellow, marginal field narrow. The head rounded in front with several short hair-like projections. The median dorsal area throughout with a series of long rather blunt transverse dentitions (resembling the vertebrae of a sole) laterally connected, slightly raised on extending wholly across the median area. This structure is most perceptible in the adylt form. | Oval, convex, pale, greenish yellow, marginal field narrow but rather broader than in brassicae, median dorsal area throughout with a series of small transverse parallel ridges not shortened or blunted as in brassicae, but extending quite across the dorsum indicating the segments of the insect. The head is rounded in front and has there a few short hairs. |

He lastly adds that the larvae are gregarious in small companies on the underside of the leaves of the respective food plants in the autumn and some even survive the winter. He concludes by remarking that the divergencies in structure and markings in addition to the widely different and exclusive food plants of each form respectively afford sufficient ground for distinguishing the two species as several of the best authors have done.

I now take these points serially :-

Adult /

Adult : (1) The distance between the antennae and similarly the form and the measurement of the head is not a sure guide. It varies in different specimens of both the species. Specimens of proletella have been found with a narrower head than that of brassicae.

(2) The position of the spots on wings is exactly the same in both the species. The division of the spots is not different in these two species. In brassicae also facia-like furcation of the spot is seen.

Newly born Larva : The larvae in both the cases soon after hatching from the eggs possess 16 pairs of hairs all round the margin. As regards the shape, generally it is more elongate and narrow in brassicae and oval in proletella. The average size in brassicae is .33 x .16 mm. and .32 x .2 mm. in proletella.

Advanced Larva and Pupa : I have carefully examined a large number of Pupae; the blunt transverse dentation or series of small transverse ridges or striations are found in both the species and can not be said to be characteristic of any of them. None of these species has hairs towards the front.

In short, the species are so similar that so long as they are kept apart some morphological differences (individuality) can be made out, but as soon as these are mixed up it becomes impossible to exactly spot the species.

In /

In my study I have come across the following points of difference though I do not dare vouchsafe that these will unmistakably guide to distinguish the particular species :-

Larva: It is narrower and more elongate in brassicae, and oval and broader in proletella.

Adult larvae : Darker in colour in brassicae and more yellowish brown in proletella.

Pupa : Average size larger, shape more oval than round and with darker tinge in brassicae than in proletella in which it is smaller in size, more round and more yellowish brown.

Adult : Wings are larger in brassicae than in proletella and the spots are more prominent in the former than in the latter.

With all this I would say that the Food-Plant test is the most unmistakable one. Brassicae will not breed on Chilidonium majus, nor proletella on Cabbage. In short, I say they are not different species but only the Biological Races of the same species as discussed in the introduction.

## A. proletella (Linne).

(Pl.VII.Figs.1-12, Pl.VI.Figs.5-8).

Phalaena(Tinea) proletella(Linneus) 1758 Syst.Nat.Ed.X.p.537,
1767 Ed.XII Tom 1,Pt.2,889.
Aleurodes proletella(Signoret) 1868, A.S.E.F.(4) VIII,p.378.
" " (Walker) 1852, List Hom., p.1092.
" " (Douglas)1878, Ent.Mo.Mag.XIV.,p.230.
1888, op.c. XXIV,p.265.
1894, op.c. XXX, p.40.
1895, op.c. XXXI,p.68.

Egg : Size .24 mm. x mm. Shape elliptical oval, stalk short attached to the middle of the base. Colour yellow when freshly laid; always laid in a complete spiral.

Larva 1st instar. : Size .41 mm. x .33 mm. Shape oval elliptical, margin crenulate with 16 pairs of hairs along the margin. The two cephalad and two caudal hairs are very long - the latter being the longer of the two. Marginal area very narrow, rimlike and paler in colour. Colour of the larva yellow, slightly darker dorsally than that of brassicae. Cephalad in the body are visible two reddish spots each divided into two representing the eyes. Abdominal segments more clearly defined than the thoracic ones. Small curled rostrum visible between the eye spots. Vasiform orifice as in the pupa but comparatively larger /

larger in size. Vasiform orifice is .03 x .033 mm. Operculum .03 mm. x .03 mm. Lingula .03 mm. The shape of the orifice is sub-circular with the anterior border straight. Two hairs are seen issuing from the caudal end of the lingula which is minutely setose. Two spines are seen - one on each side of the anterior margin of the vasiform orifice.

Pupa : Size .1.12 mm. x .837 mm. Shape more or less oval, marginal area very narrow, toothed, teeth blunt, 17 to 18 in .1 mm. Margin of the case wavy all over. Sub-marginal area nearly of equal breadth all round excepting at the anterior and posterior ends. In the stained specimens, the thoracic segments can be clearly made out along with legs, but not so clearly the abdominal ones. In the advanced pupa the eyes are visible, completely divided into two parts each having lenses of different size. To the margin of the case two setae caudad of the vasiform orifice and two anterior to the head are clearly seen. In between the caudal ones are situated two small setae just posterior to the vasiform orifice attached to the inner margin. Pupa case tightly fitting to the leaf surface and dome-like in shape. Colour yellow with a fringe of waxy filaments all over. Wax pores not clearly seen. In specimens boiled in KoH the abdominal portion of the immature insect is clearly marked /

marked out by a groove. In the latter is situated the vasiform orifice sub-cordate in shape, the anterior border of which is straight. Size of the orifice is .059 mm. x .063 mm. Operculum transversely rectangular, the caudal margin of which is finely setose. Caudad of the same is seen the Lingula touching the lower border of the orifice and with two long hairs. By changing the focus of the microscope in the groove caudad of the orifice is seen a pair of tubercles in the middle and also a pair to the side quite anteriorly.

Adult ♀ : Size 1.33 mm. Forewing 1.58 x .70 mm., wing border orange coloured, beaded - beads 17 to 18 in .1 mm., wings two black spots. Eyes completely divided. The area round about the eye is also setose. The facets of the upper division are smaller and the lower division larger. Abdomen spindle-shaped with the terminal portion concealed. The vasiform orifice is circular with a clear space round about the operculum which covers about 1/3rd of the upper portion. Operculum is semi-circular in shape, posteriorly arched in the middle from which the lingula is seen to come out. Lingula is strap-like and spathulate at the tip. The genitalia as in A.brassicae. The tip of the abdomen possesses two or three pairs of setae.

Antenna : Of the same type as in A.brassicae but smaller in length than that of A.brassicae. First segment /

segment small, cup-shaped, is .023 mm. and nearly one third of the second which is sub-pyriform and .073 mm. in length. The third is the longest and is .163 mm. The fourth is the shortest and is .046 mm. Of the last three, the fifth is the longest and sixth is the shortest. The fifth, sixth and seventh are .067 mm. .052 mm. and .061 mm. respectively. The last is pear-shaped, pointed at the end with a terminal bristle. All the last five segments as in A.brassicae are imbricate and small hairs are seen over the imbrications. Total length is .485 mm.

Legs : Of the same type as in A.brassicae. Hind femur .293 mm. Hind tibia nearly one and three-fourths of the femur and is .505 mm. Hind tarsus, 1st joint one-third of the tibia and is .164 mm. and 2nd joint is nearly one-fifth of the same and is .113 mm. Middle femur .248 mm. Middle tibia nearly one and half times the femur and is .359 mm. Middle tarsus, 1st joint .120 mm. and 2nd joint .099 mm. Proximal femur .239 mm., tibia .307 mm. First tarsal joint .133 mm. and 2nd joint is .105 mm.

Adult ♂ : Narrower that the female, nearly similar to that of A.brassicae.

Antenna : I. segment .026 mm., II. .07 mm., III. .073 mm., IV. .066 mm., V. .066 mm., VI. .056 mm., VII. .056 mm. Total length .513 mm.

Legs /

Legs : Hind femur .260 mm. Hind tibia .455 mm. Hind tarsus, 1st joint .158 mm., 2nd joint .111 mm. Middle femur .232 mm. Middle tibia .335 mm. Hind tarsus, 1st joint .118 mm. and 2nd joint .097 mm. Proximal femur .217 mm. Proximal tibia .278 mm. Proximal tarsus, 1st joint .133 mm., 2nd joint .103 mm. Total lengths - 1st Leg .730 mm., 2nd Leg .781 mm., 3rd Leg 1.075 mm.

Habitat : England - Suffolk(Coddenham), Lancashire(Manchester), Surrey(Merton), Hertfordshire(Letchworth). France, Germany, Austria, Hungary, Switzerland, Italy.

Food plants : *Brassicae oleracea, Chilidonium majus (Greater Celandine).

* Quercus robus, Sonchus sp., Veronica sp. &c.

* Parasites and Predators : Preyed on by scymnus sp. and parasitised by (1) Alaptus minimus(Walker) and (2) Macroneura maculipes(Walker).

* Kirkaldy - Bull.No.2 Board of Agr.& For.Hawaii.

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A. fragariae /

A. fragariae (Walker).

(Pl.IX Figs.6 and 7).

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Aleurodes fragariae (Walker) 1852, List.Hom.p.1092.
" " (Cockerell) 1902, P.Ac.Sci.Phil.,p.280.
" " (Signoret) 1868, A.S.E.F.(4) VIII.p.383.
" " (Douglas) 1879, Ent.Mo.Mag.XVI.p.43.

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Adult ♀ (described from a prepared slide).

Eyes completely divided - the upper division having smaller facets and the lower one larger facets; fore-wing with Rs having two flexures and one black spot on the 2nd flexure. The cubitus vein is not prominent, but in between the Rs and cubitus there is a trace of median.

Antennae: Similar in structure to that of A. brassicae and nearly equal in length. First segment is .023 mm. Second joint sub-pyriform, more than thrice as long as the first; it is .08 mm. The third is the longest and is .17 mm. It is slightly longer than that of A. brassicae ♀. It has three sensoria. Fourth joint is the shortest and .043 mm. long. Fifth is the longest of the last three segments and is .07 mm. VI. and VII. are nearly sub-equal and are .060 and .063 mm. respectively. Fifth and seventh possess each one sensorium. The latter ends in a bristle.

Legs: Hind femur is .30 mm., hind tibia one and three /

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three-fourths the femur and is .50 mm., hind tarsus - both segments together are nearly sub-equal in length to the femur - 1st segment is nearly one-third and the 2nd segment is nearly one-fourth of the tibia, measuring respectively .17 mm. and .12 mm. Middle femur .240 mm., middle tibia .350 mm., middle tarsus - 1st joint .120 mm. and 2nd joint .103 mm. First femur .233 mm., first tibia .240 mm., first tarsus - 1st joint .133 mm. and 2md joint .113 mm. Total length of legs - 1st Leg .719 mm., 2nd Leg .813 mm., 3rd Leg 1.090 mm.

Habitat : England, France.

Food plant : Fragaria (Strawberry).

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## A. lonicerae (Walker).

(PL.VII.Figs.1 - 11, Pl.IX.Figs.1 & 2).

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Aleurodes lonicerae (Walker) 1852, List.Hom.p.1092.
" " (Frauenfeld) Verh.Z.6.Ges.Wein(1867)p.796.
" " (Signoret) Ann.Soc.Ent.France(4) VIII.p.381.
" " (Douglas)1896, Ent.Mo.Mag.XXXII.p.31.

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Egg : Size .25 x .08 mm. without stalk which is .03 mm. attached nearly to the middle of the base; colour brown after three days of laying; colour of freshly laid eggs dirty white; shape elliptical; laid generally singly and standing erect.

Larva /

Larva - 1st instar : Size .35 x .16 mm. nearly half broad as long; shape elongate oval; 16 pairs of hairs all over the margin - out of these one pair cephalad and two pairs caudal are the longest. In between the caudal long hairs there is a smaller pair of hairs. Colour amber-like, flat, margin closely touching the leaf surface. Larva as it grows becomes convex and turgid, along with it a slight fringe of deciduous threads of wax is seen all over the margin. Dorsum apparently devoid of any spines or hairs. Antennae and legs active and functional before settling. In the newly born larva a dorsal ridge in the abdominal region is prominently seen. Two divided red spots on each side of the rostrum represent the eyes. Abdominal segments can be clearly seen by the constrictions, but not so the thoracic ones. In the eye spots the upper ones are smaller in size than the lower ones. A pair of yellow bodies prominently seen in the abdominal region. Vasiform orifice not so sub-cordate as in the pupa, but more or less cup-shaped. Operculum nearly half filling the orifice. Lingula spathulate and setose, the terminal portion possessing 3 or 4 spines. The caudal portion of the vasiform orifice is notched.

Pupa : Size 1.05 mm. x .73 mm. Shape elliptical oval, convex, anterior part of the body from thorax upwards more narrowed than the abdominal part which is rounded /

rounded or oval. Marginal area very narrow and possessing a thin fringe of wax. Sub-marginal area larger and striated. Colour whitish yellow, pale yellow or olive. Sometimes ashy white in empty pupal cases. Two thoracic and six abdominal segments can be clearly seen. Margin crenulate. Marginal teeth 18 in .1 mm. area. Two kinds of pupae are found - one having long spines on the dorsum and the other with the dorsum apparently smooth, but under high magnification showing small spines. On spring specimens, which are more often on the leaves of a hairy species of honeysuckle, six pairs of spines are seen - one on each side of the rostrum, one pair on each of three thoracic segments, one pair on the anterior border on each side of the vasiform orifice and one to the extreme caudal margin of the case. Pupa case fitting to the surface of the leaf. Caudal margin posterior to the vasiform orifice has two pairs of spines. Vasiform orifice more or less sub-cordate with anterior margin straight and caudal margin notched very prominently in the middle. In some mounted specimens it is seen so much notched that the tip of the lingula protrudes beyond the caudal margin of the orifice. Vasiform orifice is .06 x .07 mm. Operculum is rectangular nearly half filling the orifice; lingula spathulate, setose possesses at the caudal extremity a pair of spines. Male pupae /

pupae invariably smaller in size and the area anterior to thorax upwards is narrowed.

Adult ♀ . Size 1.33 mm. long. Colour in most of the specimens is yellow, spotless, but in some specimens black colour on the body is developed as in A.brassicae and A.proletella. Abdomen spindle shaped; genitalia as in A.brassicae. In dark coloured specimens vertex is dark. The tip of the rostrum is dark coloured in all specimens. Forewing 1.8 mm. x .72 mm. There are two flexures in the Rs and only one black spot on the 2nd flexure in the form of V.

Antenna : Seven jointed - first segment is small, stout and cup-shaped and measures .026 mm.; it is nearly one-third of the second which is sub-pyriform and is .074 mm. The third is the longest and nearly sub-equal to the total length of the last three joints. The fourth is the shortest of all the last five joints and is .038 mm. The third is .164 mm. The fifth is .063 mm. and is slightly longer than either of the last two. The sixth and the last are nearly sub-equal, measuring .056 mm. and .058 mm. respectively. Total length .479 mm.

Legs : Hind femur .277 mm. and is nearly half of the tibia. The tibia is .508 mm. and is sub-equal in length to the femur and tarsal joints put together. Hind tarsus - 1st joint .171 mm. and the 2nd joint .119 mm. Middle femur .252 mm., middle tibia .382 mm., middle /

middle tarsus - 1st joint .137 mm. and 2nd joint .105 mm. First femur .228 mm., first tibia .313 mm., first tarsus - 1st joint is .143 mm. and 2nd joint .109 mm. The total lengths of legs are - 1st Leg .793 mm., 2nd Leg .866 mm., 3rd Leg 1.075 mm.

Adult ♂ : It is generally smaller than the female and all the parts of the body proportionately smaller. The colour of the body and wings is exactly the same as that of the female. Abdomen strongly pedunculate and tapering. The claspers are forked at the tip and possess a number of spines. The forked nature of the claspers is quite distinct from that obtained in A.brassicae and A.proletella. The border of the wings in both sexes orange coloured. Eyes completely divided. Forewing 1.32 mm. x .66 mm. The border beaded and the beads are 16 in .1 mm.

Antenna : 1st joint small, cup-shaped and is .017 mm. 2nd joint is sub-pyriform and nearly four times the first, it is .066 mm. The third joint is the longest and is sub-equal to the last three joints, it measures .14 mm. The fourth is nearly sub-equal to the sixth, but smaller than fifth and seventh; it is .04 mm. Fifth and seventh are nearly equal and are .05 mm. each. The sixth is .04 mm. The total length of the antenna is .403 mm.

Legs : Hind femur .23 mm., hind tibia is one and /

and three-quarters of the femur, it is .416 mm. Hind tarsus - 1st joint is nearly one-third of the tibia and the 2nd joint is nearly one-fourth of the same, both measuring .133 mm. and .10 mm. respectively. Middle femur .21 mm., middle tibia .30 mm., middle tarsus - 1st joint .107 mm. and 2nd joint .083 mm. First femur .18 mm., first tibia is .25 mm., first tarsal joint .116 mm. and the second is .083 mm. The total lengths of the legs are - 1st Leg .629 mm., 2nd Leg .700 mm. and 3rd Leg .879 mm.

Habitat : England - Cumberland(Keswick), Sussex (Eastbourne), Dorset(Ferndown, Glansvilles Wootton), Surrey(Wimbledon). France, Germany, Austria.

Food plants : (1) Companula trachelioides.
(2) Impatiens nolitangere.
(3) Lonicera periclymentum.
(4) Salvia glutinosa.

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A. rubi (Signoret).

(Pl.IX. Figs.3 - 5).

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Aleurodes rubi(Signoret) 1868, A.S.E.France(4) VIII.p.382.
" " (Douglas) 1895, Ent.Mo.Mag.XXXI.p.33.
" " (Cockerell)1902, P.A.Sci.Phil.,p.281.

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Adult ♀ ; (described from slides).

This species appears to resemble a great deal A.lonicerae. Size 1.33 mm. to 1.4 mm. Forewing 1.47 mm.

x /

x .66 mm. Border beaded; beads 17 to 18 in .1 mm. Radial sector has two flexures and only one black spot on the 2nd flexure. Eyes completely divided. Genitalia normal.

Antenna : First joint small and is .0218 mm., second joint is .0715, three times the first joint. The third joint is the longest and is double that of the second and nearly sub-equal to the three following joints, 4th, 5th and 6th; it is .148 mm. long. The fourth is the smallest excepting the first and is .043 mm. in length. The fifth is longer than either the fourth or the sixth, but shorter than the seventh; it is .058 mm. The sixth is .0515 mm. The seventh is the longest of the last four joints. The total length of the antenna is .4368 mm.

Legs : Hind femur .269 mm., hind tibia one and three-quarters the femur and is .433 mm. Hind tarsus - both joints together are sub-equal in length to the femur, 1st joint .153 mm. and 2nd joint .111 mm. Middle femur .228 mm., middle tibia is nearly one and one half times the femur; it is .328 mm. Middle tarsal joints - both together nearly sub-equal to the femur, 1st joint .114 mm. and 2nd joint .101 mm. Proximal femur is .216 mm., proximal tibia .286 mm., first tarsal joint .126 mm. and 2nd joint .105 mm. Total length of legs - 1st Leg .733 mm., 2nd Leg .771 mm. 3rd Leg .966 mm.

Adult /

Adult ♂ : (described from slide).

Antenna : 1st joint .017 mm., 2nd joint .070 mm., 3rd joint is the longest and more than double the length of the 2nd joint; it is .150 mm. 4th joint is the smallest excepting the 1st; it is .040 mm. The 5th and 6th are sub-equal and shorter than the 7th - each of them being .056 mm. The last joint is .060 mm. and the longest of the last four joint. Total length is .449 mm.

Legs : Hind femur .253 mm., hind tibia nearly one and three-quarters the femur and is .450 mm., Hind tarsal joints together are nearly as long as the femur - 1st joint .151 mm. and 2nd joint .113 mm. Middle femur .233 mm., middle tibia .373 mm. Middle tarsus joints together nearly sub-equal in length to the femur - 1st joint .113 mm. and 2nd joint .100 mm. Proximal femur .216 mm., proximal tibia .278 mm., 1st tarsal joint .126 mm. and 2nd joint .101 mm. The total length of the legs :- 1st Leg .716 mm., 2nd Leg .789 mm., 3rd Leg .972 mm.

The other characters as regards the wings, eyes, &c. similar to those obtained in the female. The male is smaller than the female. Claspers forked at the tip.

Habitat : England - Surrey(Byfleet).
France.

A. spiraeae (Douglas).

Aleurodes spiraeae (Douglas) 1894, Ent.Mo.Mag.XXX.p.73.
" " (Harrison) 1920, Entomologist Vol.53.
" " (Cockerell) 1902, P.Ac.Sci.Phil., p.281.

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Habitat : England - Brighton, Dorsetshire.

Food Plant: Spiraea ulmaria.

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## Genus TRIALEURODES (Cockerell).

Pupa case medium to small in size, elliptical, usually elevated from the leaf by a palisade of white wax, colour variable, varying from whitish to dark brown; margin of case toothed; the wax tubes moderately developed, sub-marginal area not separated from the dorsal disk, sub-marginal area with a row of or a number of large papillae or pores, thoracic tracheal folds rarely distinguishable, usually a distinct furrow from the vasiform orifice to caudal margin of case; wax-secretion-a series of brittle glassy rods from dorsal papillae or pores and a palisade of white wax elevating case from leaf, vasiform orifice sub-cordate, usually notched on caudal end operculum transversely elliptic, about half filling the orifice, lingula spathulate, the distal extremity exposed caudad of the operculum, lobed and usually armed with two spines.

Adult usually with one flexure in the Radial sector of forewing and no trace of media excepting in freshly emerged specimens. Antennae of seven segments, segment III. the longest, IV. and VI. sub-equal; segments imbricated; sexes nearly equal in size.

### Species of the Genus Trialeurodes.

I. Pupa without any waxy rods on the dorsum, but with only glassy rods all over the margin; case whitish not very much raised on a palisade of wax - though box /

box-like; vasiform orifice pale yellow.

II. Pupa with very long tapering curved waxen rods on the dorsum, case much raised on a palisade of wax, vasiform orifice brownish yellow in colour.

(i) Pupa case yellowish white, oval to elliptical about .75 mm. x .50 mm., a sub-marginal series of glassy waxen rods from distinct pores of papillae. No waxen rods on the dorsum. In Adults rostrum reaching nearly to the abdomen, wings immaculate . . . . . sonchi.

(ii) Pupa case yellowish, oval to elliptical, about .76 mm. x .48 mm. Dorsal wax-secretion; a sub-marginal series of glassy waxen rods from distinct pores of papillae and a more dorsal secretion of very long, tapering, curved waxen rods in pairs from large circular pores; sub-marginal waxen rods rather short and blunt. The very long rods from dorsum occurring - a pair very close to cephalic margin, a pair on cephalic region, a pair on the thoracic region, a pair on the abdominal region, a pair at caudal end and a pair just within margin from caudo-lateral region. In Adults rostrum reaching nearly to the abdomen; wings immaculate .....vaporariorum.

T. sonchi /

T. sonchi (Kotinsky).

(Pl.X. Figs.1 to 9, Pl.XI. Fig.5)

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Aleurodes sonchi(Kotinsky) 1907,
(Bull.Ent.(2), Board Agr.For., Hawaii.)

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Egg: size .25 mm. long x .07 mm. broad; broad towards the stalk end, narrow and pointed towards the tip, shape sub-elliptical ; colour greenish yellow when freshly laid, becoming brown after 4 days; laid in a circle or a semi-circle or sometimes scattered. Eggs standing erect on stalk.

Larva: I. instar - almost resembling that of vaporariorum. Soon after emergence it is olive yellow possessing 16 pairs of hairs all over the margin. The pair cephalad and the pair caudal are longer, the latter being the longer of the two and more prominent, size at birth being .283 mm. x .16 mm.; shape oval elliptical; the abdominal segments more clearly defined, but not so the thoracic ones. Before settling the larva has its legs and antennae functional. Eyes as two red spots completely divided, the upper portion being smaller and the lower being larger. Vasiform orifice is sub-cordate in shape, the caudal end slightly notched. The operculum transversely rectangular about one third filling the orifice. The anterior border of the operculum deeply arched. Lingula broadly spathulate. The tip is not provided with /

with lobes as in the pupa, but possesses a large number of hairs. Towards the anterior border of the vasiform orifice there are two spines, one on each side. The larva on settling is surrounded by a thin fringe of wax all over the margin and becomes convex in shape and brownish in colour.

Pupa: Size varying from .75 mm. to .82 mm. x .50 to .52 mm.; shape oval, surface uniform, opaque greenish or yellowish waxy in colour, raised like the pupa of T.vaporariorum on a palisade of wax. The dorsum is smooth and devoid of any waxy rods. The margin all round possesses white, shining waxy rods which vary in number from 40 to 45 pairs, a pair caudad and a pair cephalad being the longest. While mounting the specimens in Canada balsam it can be clearly seen that the waxen rods issue from the row of papillae found all over the sub-marginal area. In well advanced specimens segmental division of the thorax as well as that of the abdomen can be made out. Eyes prominent, red in colour. Vasiform orifice sub-cordate, inner margin of the caudal area crenulate; operculum transversely semicircular nearly filling more than half the orifice; anterior border is arched in the middle. Lingula visible caudad the operculum; it is spathulate and has got three lobes on each side near the tip. The latter is provided with a pair of spines.

The margin of the pupa is crenulate. In live specimens the vasiform orifice is deep yellow in colour; a deep furrow from its caudal end to the margin very prominent. Two spines, one on each side towards the anterior border of the vasiform orifice. Two plate-like structures are visible just above the vasiform orifice.

Adult ♀ : Size 1.3 mm. to 1.4 mm. General colour lemon yellow, deep yellow in the thorax, the antennal tip brown. The second segment on the dorsum has a dark border and the last segment of the abdomen ventrally dark in colour. The wax-plates bordered on the outside by a dark line; wings spotless, white. The Rs of the forewing prominent and curved once in the middle. Forewing 1.23 mm. x .50 mm., border orange in colour, bluntly beaded - beads about 21 in .1 mm. Genitalia normal; tip of the rostrum black; eyes dark red divided by a xxxxxxxxxx chitinous projection.

Antenna : 1st segment is small, cup-shaped; it is .017 mm. 2nd segment is sub-pyriform and longer than three times the 1st. It is .058 mm. The third is the longest of all and is .125 mm. The fourth is the shortest excepting the first and nearly sub-equal to the terminal one. It is .046 mm. The fifth is the longest of the last four and is .063 mm. The sixth /

sixth is longer than the last one and is .050 mm. The last is .048 mm. It ends in a terminal bristle. The 3rd segment possesses three sensoria, the fifth one and the last segment also one. The total length is .407 mm.

Legs : Hind femur is .25 mm. and less than two-thirds of the hind tibia which is .417 mm. 1st joint of hind tarsus is .135 mm. and 2nd joint is .90 mm. Middle femur is .21 mm. Middle tibia is one and one quarter times the femur. The tibia is .293 mm. The middle first tarsal joint is .11 mm. and the second is .083 mm. The first femur is .183 mm. and nearly 2/3rds of the first tibia. The latter is .273 mm. The first tarsal joints are respectively .116 mm. and .086 mm. The total length of legs is, 1st .685 mm., 2nd .696 mm. and 3rd .910 mm.

Adult ♂ : Generally resembling the female; slender; abdomen strongly pedunculate and tapering. 2nd segment of the abdomen bordered by a dark line. The last segment collar-like, strongly chitinised, shiny and dark in colour. The claspers are dark excepting the copulatory organ. The claspers are not forked at the tips. Other characters as in ♀ .

Antennae : Comparatively very small. 1st joint is .013 mm., smallest and cup-shaped; 2nd joint is nearly four times the first and is .05 mm. The

third is the longest and is .08 mm. The fourth is shorter than the seventh. The fifth is the longest of the last four joints; it is .05 mm. and sub-equal to the second. The sixth is sub-equal to the fourth and is .03 mm. The seventh is .04 mm. Total length is .396 mm. Sensoria as in others. The last joint ends in a terminal bristle. Joints imbricate.

Habitat : England - Surrey, Dorset, Ferndown, Wisley.
Honolulu.

Food Plants : Sonchus oleraceus.
Chelidonium majus.

Parasites : Encarsia sp.

T. vaporariorum (Westwood).

(Pl.X. Figs.10-13. Pl.XI. Figs.3 and 4.)

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Aleurodes vaporariorum (Westwood) 1856,Gard.Chron.,852.
" " (Signoret) 1868, A.S.E.F.4,VIII,387.
" " (Weed and Conradi) 1903, Bull.N.H.Agr.Sta.,100.

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Egg : Elongate, oval with a pointed tip; stalked; size .24 mm. x .07 mm. without stalk which is .02 mm.; greenish yellow, generally standing erect on stalk; laid in circle or semi-circle.

Larva : 1st instar. Freshly born greenish yellow in colour; size .29 mm. long; shape elliptical oval. It possesses 15 to 16 pairs of hairs all over the margin /

margin. Between the posterior two pairs of hairs is a pair of much longer spines and in the centre of the caudal margin, posterior to all of these, are two very long cerci. Segmental divisions clearly defined in the abdomen but not so in the thorax. Eyes as two red spots on each side. They are divided. The pair of yellow masses of mycetoma prominently visible in the abdomen and extending to the thorax. The rostrum is short and situated between the anterior legs. Before settling, the legs are functional. After settling the larva is surrounded by a thin fringe of wax round the margin and becomes convex in size. Vasiform orifice sub-cordate; operculum is rectangular in shape; lingula broadly spathulate. The tip does not possess the lobes but has spines all over. The anterior border is not very clearly visible; there is a spine on each side of the anterior border.

Pupa : Size .7 to .82 mm. x .4 to .45 mm. Shape oval at the surface, elevated on a palisade of wax, giving the appearance of a box; colour waxy, yellowish green. In advanced pupae the two thoracic and six abdominal segments can be made out. Dorsum covered with 11 pairs of waxy processes from the spiny bosses and 7 pairs from the margin - one pair towards the middle line anteriorly, a pair in the thorax, a pair on /

on each of the third and fourth abdominal segments. All over the margin there are about 38 to 40 waxy processes. The body margin is crenulate and entire excepting the cerci and the posterior spines. In boiled and mounted specimens a sub-marginal row of papillae all over the margin is very clearly visible. Legs as blunt projections and the eyes can be seen. The vasiform orifice is sub-cordate with anterior border straight. The operculum is circular nearly half filling the orifice, the lingula protruding beyond it. The tip of the lingula possesses three lobes on each side, the posterior end of the same possessing two spines.

Adult ♀ . Size varying from 1.2 to 1.4 mm.long. Colour of the body yellow, more so in the thorax than in the abdomen. On the dorsum, 2nd segment of the abdomen has a dark border, and the last segment is dark in colour on the ventral side. The tip of the antennae is brownish and the tip of the rostrum is dark coloured. Wings are spotless white. The Radial sector of the forewing has only one flexure in the middle. The Radial sector nearly touches the outer margin. Forewing is 1.15 mm. x .46 mm. The border is orange yellow and knobbed. The knobs are about 24 in .1 mm. The hind wing is .98 mm. x .40 mm. and has only vein. Eyes divided.

Antenna /

Antenna: 1st segment small, cup-shaped and measures about .0186 mm. It is nearly one third of the 2nd segment which is sub-pyriform and .0518 mm. The 3rd segment is the longest and slightly less than the combined length of the 4th, 6th and 7th. It is .1004 mm. The fourth is .0398 mm. and is longer than either of the last two segments. The fifth is the longest, excepting the third, and is .0554 mm. The sixth and seventh are nearly sub-equal and are .0368 and .0376 mm. respectively. The total length is .3404 mm.

Legs: Hind femur is .212 mm. Hind tibia about one and a half times the femur and is .343 mm. First hind tarsal joint is nearly half the femur and is .115 mm., and second is .085 mm. Both joints together approximate to the length of the femur. Middle femur is .177mm., middle tibia .249 mm. and the tarsal joints are respectively .095 mm. and .077 mm. The first femur is .160 mm., first tibia is .231 mm.; the first tarsal joint is .099 mm. and second is .075 mm. The total length of legs is, 1st leg .565 mm. 2nd leg .598 mm., 3rd leg .755 mm. Waxplate prominent bounded by a dark line on the outer side. The genitalia normal.

Adult ♂: The male slender. All the characters nearly /

nearly the same as in the female, excepting that the antennae and legs are comparatively longer than those of the female. The claspers are not forked at the tips. The last collar-like abdominal segment to which the claspers are attached is dark coloured.

Antenna : 1st joint is small and is .022 mm.; 2nd joint is .050 mm.; 3rd joint is .108 mm. and the longest. The fourth is .037 mm. and is smaller than the last as against the seventh being smaller and the fourth longer in the female. The fifth is longer than any of the 4th, 6th and 7th joints. The sixth is sub-equal to the fourth and is smaller than the last which is .039 mm. Total length is .3522 mm. The joints in both sexes are imbricated excepting the first two and small hairs issue from these imbrications. Small stout spines are seen on the 1st and 2nd. Sensoria as in other specimens of the family.

Legs : Hind femur is .234 mm. which is just less than three fourths of the tibia. Hind tibia .379 mm. Hind tarsal joints, 1st joint is nearly one-third of the tibia and is .126 mm., 2nd joint is .091 mm. Middle femur is .191 mm., middle tibia is .282 mm., middle tarsal joints together are equal in length to the femur, they are .101 mm. and .083 mm. respectively. The first femur is .175 mm., the first tibia is .254mm. First tarsal joints are .111 mm. and .090 mm. respectively /

respectively. The total lengths are :-

1st Leg .630 mm., 2nd Leg .656 mm., 3rd Leg .830 mm.

Habitat : England (throughout the country in all greenhouses), France, Austria, Pennsylvania, Connecticut, Massachusetts, Illinois, Indiana &c.

Food plants : Greenhouse plants, very many, sometimes out of doors in summer.

Parasites : Hymenopterous parasite (Encarsia sp.)

## Genus TETRALICIA (Harrison).

Forewing with Radial sector only with a slight flexure in the middle. Whole vein sub-parallel to the inner margin of the wing, cubitus especially in certain females sometimes suggested by a fold or by a cessation of the wing granulations.

Male slightly less than the female; both sexes with seven jointed antennae. Male antennae rugged and fairly long. In the male the third joint is the longest and is sub-equal to the total length of the fourth, fifth, sixth and the seventh. In the male the 4th joint is the shortest and in the female the sixth. Male claspers fairly long and broad. Penis slight.

Pupa case with practically no waxy secretion.

Both larvae and pupae are extremely elongate.

Species /

Species coming under this genus.

T. ericae (Harrison).

(Pl.XI Fig.6).

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T. ericae (Harrison) 1917. Entomologist 50.
" " 1920 " 53.
" " 1917 Vasculum Vol.III. No.2.

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Pupa : (described from dry specimens and slides). Size .71 x .31 mm. Shape elongate, elliptical. A little broader and blunt at the cephalic end; colour jet black in dry specimens on leaves. The underside is whitish with papery white lining. The dorsal ridge along the abdominal segments is very prominent. Marginal area narrow, toothed. Dentition blunt. The teeth 12 in .1 mm. area of the margin. Caudal marginal end narrow. Case closely fitting to the leaf surface. Dorsum covered all over with small spines; all the abdominal segments have each a pair of small spines. Of all the spines two pairs are very prominent - one near the head and the other situated near the anterior border of the vasiform orifice. In specimens boiled in caustic potash the colour of the pupa becomes brown and three pairs of blunt legs are clearly seen. In the mounted specimens, in the middle of the body, a line is seen demarcating the thoracic portion from the abdominal one. From the caudal margin of the /

the pupa issue out two pairs of long spines - one just below the vasiform orifice and the other one, a little smaller than the former, is situated one on each side of the long pair. Vasiform orifice is sub-circular or cup-shaped with the anterior border straight. Operculum more than half filling the orifice. Lingula more or less obscured and can not be made out very clearly. The whole appearance of the pupa is like the larva of coccidae of the Lecanium species excepting the black colour.

Adults - not seen.

Habitat : England - Durham (Chest Moor).
S.Yorks (Skipwith Common).
Surrey (Camberley).

Food plants : Erica tetralix.

T. vaccinii (Kunow).

Aleurodes vaccinii (Kunow) 1880, Ent.Nachr.VI. p.46.
" " (Douglas) 1880, Ent.Mo.Mag.XVII, p.89.
" " (Cockerell) 1902, P.A.Sci., Phil., p.281.

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Habitat : England; Germany.

Food plants : (1) Vaccinium uliginosum.
(2) " myrillus.

Vaccinium
Myrtillus

New /

## New Genus - NEO-BEMESIA.

Pupa case oval in outline; colour usually pale yellowish or brownish; margin toothed and wavy; wax tubes or pores not seen; sub-marginal area broad and striated; dorsum without papillae or pores. Vasiform orifice triangular or V form; lingula long and spathulate; caudal area round about the lingula wrinkled or with folds.

Adults with one flexure in Radial sector of fore-wing and no spur of media. Wings immaculate. Antennae of seven segments, the third of which is the longest and the fourth the shortest. Male claspers not forked at the tips. Eyes not divided, strongly reniform.

### - rubicola (Douglas).

(described from slides and dry specimens).

(Pl.XIV. Figs.1 - 6).

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Aleurodes rubicola (Douglas) 1891, Ent.Mo.Mag.XXVII.p.200., and 1894, op.c.XXX.p.87.
" " (Cockerell)1902, P.Ac.Sci.Phil.,p.281.

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Egg : (in the body of ♀) elliptical, curved on the inner side, tip pointed, broad towards the attachment of the stalk. Size .2 mm. long.

Larva : II. instar ; size .33 mm. Shape more or less oval with two pairs of cerci to the caudal margin /

margin. Under high magnification the margin is seen to possess 16 pairs of hairs, the pair cephalad and a pair caudad longer. Vasiform orifice is V form or triangular in shape, but the bottom is broad. The orifice is comparatively bigger for the size. The pattern of irregular lines present in the pupal vasiform orifice is not seen. The vasiform orifice is placed at the caudal end.

The larva as it grows changes in shape, but still more or less oval. The upper half of the body is slightly broader than the lower half. Margin crenulate. Marginal hairs disappear; only two pairs of cerci persist at the caudal end. Margin very narrow. Two divided reddish brown spots near the rostrum represent the eyes. Vasiform orifice becoming completely V formed. The operculum is semi-circular, lingula spathulate and deeply cetose. The irregular pattern of lines inside the vasiform orifice is just beginning to appear under the tip of the lingula. The anterior border of the orifice is not straight.

Pupa : Size 1.208 mm. x .87 mm. Shape oval. Margin crenulate; marginal area narrow; marginal teeth 14 to 15 in .1 mm.; sub-marginal area broad and striated. On examining the pupal skins or mounted pupae, the margin appears wavy and has four folds on each side - the part caudal and that cephalad is like a flap. The empty cases are waxy white and possess a series /

series of white, short and blunt projections on the dorsum all over the abdomen. The rent made by the adult in hatching is not T shaped. The pupal case is convex. The abdominal segments more clearly defined than the thoracic ones. The vasiform orifice is typically V shaped and to the outside is another V-shaped area. Lingula long and lanceolate and almost touching the bottom of the orifice. The tip is deeply setose. The vasiform orifice is .098 mm. x .068 mm. The operculum is rectangular and is .044 x .034 mm. Towards the bottom and round about the lingula is seen a pattern of irregular lines. Towards the anterior border there is a pair of spines - one on each side. Inside the outer V-shaped enclosure the colour of the dry specimens is yellow. General colour of the dry pupa is brownish.

Adult ♀ : Size 1.25 mm. Colour of the body orange yellow, legs yellow, eyes reddish brown, strongly reniform, tips of legs black. Antennae yellow. Wings spotless white with the Radial sector and cubitus prominent. Radial sector with one flexure in the middle. Margin of the wings knobbed, orange coloured. Knobs about 22 in .1 mm. Forewing 1.16 x .53 mm., hind wing smaller with one vein and no spots. Tip of rostrum dark coloured.

Legs : Hind femur .273 mm. Hind tibia .46 mm.

and /

and is nearly one and three quarters the femur. Hind tarsal joints, 1st .150 mm. and the 2nd. .100 mm. Middle femur .223 mm. Middle tibia one and one quarter times the femur. Middle tarsal joints, 1st .093 mm. and 2nd .083 mm. First femur .200 mm. and first tibia .280 mm. First tarsal joints, 1st is half the femur and more than one third of tibia, it is .100 mm., 2nd is .086 mm. Total length - 1st Leg .666 mm., 2nd Leg .672 mm. and 3rd Leg .948 mm.

Antenna : First segment is very small and cup-shaped and is .026 mm. Second segment appears to be very broad at the tip; it is sub-pyriform and .066 mm. long x .04 mm. Third is the longest and is nearly sub-equal to the total length of the last four segments; it is .136 mm. The fourth segment is the smallest and is .026 mm. The fifth and the sixth are equal and are .033 mm. long. The last segment is the longest of the last four segments and is .036 mm. Total length .3512 mm.

The vasiform orifice is elliptical and there is clear space all round the operculum. The operculum is comparatively large. Lingula is short and strap-like. The operculum is strongly arched in the middle on the lower side. Lingula protrudes beyond the orifice.

Adult ♂ : It is smaller than ♀, but the antennae and the last two legs appear to be longer. The claspers are /

are not forked at the tips as in A.brassicae, and have some spines on them. The rest of the characters as in ♀ .

Legs : Hind femur is .261 mm. Hind tibia is one and half times the femur and is .430 mm. Hind tarsal joints, 1st .141 mm. and 2nd .101 mm. They are together nearly equal to the femur and slightly longer than half the tibia. Middle femur .221 mm., middle tibia slightly longer than one and one quarter times the femur; it is .303 mm. Tarsal joints, 1st joint .111 mm. and 2nd .088 mm. Proximal femur .186 mm., proximal tibia .241 mm. and one and one-third the femur. First tarsal joints respectively are .116 mm. and .093 mm. The total length, 1st Leg .636 mm., 2nd Leg .723 mm. and 3rd Leg .933 mm.

Antennae : First joint cup-shaped, very small; it is .02 mm. long. The second joint is sub-pyriform. It is three times the first and .066 mm. The third is the longest and is double that of the second; it is .126 mm. The fourth is the shortest, excepting the first one, and is .02 mm. The fifth is longer than the fourth but shorter than the sixth and the seventh; it is .033 mm. Sixth and seventh are sub-equal and each are .04 mm. The total length is .385 mm.

Habitat : England - Surrey(Oxshott,Merton,Wimbledon)
London (Blackheath).

Food plant : Rubus.

A. ribium (Douglas).

Aleurodes ribium (Douglas) 1888, Ent.Mo.Mag.XXIV.p.264.
" " " 1889, Op.c. XXV. p.256.
" " (Cockerell)1902, P.Ac.Sci.Phil.,p.281.

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Habitat : England.

Food Plant : Ribes nigrum and rubrum.

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tion is covered with cottony, waxy material and a palisade of white wax elevating the case from the leaf. Vasiform orifice cup-shaped or sub-circular with the anterior border not quite straight, operculum rectangular about one-third filling the orifice. Lingula rounded, the distal extremity with a head not lobed, deeply setose and armed with two spines in the centre. The vasiform orifice towards the caudal extremity has an irregular pattern of lines, sometimes obscuring the lingula.

Adults with one flexure in the Radial sector of forewing and no trace of media. Antennae of seven segments /

## New Genus NEO-ALEUROTULUS.

Pupa case medium to small in size, elliptical oval, usually elevated from the leaf by a palisade of white wax, colour variable, ranging from pale yellow to dark brown, sub-marginal area without any papillae or pores noticeable as in the genus Trialeurodes, thoracic tracheal folds rarely distinguishable, without any furrow from the vasiform orifice to the caudal margin of the case, but the area caudad the vasiform orifice fimbricate, dorsum of the pupa with chitinous hollow processes through which flocculent waxy material is thrown outside. Dorsally the abdominal portion is covered with cottony, waxy material and a palisade of white wax elevating the case from the leaf. Vasiform orifice cup-shaped or sub-circular with the anterior border not quite straight, operculum rectangular about one-third filling the orifice. Lingula rounded, the distal extremity with a head not lobed, deeply setose and armed with two spines in the centre. The vasiform orifice towards the caudal extremity has an irregular pattern of lines, sometimes obscuring the lingula.

Adults with one flexure in the Radial sector of forewing and no trace of media. Antennae of seven segments /

segments - segment III. the longest, IV. to VI. sub-equal; segments imbricated; sexes nearly equal in size. Claspers of male not forcipate as in A.brassicae; eyes reniform, not divided; wings immaculate.

Species coming under this genus.

(1) immaculata (Heager).
(2) phillyreae (Haliday).

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(1) Pupa case medium to small in size, smoky brown in colour. Size 1.08 mm. x .704 mm. Dorsum covered with 72 to 75 chitinous hollow processes. Margin of the case is crenulate. Marginal teeth 12 in .1 mm. Vasiform orifice surrounded by a dark brown area - the orifice is yellow ..... immaculata.

(2) Pupa case madium to small in size, smoky brown in colour. Size 1.016 mm. x .706 mm. Dorsum covered with 68 to 70 chitinous hollow processes. Margin of the case crenulate. Marginal teeth of the case 9 in .1 mm. There is a dark band in the centre of the abdomen dorsally, reaching the caudal margin. Vasiform orifice is surrounded by a dark area. The orifice is yellow..... phillyreae.

## Immaculata (Heager).

(Pl.XII Figs.6 to 9. Pl.XI Fig.2).

A.immaculata(Heager) 1856,Sb.Ak.Wein.XVIII,p.33.
" (Signoret)1868, A.S.E.France(4) VIII.p.390.
" (Douglas) 1884, Ent.Mo.Mag.XX.p.215.
" (Sharp) 1901, Cam.N.Hist.VI. p.287.
" (Cockerell)1902,P.Ac.Sci.Phil.,p.281.

Larva : (described from slides and dry specimens). Size .35 mm. x .18 mm.; nearly doubly long as broad. Shape elliptical. Margin very narrow. Teeth-like projections all over the margin from which small hairs issue. To the caudal end two long cerci on the margin below the vasiform orifice. In the dry specimen dorsum free from any processes. Segmentation in the abdomen clear, but not so in thorax. Two red spots cephalad represent the eyes. Vasiform orifice more or less sub-circular with the anterior border slightly curved. Operculum covers about one-third of the orifice. Lingula short, blunt and thick. In some specimens it is more or less clouded. Inside the orifice by the side of the lingula an irregular pattern of lines is seen.

Pupa : (described from slides and dry specimens). Size 1.08 mm. x .704 mm. More or less oval in shape. Colour of the dry specimens and pupal skins smoky white, darker or more brownish in the centre. Pupa elevated /

elevated from the leaf surface on a palisade of white wax and appearing boxlike. Dorsum of the pupa covered all over and on the margin by blunt, hollow chitinous processes which are regularly distributed. If the pupal case is divided by a median line on each side there are three rows of these processes, one close to the centre on the abdominal and thoracic segments. One is quite peripheral or on the margin and one is situated in between these two. The marginal row consists of larger processes which are 16 to 17 on each side. In between the marginal processes is placed alternately a row of small tubercles. The middle row is of smaller processes and the one internal or central is made up of still smaller processes. All over the dorsum there are 72 to 75 processes. These processes are hollow chitinous structures from which wax is seen to come out in flocculent mass which is seen spreading all over the dorsum. The space just below the vasiform orifice is indented and fimbricated. Vasiform orifice is sub-circular with the anterior margin not quite straight. The orifice is .07 mm. x .056 mm. Operculum is rectangular and covers the orifice nearly half. It is .026 x .036 mm. Lingula is .02 mm.long. It is tube-like, knobbed at the tip from which small hairs project. Inside the orifice is seen a pattern of irregular lines. Towards the anterior border on each /

each side of the vasiform orifice are two small tubercles with the terminal hairs and similar ones towards the caudal border. The marginal teeth of the case are 12 in .1 mm.

Adult ♀ (described from slides.)

Forewing 1.3 mm. x .66 mm. Border orange coloured. Teeth or beads 20 to 21 in .1 mm. The Radial sector of the forewing has only flexure, cubitus long and prominent. Wings spotless white. Eyes reniform, not completely divided. Two facets joining the lobes.

Legs : Hind femur .288 mm. Hind tibia one and half times the femur and is .458 mm. Hind tarsus less than half the tibia - 1st segment is .140 mm. and the 2nd segment .097 mm. Middle femur .247 mm. Middle tibia .332 mm. 1st middle tarsus segment is .113 mm. and the 2nd is .087. Proximal femur .208 mm., proximal tibia nearly one and half times the femur and is .293 mm. First tarsal, 1st segment .106 mm. and the 2nd is .087 mm. Total length of legs - 1st Leg .711 mm, 2nd Leg .779 mm., 3rd Leg .988 mm. The tarsal joints of the last leg appear to be far too long as compared to those of the other two legs.

Antennae: Total length .470 mm. First joint is small, cup-shaped and less than one-third of the second which is sub-pyriform. Both these joints are .029 and .71 mm. respectively. Third joint is the longest /

longest and is .164 mm. The fourth joint is the shortest and is .041 mm. The fifth is .066 mm. and is longer than the sixth and the seventh. Sixth is the smallest of the last three and is .046 mm. The seventh is .053 mm. Sensoria as in others. The last joint has a pointed tip ending in a bristle.

Adult ♂ (described from slides.)

Same as the ♀ but smaller in size.

Legs : Hind femur .253 mm., hind tibia more than one half times longer than the femur. It is .400 mm. Hind tarsal joints together are nearly two-thirds of the femur and less than half of the tibia. The 1st joint is .106 mm. and the 2nd. is .097 mm. Middle femur .226 mm., middle tibia .294 mm., middle tarsal joints, 1st joint .090 mm. and 2nd joint .076 mm. The first femur .200 mm., first tibia .256 mm., first tarsal joints .100 mm. and .078 mm. respectively. Total length - 1st Leg .634 mm., 2nd Leg .687 mm., 3rd Leg .838 mm.

Antennae: Total length .428 mm. First joint is small and is .023 mm. It is slightly more than one-third of the second joint which is .063 mm. Third joint is the longest and is .150 mm. Fourth joint is the smallest and is .036 mm. Fifth and sixth respectively .050 mm. and .046 mm. The last is .060mm. Vasiform orifice is of the same type as in the female.

Habitat /

Habitat : England - Oxford(Henley).

Food plant : Hedera helix.

## Phillyreae (Haliday).

(Pl.XII Figs.1-5. Pl.XI Fig.1)

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Aleurodes phillyreae(Haliday) 1834, Ent.Mag.11,p.109.
" " (Walker) List Hom.Brit.Mus.,p.1093.
" " (Signoret) 1868, A.S.E.France(4)VIII.p.388.
" " (Maskell) 1876, T.N.Z.I.,XXVIII.,p.434 & 438.
" " (Cockerell)1902, Pro.Ac.Sci.Phil.,p.281.

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1st Larva (described from slides and dry specimens).

Size .27 mm. x .13 mm. Shape more or less elliptical. Margin narrow, rimlike; teeth like projections. Two cerci from the caudal margin very prominent. Segmental constrictions of the abdomen defined more clearly than those of the thorax. Two divided red spots representing the eyes. Vasiform orifice nearly sub-ovate with both margins straight. Operculum filling more than one-third the orifice. Lingula rounded with a definite knob. The bottom of the orifice notched. Dorsum smooth.

II. instar : (described from slide).

Size .416 mm. x .28 mm. Shape more or less oval, very narrow and crenulate. The marginal teeth-like projections present in the previous stage have disappeared.

To /

To the caudal end under the vasiform orifice are seen two pairs of cerci-like hairs. By changing the focus and careful examination, small tubercles with projecting hairs are seen on the dorsum. This may be the beginning of the future chitinous processes. Brown spots in front represent the eyes. The segmentation in the thorax not so clear as in the abdomen. Vasiform orifice has taken a different form from that of the 1st larva. The anterior border is curved and the sides are rounded. The caudal border is straight. Operculum flap-like, occupying nearly more than half the orifice. The pattern of lines inside the orifice, which is very prominently seen in the pupa, is faintly seen.

Pupa : (described from slides and dry specimens). Size 1.016 mm. x .706 mm. Shape more or less oval. Colour of the dry specimen smoky white, more dark in the centre. In general the colour appears to be a bit darker than in "immaculata". The pupa raised on a palisade of wax and appearing boxlike. Dorsum all over covered by chitinous processes which are hollow structures from which flocculent waxy material is seen coming out. On the dorsum there are four lines of these processes - one on each side of the central median line consisting of 7 to 8 processes, three on the thorax and five on the abdomen. The one beyond this /

this contains 5 to 6 processes and is seen on the abdomen only. The one beyond it extends all round in the sub-marginal area and contains 10 to 11 processes. The last is the marginal one and contains 12 to 13 processes. In all the dorsum contains 68 to 70 hollow processes. The outer processes are larger and the inner ones smaller. The vasiform orifice is sub-circular and appears to be placed in a pit. Towards the anterior border there are two spines and two on each side. The caudal area is fimbricate and possesses on each side of the fimbrication one spine. The operculum is small and flap-like filling nearly one-fourth of the orifice. The caudal area of the vasiform orifice is a network of lines. The lingula is small (as compared to that in "immaculata") blunt and thickened at the tip. The marginal area is crenulate. Marginal teeth about 9 in .1 mm.

Adult ♀ (slides and dry specimens).
General colour yellow, size 1.53 mm. long. Wings pure white without any black spots. Forewing 1.83 mm. x .83 mm., border orange beaded which are blunt projections from each of which small hairs come out, the tip ones being the longest. The beads are 16 in .1 mm. Eyes are strongly reniform. The junction between two eye-lobes is formed by two facets. The facets are not of uniform size in these lobes. The Radial sector of the/

the forewing has only one flexure in the middle. It is long and almost touches the outer margin. The cubitus is much pronounced. Genitalia normal. Tip of rostrum black.

Antennae: First segment small cup-shaped. It is .028 mm. The second is more than double the first and is .066 mm. The third is the longest and is nearly sub-equal to the total length of the three succeeding segments IV, V and VI. It is .149 mm. long. The fourth is the smallest excepting the first. It is .041 mm. The fifth is longer than the last two. It is .063 mm. Sixth and seventh are nearly equal. They are respectively .050 and .053 mm. The total length is .453 mm. The five segments (last) are imbricate. Sensoria as usual.

Legs : Hind femur is .322 mm. Hind tibia about one and three quarters of the femur and also nearly double the combined length of the hind tarsal joints. It is .533 mm. First hind tarsal joint is nearly half the femur and the second is about one-third of the same. The joints respectively are .163 mm. and .108 mm. Middle femur .273 mm. Middle tibia is about one and one-quarter times the femur. Middle tibia is .353 mm. Middle tarsal joints - 1st joint is .117 mm. and the 2nd is .092 mm. Proximal femur .247 mm., proximal tibia is .311 mm. The tarsal joints /

joints - 1st joint is ,129 mm. and 2nd joint is .093 mm. Total length of legs - 1st Leg .780 mm., 2nd Leg .835 mm. 3rd Leg 1.126 mm.

Adult ♂ (described from slides).

A little smaller in size than ♀. Wings and other characters similar. Claspers of the male not forked at the tips like A.brassicae.

Antennae: First joint very small, cup-shaped. It is .026 mm. The second is sub-pyriform and .064 mm. long. The third is the longest and is nearly three times that of the second and is sub-equal to the total length of IV, V and VI. The fourth is the smallest of the last five joints. It is .036 mm. The fifth is .064 mm. and longest of the last four joints. The sixth is longer than the fourth, but shorter than either the fifth or seventh. The seventh is .054 mm. and longer than the sixth which is .045 mm. The last five joints imbricated as in others and sensoria as usual. The total length of the antenna is .435 mm.

Legs : Hind femur is .279 mm. Hind tibia is nearly one and three-fourths the femur. It is .451 mm. Hind tarsal joints - 1st joint exactly half of the femur and 2nd joint is one-third of the femur. Both joints, which are respectively .139 mm. and .094 mm., are half of the tibia. Middle femur is .247 mm.

Middle /

Middle tibia one and one-fourth the femur. It is .314 mm. The middle tarsal joints - 1st joint is .106 mm. and 2nd joint is .084 mm. The proximal femur is .244 mm. The tibia is .293 mm. 1st tarsal joint .116 mm. and 2nd is .086 mm. Total length - 1st Leg .737 mm., 2nd Leg .748 mm. and 3rd Leg .963 mm.

Habitat : England - Surrey(Merton)
Ireland, France, Germany, Austria, Hungary, Italy.

Food Plants : Fraxinus excelsior.
Phillyreae latifolia.
" media.
Pyrus.
Mespilus.
Rhamnus alternus.

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Unplaced Species /

## Unplaced Species.

(1) A. avellanae (Signoret).

Aleurodes avellanae (Signoret) 1868, Ann.S.E.F.(4) VIII.p.385.
" " (Douglas) 1893, Ent.Mo.Mag.XXV.p.154.
" " (Cockerell) 1902, P.Ac.Sci.Phil., p.280.

(2) A. azaleae

(3) A. Bagnalli (Harrison)

(4) A. carpini (Koch)

Aleurodes carpini (Signoret) 1868, A.S.E.F.(4) VIII.p.382.
" " (Douglas) 1895, Ent.Mo.Mag.XXXI.p.117.
" " (Cockerell) 1902, P.Ac.Sci.Phil., p.281.

(5) A. quercus (Signoret)

Aleurodes quercus (Signoret) 1868, A.S.E.F.(4) VIII.p.384.
" " (Cockerell) 1902, P.Ac.Sci.Phil., p.281.
" " (Harrison) 1920, Entomologist, 53.

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## Aleurodes azaleae (Baker and Moles).

(Pl.XIII Figs.1-4).

Aleurodes azaleae (Baker and Moles) 1920, Pro.Ent.Soc., Washington, XXII, 5.

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This species has been described as a new species by Baker and Moles in the Journal above referred to.

This /

This has been put under the genus Aleurodes, but on examining the characters afforded by this species it will have to be kept among the Unplaced species.

I add as follows to the description given by the authors of the pupa and the adult, the following :-

Egg : Elliptical, curved on one side and bulging out on the other side. Size inside the body .45 x .08 mm. without the stalk which is .017 mm. Thick in the middle with a sharp point. Stalk not attached to the middle but to one side.

Larva. III. instar : Colour pale yellow, translucent, shape oval elliptical. Size .53 mm. x .033 mm. Margin crenulate with blunt teeth. Teeth 17 to 18 in .1 mm. By changing the focus under high magnification papillae like structure is seen from which the wax threads forming the thick waxy fringe is formed. The fringe is very long, measuring .08 mm. in length. Just near the margin the wax is very thick and becomes thin afterwards. The fringe is not continuous all round the margin. Two thoracic and six abdominal constrictions are noticed. The two red spots in front of the body represent the eyes. The vasiform orifice of the same type as in the pupa except that it is prominently notched in the middle before the caudal prolongation. The caudal margin under the vasiform orifice possesses two long cerci. Thoracic folds not so prominent as in the pupa.

Pupa /

Pupa : Shape elliptical oval at the surface, elevated on a palisade of wax and thus having a box-like appearance. The marginal crenulations show under high magnification papillae like structure. Dorsum is seen full of small wax pores.

Adult : Colour pale yellow. Male decidedly smaller than the female. Wings pure white, immaculate. Rs of the forewing has one flexure in the middle. Eyes not divided, reniform. The two portions of the eye joined by two facets. The facets of the lower portion of the eye slightly bigger in size than those in the upper. Claspers not forked at the tips.

Legs ♀ : Hind femur .266 mm., hind tibia .423 mm., hind tarsus 1st joint .133 mm., 2nd joint .10 mm. Middle femur .200 mm., middle tibia .29 mm., middle tarsal joints, 1st joint .093 mm., 2nd joint .073 mm. Front femur .183 mm., front tibia .24 mm., front tarsus, 1st joint .116 mm., 2nd joint .083 mm.

Legs ♂ : Hind femur .233 mm., hind tibia .383 mm. hind tarsal joints, 1st joint .116 mm., 2nd joint .093mm. Middle femur .19 mm., middle tibia .28 mm., middle tarsal joints, 1st joint .10 mm., 2nd joint .08 mm. Front femur .173 mm., front tibia .233 mm., front tarsal joints, 1st joint .106 mm., 2nd joint .083 mm.

Locality : Edinburgh (Cramond).

A. quercus (Signoret).

(Pl.XIV Figs.7 - 9 ).

Aleurodes quercus(Signoret) 1868,A.S.E.France(4)VIII.p.384.
" " (Cockerell)1902,P.A.Sci.Phil.,p.281.

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Adult ♀ (described from actual specimens and slides). Size 1.16 mm. long. General colour yellow; thorax yellowish brown; no black spots on the body or the wings; even the last segment of the abdomen reddish yellow. Wings pure white without any black spots. Radial sector of the forewing once bent in the middle. Both Radial sector and cubitus well pronounced. Tip of the rostrum black. Eyes reddish brown, strongly reniform. The junction between two eye-lobes formed by two facets. Forewing is 1.23 x .53 mm. Border orange colour, beaded. Beads 18 to 20 in .1 mm. Eggs about 12 inside the body. Genitalia normal.

Antennae: First segment small, cup-shaped; it is ,017 mm. The second is sub-pyriform and about three times the first; it is .05 mm. The third is the longest and is more than double the second and nearly sub-equal to the total length of IV,V and VI; it is .111 mm. The fourth is the smallest of the last five segments; it is .03 mm. The fifth is .04 mm. and is longer than the fourth and the sixth. The latter is .038 mm. The last is .046 mm; it is the longest /

longest of the last four joints. All the last five segments imbricate. Sensoria as usual. The total length is .332 mm.

Legs : Hind femur .233 mm.; hind tibia one and three-fourths the femur and is sub-equal to double the length of the tarsal joints; it is .400 mm.; hind tarsal joints, 1st joint .116 mm., 2nd joint .083 mm. Middle femur .200 mm., middle tibia .260 mm., middle tarsal joints, 1st joint .093 mm. and 2nd joint .066 mm. Proximal femur .17 mm., proximal tibia .233 mm. First tarsal joints, 1st joint .100 mm. and 2nd joint .073 mm. Total length of Legs - 1st Leg .576 mm., 2nd Leg .625 mm., 3rd Leg .832 mm.

Adult ♂♀ : (described from actual specimens and slides).

Size 1.13 mm., slightly slender and smaller than ♀ . Colour yellow. Claspers not forked very strongly like those of A.brassicae, but slightly cleft at the tip. Rest of the characters as in ♀ .

Antennae: First segment small, and cup-shaped; it is .017 mm. Second is sub-pyriform and nearly thrice in length of the first. Third is the longest and exactly double the second and slightly less than the combined length of the last four segments; it is .100 mm, and Second is .05 mm. The fourth is the smallest of the last five segments. It is sub-equal to /

to the sixth and .027 mm. The fifth is longer than the fourth, sixth and seventh. The sixth is .027 mm. The last segment is longer than the sixth and is .033mm. Total length .294 mm. Smallest of all the species under study.

Legs : Hind femur .200 mm. Hind tibia nearly one and half times the femur is .333 mm. It is exactly double the combined length of both the tarsal joints. The latter are, 1st joint .100 mm. and 2nd joint .066 mm. Middle femur .17 mm., middle tibia .233 mm., middle tarsal joints, 1st joint .083 mm. and 2nd joint .066 mm. First femur .15 mm., first tibia .17 mm., first tarsal joints, 1st joint .093 mm. and 2nd joint .060 mm. Total length of legs - 1st Leg .473 mm., 2nd Leg .552 mm., 3rd Leg .696 mm.

Habitat : England - Durham (near Birtley).
France.

Food plant : Quercus pedunculata.

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Antennal Measurements of Different Species of British Aleurodidae.(Averages of 5 specimens).

| | | | I. | II. | III. | IV. | V. | VI. | VII. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| (1) | A.azaleae | ♀ | | | .089 | .026 | .028 | .039 | .033 | |
| | | ♂ | | | .07 | .02 | .028 | .036 | .038 | |
| (2) | A.brassicae | ♀ | .033 | .088 | .161 | .05 | .070 | .055 | .059 | .516 |
| | | ♂ | .03 | .074 | .22 | .068 | .08 | .066 | .050 | .588 |
| (3) | D.chittendeni | ♀ | .033 | .073 | .133 | .03 | .033 | .04 | .033 | .375 |
| | | o | | | | | | | | |
| (4) | A.fragariae * | ♀ | .023 | .08 | .170 | .043 | .070 | .06 | .063 | .509 |
| (5) | A.immaculata | ♀ | .029 | .071 | .164 | .041 | .066 | .046 | .053 | .470 |
| | | ♂ | .017 | .071 | .150 | .040 | .056 | .056 | .060 | .428 |
| (6) | A.lonicerae | ♀ | .026 | .074 | .164 | .038 | .063 | .056 | .058 | .479 |
| | | ♂ | .017 | .066 | .140 | .04 | .040 | .050 | .050 | .403 |
| (7) | A.phillyreae | ♀ | .028 | .066 | .149 | .041 | .063 | .050 | .053 | .450 |
| | | ♂ | .026 | .064 | .148 | .036 | .064 | .045 | .052 | .435 |
| (8) | A.proletella | ♀ | .023 | .073 | .163 | .046 | .067 | .052 | .061 | .485 |
| | | ♂ | .026 | .07 | .173 | .066 | .066 | .056 | .056 | .513 |
| (9) | A.quercus | ♀ | .017 | .050 | .111 | .03 | .04 | .038 | .046 | .332 |
| | | ♂ | .017 | .050 | .100 | .027 | .04 | .027 | .033 | .294 |
| (10) | A.rubi | ♀ | .0218 | .0715 | .148 | .043 | .058 | .0575 | .063 | .437 |
| | | ♂ | .017 | .070 | .150 | .040 | .056 | .056 | .060 | .449 |
| (11) | A.rubicola | ♀ | .027 | .060 | .136 | .0266 | .033 | .033 | .036 | .351 |
| | | ♂ | .020 | .066 | .126 | .020 | .033 | .04 | .04 | .385 |
| (12) | T.sonchi | ♀ | .017 | .0508 | .125 | .046 | .063 | .050 | .048 | .3998 |
| | | ♂ | .013 | .050 | .08 | .033 | .05 | .03 | .04 | .296 |
| (13) | T.vaporariorum | ♀ | .0186 | .0518 | .100 | .0398 | .0554 | .0368 | .0376 | .3404 |
| | | ♂ | .022 | .050 | .108 | .037 | .059 | .037 | .039 | .3520 |

* One specimen only.

Measurement of Legs of Different Species of British Aleurodidae. (Averages of 5 specimens).

| | | | Femur | Tibia | 1st Tarsal joint. | 2nd Tarsal joint. | Total |
|---|---|---|---|---|---|---|---|
| | | | mm. | mm. | mm. | mm. | mm. |
| (1) | azaleae | ♀ 1st Leg | .183 | .240 | .116 | .083 | .622 |
| | | 2nd " | .200 | .290 | .093 | .073 | .656 |
| | | 3rd " | .266 | .423 | .133 | .100 | .922 |
| | | ♂ 1st Leg | .173 | .233 | .106 | .083 | .595 |
| | | 2nd " | .190 | .280 | .100 | .080 | .650 |
| | | 3rd " | .233 | .383 | .116 | .093 | .825 |
| (2) | brassicae | ♀ 1st Leg | .251 | .326 | .135 | .106 | .816 |
| | | 2nd Leg | .270 | .367 | .123 | .096 | .856 |
| | | 3rd " | .298 | .525 | .159 | .116 | 1.098 |
| | | ♂ 1st Leg | .166 | .343 | .133 | .100 | .742 |
| | | 2nd " | .216 | .363 | .130 | .100 | .809 |
| | | 3rd " | .270 | .523 | .153 | .113 | 1.059 |
| (3) | chittendeni | ♀ 1st Leg | .20 | .250 | .100 | .083 | .633 |
| | | 2nd " | .22 | .300 | .106 | .083 | .709 |
| | | 3rd " | .30 | .43 | .133 | .093 | .956 |
| | | ♂ 1st Leg | .173 | .223 | .093 | .073 | .562 |
| | | 2nd " | .200 | .266 | .093 | .066 | .625 |
| | | 3rd " | .240 | .373 | .116 | .083 | .812 |
| (4) | fragaria | ♀ 1st Leg | .233 | .240 | .133 | .113 | .719 |
| | | 2nd " | .240 | .350 | .120 | .103 | ..813 |
| | | 3rd " | .300 | .500 | .170 | .120 | 1.090 |
| (5) | immaculata | ♀ 1st Leg | .218 | .293 | .116 | .084 | .711 |
| | | 2nd " | .247 | .332 | .113 | .087 | .779 |
| | | 3rd " | .288 | .458 | .140 | .097 | .983 |
| | | ♂ 1st Leg | .200 | .256 | .100 | .078 | .634 |
| | | 2nd " | .223 | .294 | .096 | .076 | .689 |
| | | 3rd " | .253 | .400 | .106 | .079 | .838 |

(6) /

| | | | | Femur | Tibia | 1st Tarsal joint. | 2nd Tarsal joint. | Total. |
|---|---|---|---|---|---|---|---|---|
| | | | | mm. | mm. | mm. | mm. | mm. |
| (6) | loniceræ | ♀ | 1st Leg | .228 | .313 | .143 | .109 | .793 |
| | | | 2nd " | .252 | .382 | .127 | .105 | .866 |
| | | | 3rd " | .277 | .508 | .171 | .119 | 1.075 |
| | | ♂ | 1st Leg | .180 | .250 | .116 | .083 | .629 |
| | | | 2nd " | .210 | .300 | .107 | .083 | .700 |
| | | | 3rd " | .230 | .416 | .133 | .100 | .879 |
| (7) | phillyreæ | ♀ | 1st Leg | .247 | .311 | .129 | .093 | .780 |
| | | | 2nd " | .273 | .353 | .117 | .092 | .835 |
| | | | 3rd " | .322 | .533 | .163 | .108 | 1.126 |
| | | ♂ | 1st Leg | .244 | .293 | .116 | .084 | .737 |
| | | | 2nd " | .247 | .314 | .106 | .081 | .748 |
| | | | 3rd " | .279 | .451 | .139 | .094 | .963 |
| (8) | proletella | ♀ | 1st Leg | .239 | .307 | .133 | .105 | .784 |
| | | | 2nd " | .245 | .359 | .120 | .099 | .823 |
| | | | 3rd " | .293 | .505 | .164 | .113 | 1.075 |
| | | ♂ | 1st Leg | .217 | .278 | .132 | .103 | .730 |
| | | | 2nd " | .232 | .335 | .118 | .097 | .782 |
| | | | 3rd " | .260 | .455 | .158 | .111 | .984 |
| (9) | rubi | ♀ | 1st Leg | .216 | .286 | .136 | .105 | .733 |
| | | | 2nd " | .228 | .328 | .114 | .101 | .771 |
| | | | 3rd " | .269 | .433 | .153 | .111 | .966 |
| | | ♂ | 1st Leg | .216 | .273 | .126 | .101 | .716 |
| | | | 2nd " | .233 | .333 | .113 | .100 | .789 |
| | | | 3rd " | .269 | .433 | .158 | .111 | .972 |
| (10) | rubicola | ♀ | 1st Leg | .200 | .280 | .100 | .086 | .666 |
| | | | 2nd " | .223 | .273 | .093 | .083 | .672 |
| | | | 3rd " | .256 | .456 | .136 | .100 | .948 |
| | | ♂ | 1st Leg | .186 | .241 | .116 | .093 | .636 |
| | | | 2nd " | .221 | .303 | .111 | .088 | .723 |
| | | | 3rd " | .261 | .430 | .141 | .101 | .933 |
| (11) | quercus | ♀ | 1st Leg | .173 | .233 | .100 | .073 | .579 |
| | | | 2nd " | .200 | .266 | .093 | .066 | .625 |
| | | | 3rd " | .233 | .400 | .116 | .083 | .832 |
| | | ♂ | 1st Leg | .150 | .173 | .093 | .060 | .476 |
| | | | 2nd " | .173 | .233 | .083 | .066 | .555 |
| | | | 3rd " | .200 | .333 | .100 | .066 | .699 |
| (12) | sonchi | ♀ | 1st Leg | .183 | .273 | .116 | .086 | .658 |
| | | | 2nd " | .210 | .293 | .110 | .083 | .696 |
| | | | 3rd " | .256 | .417 | .136 | .100 | .903 |
| | | ♂ | 1st Leg | .130 | .201 | .100 | .076 | .507 |
| | | | 2nd " | .160 | .233 | .096 | .073 | .562 |
| | | | 3rd " | .200 | .310 | .113 | .083 | .706 |
| (13) | vaporariorum | ♀ | 1st Leg | .160 | .231 | .099 | .075 | .565 |
| | | | 2nd " | .177 | .249 | .095 | .077 | .598 |
| | | | 3rd " | .212 | .343 | .115 | .085 | .755 |
| | | ♂ | 1st Leg | .175 | .254 | .111 | .090 | .630 |
| | | | 2nd " | .191 | .282 | .101 | .083 | .656 |
| | | | 3rd " | .234 | .371 | .126 | .091 | .830 |

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