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OBSERVATIONS

RELATIVES A

LA BIOLOGIE

DE

" *Lycaena Alcon* "

ON THE LIFE HISTORY

of *Lycaena Alcon*

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ON THE LIFE HISTORY
of *Lycaena Alcon*, F.

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I have just had the pleasure of making observations completing the outline of the life history of *Lycaena Alcon*, F. What we knew up till last year was that the young larva fed in the flowers and in the soft tissues of *Gentiana pneumonanthe* in the early autumn (or late summer) up to its third instar, thereafter failure to rear it. There are some German reports describing the full-grown larva, as an ordinary plant-feeding larva, which are obviously founded on error of observation, or on mere guesswork.

My observations on *L. arion* afforded me the satisfaction of solving the mystery surrounding its life-history, in which my success no doubt depended largely on the previous work, chiefly of Mr. F. W. Frohawk.

In the present case, my investigations were due to Mr. C. Oberthür, who, assisted by Mr. H. Powell, showed that the larva of *alcon* was very probably dependent in some way on ants, probably in some similar way to that of *L. arion*. Mr. Oberthür & Mr. Powell were probably led to this opinion on some degree by the facts of the history of *L. arion*. Their own observations are recorded in the *Etudes de Lépidoptérologie comparée*, Fasc. XIV (1917). They supplied me with young larvae in both 1916 and 1917 in the belief that my experience with *L. arion* would enable me to do something with them, and in the event, it is satisfactory to find that their trust was not disappointed. Though I have done my share of the work I am glad to point out that much of the credit of the result belongs to Mr. Oberthür and Mr. H. Powell just as in the matter of *L. arion*, it was

rather a matter of accident that the first success fell to my share rather than to Mr. Frohawk's.

In, I think, 1907, Mr. Gillmer of Cothen, sent me eggs and young larvae of *L. alcon*, and his observations confirmed by mine showed that the young larva fed in the flowers of *Gentiana pneumonanthe*, or burrowed in the succulent tissues of its young shoots, but we both, of course, failed to get it beyond the third instar. I refer to this in *Ent. Record*, Vol. XXX, p. 25. I believe Mr. Gillmer published his observations, but I have lost the reference.

Mr. Oberthür and Mr. Powell sent me larvae in 1916, but I got no further with them. He and Mr. Powell in 1917 found that the larva of *L. alcon* would imbibe the fluids of ant pupae and Mr. Powell saw an ant, supposed to be *Tetramorium caespitum* carry off a young larva of *L. alcon*. At the same time, Mr. Oberthür and Mr. Powell sent me larvae in their third instar, which I installed in nests of *Myrmica* and the following notes were made in reference to their larvae :—

All the larvae I have seen reached, whilst feeding on the Gentian, their third instar and got no further, with but one exception, this was one of the larvae sent me in 1916. This larva was in a gentian flower, that had been abandoned by its brethren of probably equal age. It was still in the third instar, but was ready to moult. It did not do so but died. I was able, however, to mount the skin of the third instar of the specimen, and also that of the fourth instar that it covered. I will refer to this later.

Sept. 9th 1917. Received from Mr. Powell at Rennes some third stage larvae of *Lycaena alcon*, together with an account of an ant carrying a larva a considerable distance, presumably towards its nest, but before it got there it got hidden together with its burden in some thick herbage and could not be traced further. The weather was wet and stormy and no effort could be made to get any sort of ant's nest to put any in.

Sept. 10th. Got some *Myrmica scabrinodis* from Earlswood Common, but got no queen and by way of brood only some pupae, placed them with the larvae of *L. alcon* in an improvised observation nest. The ants seemed quite friendly with the *alcon* larvae, and one of the latter seemed to be trying to taste a pupa, but without obvious success.

Sept. 11th. Got some more ants but hardly any brood and placed them in another nest with two larvae of *alcon*, all seemed friendly.

Sept. 14th. After various unsuccessful attempts, got two lots (from two nests) of *Myrmica scabrinodis* from Betchworth, and established them in two nests, each without a queen but with a fair amount of brood to which I added some larvae from other nests. The ants accepted the foreign brood without objection, as well as the larvae of *L. alcon* from the previous very few ants with which they had so far lived, few, as some had escaped, my improvised nest not being at first altogether ant-proof.

The new ants instantly attacked ants of these first nests when allowed to meet them, but accepted the *alcon* at once, so that these could have no scent, or other badge of belonging to the earlier nests.

Sept. 16th. The *alcon*, 2 in each nest, are always amongst the brood, generally at the edge, rather than in the midst and seem to receive little attention from the ants. They look well, but have not grown markedly at all. Larvae not with the ants have all died.

When the ants move their brood, they carry the *alcon* larvae along just as they do their own larvae and pupae, not seizing them in any special way. In the case of *L. arion*, the Lycaena larvae were left alone and found their own way after the brood nest when it was removed.

Sept. 17th. The four larvae (2 in each nest) have distinctly grown measuring 4.5 mm. long instead of 3.0 mm. when they

leave the Gentian, and the segments are markedly bulging, i. e. the incisions are marked, and also each segment has on each side two definite fulnesses or prominences about spiracular level, a larger one above, towards anterior margin of segment, and across the dorsum is another still larger along the posterior half of each segment.

Sept. 18th. Condition much as yesterday.

Sept. 19th. Much the same, larvae measure fully 5 mm. if not perhaps 5.5. It is observed that when the disturbance of letting in the light to see what is going on leads the ants to move the brood to another place, the larvae of *alcon* are usually the first to be seized and carried off, before the ants own brood is touched, the movement is very simultaneous and several ants begin it, so that some ant brood goes off pretty much with the *alcon*. When the thing is done half-heartedly and only some brood is removed, the *alcon* are nearly always taken first, and hardly ever left behind.

Sept. 20th. Much the same, the *alcon* are usually at the margin of the heap of brood, not in or under it as *arion* usually was. Have not been able to see *alcon* eat any ant larva but to-day saw an ant mouth to mouth with one, just as they may be seen with their own larvae, no doubt when feeding them. Twice to-day noticed how an *alcon* larva was carried off on disturbance, before any ant larva was touched.

Sept. 22nd. Seen to-day in one nest in middle of brood. The segments are swollen so as to make the lateral outline a series of curves with the incisions well marked.

Sept. 30th. The larvae of *alcon* remain much the same, over 5 mm. long with swollen segments. The larvae of the ant diminish in numbers and amongst the contents of " midden " are remains of ant larvae consisting of the collapsed skin and dark intestine with contents, as though all their fluids had been

drained away. No proof of ant larvae being eaten has so far been found, but yesterday an *alcon* larva was circled round the larger (posterior) end of an ant larva, with its head in the ventral concavity, so that one might say that the ant larva was curled round the head of the *alcon* larva. The ant larva is, however, so immobile that the position was of course due to the action of the *alcon*. It seemed impossible to avoid believing that the *alcon* was, or was about to, eat or suck the juices of the ant larva. The process was of course interfered with by letting the light into the nest.

Oct. 5th. Largest is about 6 mm. long, others fully 5, and all have segments so swollen and incisions so stretched that they can hardly grow much more without a moult. (It will be seen later that this was a very erroneous conclusion to arrive at).

Oct. 8th. In each of the two nests a larva of *alcon* was in the position described on Sept. 30th. The head of the *alcon* was in the hollow of the curved ant larva and its front segments curled round the end of the ant larva. In both cases, the *alcon* was seized at once by an ant, as always occurs when the nest is examined and carried off. The *alcon* in each case held on to the ant larva that was carried off with it. It is difficult to say whether the *alcon* held the ant larva by its jaws or by its legs round the end of the ant larva. It is unfortunate that the disturbance of letting the light into the nest prevents the further procedure of the *alcon* being observed, as they shortly dropped the ant larva.

The middens were examined two days ago and remains of ant larvae found consisting apparently only of skins and intestinal contents.

Oct. 10th. Much the same. The nests with *alcon* have dwindling broods and most days one or two apparently sucked larvae are in the " midden ". The nests without *alcon* maintain the brood undiminished. One larva of *alcon* taken from one of

the nests and placed in the strongest nest (with most brood) of the other three; various ants examined it, several mouthed it, then they left it and many ran over it, after several minutes an ant carried it off to the new brood heap they were making, owing to my letting light into the nest. So far it seemed they were as friendly to it as its late hosts, this remains to be seen.

Oct. 11th. The *alcon* larva placed yesterday in a new nest (after being 30 days — Sept. 10-Oct. 10 — in the previoust nest) is found to be quite at home amongst the brood, the only difference noted in its treatment by the ants, is that in the excited effort to remove the brood, when light is let into the nest, the *alcon* larva instead of being taken first, as has usually been the case in the two previous nests, was not touched till about two-thirds of the brood had been removed — the three other larvae of *alcon* in the two old nests remain practically as before.

Oct. 12th. The transferred larva seems to be going well and on good terms with his hosts. Took the second larva from the other nest (with two *alcon*) and placed it in another nest, it was at once carried to the brood nest and seemed at home there some minutes later.

Oct. 14th. Nests labelled 1 and 2 original nests with each two larvae, now one each, one from each having been moved to nests 3 and 4 each with one larva. Nest 5 has not yet had a larva of *alcon.*

The *alcon* larvae now in 3 and 4 are to-day carried off by the ants preferentially as was and still is the case in nests 1 and 2. The cooler weather (frosty mornings) seem to have made ants and larvae less active, but yesterday an *alcon* was seen folded round the front of a larva of *M. scabrinodis* with its head in the ventral recess of the ant larva. It was covered up at once but a few minutes later, it was seen to have left the ant larva and was being carried off by an ant. Such disturbance

probably accounts for ant larvae being found in the " midden " dead but only partially sucked out.

Oct. 18th. Received larvae of *F. umbratus* last evening from Mr. Donisthorpe, placed two of them in nests 4 and 5 and larva of *alcon* from 4 amongst the mass of *umbratus* larvae in a tube. The *M. scabrinodis* approached the *umbratus* larvae in their nests, looked askance at them and shortly not a few approached them and seemed to seize them or to be about to seize them, and instantly drew back sharply, almost as if stung, or animated by extreme disgust, probably not the former as they immediately resumed an ordinary demeanour.

Oct. 19th. The *L. alcon* restored to nest 4, and was at once accepted, its 24 hours sojourn with *F. umbratus* larvae did not seem to have given it any of the attributes of those larvae in the view of its hosts. In the *umbratus* tube it had done nothing but was possibly less stout.

The *umbratus* larvae in the *scabrinodis* nest are uninjured, but cast out as midden material.

Oct. 21st. The *L. alcon* seem much the same, quite as stout, 5-6 mm. long, but do not grow further, collapsed larvae of *scabrinodis* are regularly found in nests (5 yesterday), but never in nest 5, that has no *alcon* guest.

In No. 4 nest one larvae of *umbratus* is seen bitten in several places, the other and those in 5 are not seen, whether demolished or somewhere hidden is not evident.

Put two more *umbratus* larvae in nest 4.

Oct. 23rd. Find 3 larvae of *umbratus* in nest 4 and the same in nest 5, discarded from nest and lying about, each separate. There is no definite midden in either of these nests and possibly these larvae are too bulky to be taken to one, which might have been instituted by using these larvae so. A definite midden is interfered with by my process of raiding it for damaged ant larvae.

Oct. 25th. Brought an observation nest of *M. scabrinodis* given me by Mr. Donisthorpe, it has a number of workers, a good deal of brood, but no queen. It was taken a few days ago and seems to be settling down satisfactorily. It will be available to transfer *L. alcon* to when any of present nests are exhausted of brood, labelled No. 6.

Nov. 2nd. Mr. E. C. Knight draws larva, the larva seems not quite so long and less active, it suggests that by season or by recent colder weather, they are shrinking, emptying the primae viae with a view to hibernating, this is in agreement with the circumstance that no sucked out ant larvae have been retrieved from middens since Oct. 26th.

Removed *alcon* larva from nest 4, where ant larvae now are absent, to nest 6. Three hours later the ants, which at first carefully examined it, treat it with neglect, walking past it and over it without any notice, and they have not carried it to brood nest; removed it to a position nearer the brood.

Nov. 4th. *Alcon* in nest 6 seen this morning in midden, put in brood nest, seen an hour later, alone in middle of a cell, again put nearer, two hours later seen in brood nest, and an ant seized it at once to take it to a safer place. Gave this nest several house-flies last evening, which made them very active, the flies this morning are disintegrated. This may have made their proceedings otherwise irregular. The *alcon* in 1, 2, and 3 unchanged, no sucked ant larvae in any midden. *Alcon* 3 and 4 (now 6) were drawn by Mr. E. C. Knight on 2nd.

Nov. 5th. Nest 6. *Alcon* looks all right but is outside brood nest.

Nov. 6th. *Alcon* seem in the attitude of curled round head of grub with his own head in the concavity of the ant larva. This *alcon* is looking well, that in 6 just outside heap of ant larvae.

Nov. 10th. No. 3 transferred yesterday to plaster nest, they have not quite settled down, ants in two corners, one group with brood, the other with *alcon*. *Alcon* in all nests much the same, close to the brood in No. 6.

Nov. 15th. The *alcon* in nest 6 is usually just outside the (considerable) heap of ant larvae — as usual in the nests.

Nov. 18th. *Alcon* in 6 with some ants in a corner, mass of brood in opposite corner.

Nov. 28th. *L. alcon* all looking well and with brood, but do not grow, still about or a shade over 5 mm. One ant larva from midden to-day; 3 on 24th; 2 on 18th. These were dead larvae and probably sucked by *alcon* but were not so characteristic as the earlier ones.

Dec. 7th. *Alcon* in nest 6 is now usually amongst ants and brood, but in a secondary group, not in the main mass.

Dec. 8th. *Alcon* in nest 6 found dead with several ants in a corner away from largest group. It was injured apparently by several bites about the central segments and was shrivelled a little (by juice being sucked?). The other three seem well and are treated as usual; this one (No. 6) was put in from another nest and was never treated by the ants like the others as being *more* precious than their own brood.

Dec. 11th. No. 3 *alcon* looks rather smaller, other two as usual.

Dec. 24th. Brood being very scarce in nests 1, 2, and 3 took some from 6 and placed in them.

Dec. 29th. *Alcon* in 1, 2, and 3, are found in and under the little heap of brood with the ants over as usual. The *alcon* look rather thinner than they did. Some 6 ant larvae in midden, but have not the appearance of having been sucked by the *alcon*, may have been injured in removal, or not kindly accepted by ants.

Jan. 2nd 1918. All three *alcon* amongst brood, but do not look so fat as they did.

Jan. 11th. Alcon well and in middle of brood. No. 3 seems a little shrunken.

Feb. 6th. The nests have been looked at once or twice a week since last note, no particular change being noticed and no indication of ant larvae being sucked or eaten. No. 1 and 2 seem a little less plump and No. 3 is perhaps more shrunk and looks a little darker, but all are otherwise well, the larvae are always amongst or close to the ant brood, which is not too numerous. To-day after being left undisturbed for perhaps 2 weeks about 10 dead (and sucked) ant larvae are found on the feeding glass (midden) in No. 2, the weather recently has been mild, but the room they are in has usually been warmed.

Feb. 10th. A dead (sucked?) ant larva removed from No. 1.

Feb. 25th. Three dead ant larvae removed from No. 2.

Mar. 3rd. No dead ant larvae seen since last entry; *alcon* larva in No. 3 looks rather small and pinched, the others fairly well and as usual.

Mar. 13th. Larvae of *alcon* seem well, a dead ant larva was found in midden of nest 1, on 6th instant and again to-day, their appearance does not decide clearly whether they are casualties or whether they were sucked by *alcon.* On the whole the latter is more probable, as the larva in No. 1 seems perhaps the most thriving of the three.

A queen of *M. scabrinodis* added to nest received Octr. 25th.

April 9th. Added various ant brood to all nests (sent by H. St. J. K. Donisthorpe). The three larvae of *alcon* look rather pinched and shrunk but otherwise well, perhaps they are not kept warm enough.

April 18th. Alcon in nest 3 which has been looking shrunk and darker lately is to-day found to be dead and lying in

middle of a space away from ants brood, it is still, larger than on entering nest, is dark in colour, with one portion of darker, but hardly black, there is no sign of injury by ants, either before or after death. *Alcon* in Nos. 1 and 2 are not perhaps quite as large as they were, but look well, they are more often at edge of brood than in it, no proof that they are feeding, recent addition of brood makes finding of dead ant larvae indecisive.

May 9th. Larvae (2) of *alcon* look rather better than they did, but do not grow and there are no clear indications that they feed, they seem a little plumper however and are more rosy (less dark), they measure about 4.5 mm. long.

A good many ova in nest to which ♀ added April 9th.

May 15th. Alcon larvae in No. 1, when nest was uncovered was seized in the usual way by an ant and carried off, it carried with it a full-grown ant larva, which the *alcon* held by its legs and apparently jaws, and did not drop it until it came in full collision against an impediment (piece of sponge). The *alcon* larva looked well and seemed a little larger than recently. Recent measurements have been 5 mm. slightly under than over.

May 18th. Alcon larvae looking better, plumper, segments full and rounded and incisions well-marked, and colour paler. This improvement in the *alcon* larvae coincides with two points in their surroundings, the temperature has been much higher for some days in my room, to-day, e. g. 71° (21.6° Cent.). Previously it was very low never up to 60° (15.5° Cent.), oftener 50°-54° (10°-12° Cent.). The other change, perhaps also dependent on the temperature, is that the ant larvae appear to be about fully grown, having till recently been, though in last instar, only about half-grown.

May 26th. The *alcon* larvae look plump and fat and paler and are nearer 7 mm. long than 6 mm., and are more active than they were, bending and reaching about. The ants still carry them about when the nest is disturbed by letting in light. The

colour is a lively rose, slightly darker perhaps than " La France ". Not quite what Ridgeway calls *La France Pink* (3. o. R. f.) but nearer an intermediate between his Deep Rose Pink and Rose Colour (71 V-RR *d* & 6).

May 29th. Larvae much the same, fatter if anything; though they must be 6 or seven times the bulk *not length*, &c., they were at end of winter, nothing has yet been traced as to how they feed, they are not seen feeding, no sucked out ant larvae are found in midden, nor is any *alcon* frass detected.

June 1st. Each of the two larvae is now 9 mm. long, looks as if it might moult soon, the skin being stretched and the incisions expanded and opened. Nothing has been observed to shew how they are fed, one is inclined to suspect that the ants feed them, as there is no direct or other evidence that they eat or suck the ant larvae. The ants are well supplied with dead diptera and honey, and their own larvae are many of them very large and fat.

June 3rd. No. 2 nest larva of *alcon* is seen with head in ventral sinus of a full grown ant larva; and its thoracic segments curved round the ant larva, so that it holds it partly by this grasp round it, partly probably by its jaws. Curiously a sucked ant larva is found in the midden of this nest; though none have been found for many weeks, though looked for whenever nests examined. The skin of *alcon* larva looks very tight and glazed.

June 12th. Larvae much the same, one when rather extended was 10 mm., the skin is very tense smooth and shining, and there is a depression but no fold or overlap at the incisions. To-day it is noticed that both Larva 1 and Larva 2 are not with the mass of the brood, but at a separate point, away from brood in No. 2 and with some smaller ant larvae in No. 1. There are, however, a fair share of ants in attendance in both cases.

June 15th. No. 2. *Alcon* being in a favourable position for measurement, was found to be 10 mm. long, more rather than less.

June 18th. (6.30 p. m. Greenwich Time). No. 1 *alcon* was found lying on his back with his head bent down towards abdominal aspect of about 1st abdominal segment, and held between his head and body there appeared about one-third (1/3rd) of an ant larva, the remainder obviously eaten (or collapsed fom contents being sucked).

June 22nd. No. 2 *alcon* seen on his side with head pressed close to ventral surface about 3rd thoracic, as if holding there something he was eating, the portion of ant larva, if so, had become too small to project into view.

June 25th. Both larvae have the skins very tense and shining. One measured yesterday was 11 mm. long. It is rather ludicrous to see the ants endeavouring to move about these larvae so much larger and heavier than themselves, in which, however, they are not altogether unsuccessful. No search for *alcon* frass or remains of sucked ant larvae, as numerous as found in the autumn, has had any success; it may be mentioned than an ant pupa half-eaten (or sucked) at least damaged and collapsed was seen close to *alcon* larva, who had no doubt been eating it, but his actual contact with it was not seen, uncovering the nest &c. had no doubt disturbed it before it was noticed.

June 26th. No. 2 *alcon* quite straight measured 12 mm., not stretched, as its tense skin would obviously admit of little stretching. No. 1 with a slight curve measured 11 mm.

June 29th. Both larvae happening to be favourably placed for the purpose were measured and found to be 12 mm. long in each case, the tint is decidedly paler than it was, may be described as pale flesh-coloured, the skin seems less tense than a week or two ago; the incisions are not so deep, suggesting that the skin has grown and stretched.

July 1st. The larvae of *alcon* are (especially No. 2) often away from the ant brood, they are fat, and comparatively pale. The skin is very delicate and not only the dorsal vessel but all the fat masses are very plain beneath it, the hairs are very scattered, but very obvious, being dark on a pale back-ground, obvious, that is, under a high-power hand lens. The flesh colour is pale and is seen to result from a coloured layer, superficial to the fat masses and hardly distinguishable from the skin. The attempts of the ants to remove them, in which they have but trifling success, are rather ludicrous. If the ants were as stout as the larvae of *alcon*, the latter would be 25 to 30 times their bulk, but as the ants are much more slender and at the waist very exiguous, the larvae of *alcon* must be more like 100 times the bulk of an ant.

July 9th. For several days the *alcon* have been more lethargic and yesterday and to-day are quite so, and the thoracic segments are slightly longer and rounder and there is a slight waist at 1st abdominal segment, the appearances strongly suggest that pupation and not merely larval-ecdysis is contemplated.

July 10th. No. 1 *alcon* is found at 11 a. m. changed to pupa, the abdomen is similar in appearance and coloration to the larva, the thorax is whitish, the appendages (legs, wings, &c.) are of glassy transparency and of the faintest grey tint. An ant is seated on the pupa, the cast larva skin is missing, carried off, of course, by the ants, but it is not seen in midden or elsewhere. The position of the pupa is the same as the larva had yesterday, quite alone, 70 mm. from brood nest. The ants, however appear to visit it frequently. The wings, &c., have extended downwards a good way beyond that noticed at 11 a. m. when the change to pupa must have therefore been very recent. The colours are still larval, but the form and proportions are now that of a pupa, length 12 mm., dorsally thorax 4 mm., abdomen 8 mm., ventrally head to end of wings 9 mm., abdomen 3 mm.; height, at 3rd abdominal segment 4 mm., at thorax 3 mm. The free portion

of abdomen, probably has to do some shrinking and bending ventrally, or rather shrinking of ventral aspect, so as to bring the end to a ventral aspect.

July 10th. (4 p. m.). No. 2 *alcon* is found to have moulted to pupa. There is a dark substance over the last segment, which is probably the cast skin, and at this an ant is tugging, whether to help the moult of for what purpose is doubtful.

5 p. m. The pupa still has the cast skin (?) attached and has been moved a matter of 70 mm. by the ant or ants, but is at present at rest but with three ants in attendance.

Not feeling clear as to the relation of ants and pupae and with suspicion that the larvae, having for some days been at a distance from the brood nest, were really seeking a place away from the ants in which to pupate, I have barricaded each of the pupae in a corner of the nest where the ants cannot reach them, this may or may not prove to be a proper proceeding.

It is certainly difficult to believe that the fat, lethargic larva, stiff and helpless by the tense distension of its skin could by its own efforts find a suitable puparium inside or outside the ants' nest, but it is the case that the wandering of the larva from the brood nest during the last week or ten days was assisted, if not entirely managed by the ants. It is also, of course, the fact, that my observation nests afforded no suitable place apart from that occupied by the ants, whether it was to be reached by the larva's own efforts or by the assistance or complete management of the ants.

July 12th. The thorax, wings and appendages of No. 2 have become of an olive-brown colour. No. 1 is only slightly darker than at first, both have the last segment more bent very ventrad, so that the medio-ventral line of the abdomen beyond appendages is very short as usual in Lycaenids.

July 14th. Pupa of *alcon* in No. 2, length 10 mm., height at 4th abdominal segment 3.5 mm., at meso-thorax 3 mm., at

5th-6th abdominal segment 2.5 mm. The special feature of the pupa is that the wings are fairly straight down to 6.3 mm. from anterior end and then suddenly bend all along their hind margin, so that their surface is directed as much backwards as outwards, for about 1 mm. of their length, and rather over 0.5 mm. of the length of the pupa. This results in the remaining abdominal segments (2 mm. in length) having a ventrad curl instead of the usual lycaenid form of their ventral surface being in line with the appendages. The colour of the abdominal segments is a light warm reddish brown, with dark brown spiracles, the thorax and appendages are a somewhat olive-tinted brown, looking rather translucent as if fluid. The fine sculpture hairs, etc. (if any) must await a mounted shell.

July 14th. No. 1 pupa *alcon*, in form agrees with No. 2, is larger, 11 mm. long, abdomen pink or flesh colour, thorax and appendages very pale ochreous looking, soft and transparent, abdomen not transparent looks solid but soft.

July 15th. No. 2 *alcon* collapsed, the change of colour obviously was due to the death of pupa. It had lain in nest when first changed close to a discoloured surface due to decay of ant food, this may or may not have been the cause of the death.

July 23rd. The No. 1 pupa now shows the wings opaque, as if the wings within were white and solid, beneath the transparent pupa shell, as is probably the case, beyond Poulton's line the contents appear to be clear fluid.

July 25th. The eyes show a rather darker tint than their surroundings.

July 26th. Eyes distinctly brown. The wings show the wings of the imago apparently white, but slightly ochreous as seen through the transparent pupal skin, which has that tint. Round the hind-margin the wings are some 0.5 mm. short of their pupal cover, where owing to its inclined surface, it presents a consi-

derable depth of space, seemingly filled with clear fluid, which looks, however, quite dark, by contrast with the whiteness of the imaginal wings.

July 27th. Eyes nearly black.

July 30th. Eyes and antennae nearly black, wings creamy with a pink tone.

July 31st. Pupa very dark, nearly black; underside of abdomen still brownish, wings shot blue with a black border.

August 1st. Pupa becoming whitish, first (early) at wing bases, now (later) nearly all over, due to absorption or evaporation of fluid between the insect and the pupa case, the layer of air admitted, giving a white appearance, modified a little by the insect beneath. But the blue of wings is much less definite and obvious than it was yesterday morning when in wet contact with the pupa case.

August 2nd. A ♂ *Lycaena alcon* emerged this morning.

The changes in the colouring of the pupa as the imago matures are much the same as in other Lycaenid pupae, but the delicacy and transparency of the pupal skin are much greater than in most other species, so that the changes are more definitely seen and especially the whiteness due to the entrance of air between the insect and the pupal skin is only equalled in a few Heterocera with delicate pupal cases.

Some details of the pupal skin are shown in Figures 15-20. There are a good many small branched hairs; they are about 0.075 mm. long and divide into, usually, four diverging spicules at about half their length. They are shown in Fig. 20 (x 200). They may be seen less magnified in most of the other photographs. They occur all over the pupa, except on the head and appendages, and are most numerous near the spiracles. In Fig. 15 showing the head cover, the photograph omits the dorsal extension and dorsal head piece, which are indicated in dia-

grammatic outline. Figs. 15 and 16 are not in alignment, but the distance between them (measured on the photographs) is about 12 mm., a portion of the dorsal head piece appearing in Fig. 16. There are very small lenticles over the same areas as the spicular hairs, perhaps more numerous near the spiracles, most numerous on the prothorax (Fig. 16). There are several on the anterior legs at an articulation and one is seen on one of the second pair of legs. There are a few cremastral hairs, very short (about 0.07 mm.) and with ends that obviously represent the anchor-like end often seen in cremastral hairs; they are small knobs transversely widened and overhanging towards the base, there is often a bend just below it. They must be functionless and are only vestigial. On the dorsum of the seventh abdominal segment, is the conspicuous scar of the honey gland, a transverse mark wider at the ends, where the tissue is so thin as to look like two apertures.

The Life History of *Lycaena alcon* proves therefore to be quite parallel to that of *L. arion* but amongst the points of difference there is one that is of a remarkable character. Both leave their plants and are accepted by the ants as very small larvae, but in the case of *L. arion* this small larva is in the fourth instar, remarkably small for that stage but with a panoply of skin hairs and tubercles very closely packed and suitable for a much larger larva. It undergoes no further moult.

L. alcon leaves the food-plant in the third instar, and instead of being like the larva of *L. arion* specially equipped with hairs, etc., that would be suitable when it becomes a larger larva, it is to all appearances an ordinary third stage Lycaenid larva, exactly parallel to those of the Plebeiid and other Blues that go into hybernation in the third instar. Like *L. arion* however, it undergoes no further moult, and presents the remarkable and I believe unique character of a Lycaenid larva that has only two moults (three instars).

One corollary of this is that when full-grown, the larva, not being provided with a special arrangement of hairs, etc., in view

of the increase of size, has an ordinary third stage skin very much stretched and distended, so that :

1. The hairs, etc., though present, are those suitable to an ordinary third stage larva and are, till looked for, practically invisible.

2. The colouring matter which lies immediately beneath the skin and made the larva when it leaves the gentian a dark red brown, is attenuated so that the larva when 7 or 8 mm. long is a pale flesh colour, and when full grown shows only some pink shading.

3. The larval skin is so stretched and attenuated that the fat-bodies are very conspicuous in a way rarely seen except in some internal-feeding larvae and that I have certainly never seen in any other butterfly larva.

Lycaena alcon, then, dropped the third moult, and managed to feed up to full growth in an unmodified third instar skin. That in once had a third moult is not only certain from the rule in other Lycaenids but is confirmed by my lucky observation that it may on rare occasions revert to having a third moult. That the larva died, by no means proves that such a reversion has necessarily a fatal result, as this larva had considerable experiences of travel by post and was not improved in health by my examinations and disturbances of it at this critical moment. The fourth instar in this specimen presented an ordinary skin panoply and nothing like the special fourth stage skin armature of *L. arion*.

It seems probable that the common ancestor had a history something like that of *L. alcon*, but in the fourth instar. From this condition, *L. alcon* progressed by dropping a moult, *L. arion* by assuming a special fourth stage skin armature, or rather perhaps, it retained a proper fourth stage armature, which looks special owing to the dwindled size of the larva on entering the fourth stage.

Another difference between *L. alcon* and *L. arion* is that *L. arion* eats the whole of the ant larva. I found no evidence that *L. alcon* did so and in the autumn at any rate it only sucked the juices of the ant larvae. In the spring, if it eat up the ant brood, it was only the pupa that it completely devoured, if it did so. In the spring I found few if any remains of sucked larvae, nor did I find any frass of *L. alcon*, if there was any it must have been in very minute pellets indistinguishable from those of the ants.

This and various other points require further observations, in various directions, my observations were directed especially to getting the larvae to complete their life-history and I avoided all disturbances I could, and anything that might injure the health and temper of the ants. I had only four larvae duly adopted by the ants, they were all in poor weak nests of ants, obtained by myself in the emergency of providing at once for the larvae received, and I had to make the actual observation nests at the same time, at all of which I should claim too high a status if I called myself an amateur. Later, one of my nests quite failing, Mr. Donisthorpe most kindly supplied me with a good nest, and the ants therein accepted the transferred larva of *L. alcon* for a time, but then destroyed it, probably not because it was *L. alcon*, but because it came from another nest.

It is noteworthy that neither species, *alcon* and *arion*, has a larval moult during its life with the ants, yet it would appear that if it did it would not be in any danger from the ants whilst moulting. The ants were present during the moult to pupa of both the *L. alcon*, and seemed, if they did anything, to desire to give assistance, just as they do with their own brood in the emergences of the imagines. Possibly they similarly assist in larval moults of their brood, but I have seen nothing to confirm this view. Though I shut off the ants from the pupae, they several times happened to reach and seemed quite solicitous about them. I removed the healthy pupa from the nest two

days before its emergence, chiefly because the nest it was in afforded no space for wing expansion; the loss of ant attention was certainly not harmful.

Captain Purefoy, who has had the satisfaction of successfully rearing *L. arion* to the imaginal state, tells me that the ants are quite friendly to its pupa, and that the imago emerges whilst the pupa has ants in attendance, the butterfly making its own way out of the ant's nest.

September 1918. There are two points of difference in habits between the larvae of *L. arion* and *L. alcon*, that should be noted. One of these has long been known. *L. arion* during its life on the thyme is an insatiable cannibal. Naturally, only one egg is laid on a head of thyme and this propensity cannot be indulged, but in captivity, if it be not kept in mind, the numbers of the larvae being fed diminish rapidly. *L. alcon*, on the other hand, lays a good many eggs on a flower, whether by different mothers I don't know, but the larvae live amicably together, even as many as half-a-dozen in one flower.

The other point is one that I observed last year, but not in sufficient instances to satisfy me, that perchance, want of observation was possibly more in question. This season, however, confirms last year's observations, and Captain Purefoy remarks (in litt.) the same facts. When introduced to the ants, there is, with *L. alcon*, none of the remarkable and elaborate ceremonial that takes place with *L. arion*, various ants hardly notice the larva, but the one that does, almost at once, picks up the larva in almost any way and carries it into the nest, the larva itself being as unresponsive as it afterwards is in the nest, when the ants carry it about in changing the place of the brood nest.

Sept. 13. Mr. Donisthorpe writes on 12th that larvae of *L. alcon* introduced into nests of *Tetramorium caespitum* on 9th and 10th are all dead; he sends their remains and of these four are without any sign of injury; the other three are doubtful. He says :

" I never saw any direct attack, but the ants seemed to me to carry them about far too much, lugging them from chamber to chamber and dumping them down, falling down with them from the walls of the nest, etc. "

When sent to Mr. Donisthorpe, the larvae all seemed to me to be in good and proper condition, and the majority must certainly have been so.

September 19th 1918. Placed a larva of *L. alcon* in an unoccupied corner of an observation nest of *Myrmica laevinodis.* When, in a few minutes the disturbance brought the ants to the spot, the ants ran over it, a few examined it for a second or so with their antennae and passed on. The *L. alcon* larva, however, almost as soon as the ants came to it, bunched itself up in the *L. arion* manner, the head being close to the third pair of legs and the thoracic segments much swollen, so that the incisions were stretched and showed a smooth and paler area. The ants, however, took no greater notice than immediately before. A few minutes later, the ants ceased to bustle about so much and shortly one ant took more notice of the *L. alcon* larva, licking it over, especially the thorax; it never approached the honey gland region, it had approached it from the head end. After about half a minute, it desisted, withdrew, and cleaned its legs and antennae, and then disappeared amongst the other ants. In less than a further minute, an ant, I have no doubt the same one, came in a business like way, got behind the *L. alcon* larva, seized it between the thorax and abdomen and carried it off. It made no preliminary examination, but did this at once; a fresh ant would certainly have spent some time in examining the larva. No ant got any honey from the *L. alcon.*

This observation shows that my failure to see such a scene before, was somehow due to my default, and not due to *L. alcon* not behaving like *L. arion* as I erroneously concluded.