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Notes upon some aquatic Hymenoptera

(Anagrus Brocheri SCHULZ
Prestwichia aquatica LUBB., Agriotypus armatus WALK.)

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In 1918, the author gave an account of all then known aquatic Hymenoptera of Europe (1), in which was collected facts gathered from litterature as well as a considerable number of hatchings of different forms, not hitherto mentioned in litterature.

Only in few instances I had so much material myself that I could follow the developmental stages of a species, but in *Anagrus, Prestwichia* and *Agriotypus* I fortunately had enough for that purpose, and I thank Mr J. A. LESTAGE for kindly proposing me to publish the results respecting these forms in this periodical.

1. *Anagrus Brocheri* SCHULZ.

It is a well known fact that two species of *Anagrus* are bound to freshwater, viz. *subfuscus* FÖRSTER, and *Brocheri* SCHULZ.

Anagrus subfuscus FÖRST. was reared by HEYMONS (2) from ,, *Calopteryx virgo* ''—eggs inserted in the underside-tissue of *Nymphæa-* and *Nuphar*-leaves; RUSCHKA and THIENEMANN (3) reared it from *Agrionine*-eggs in leaves of *Stratiotes* and *Nuphar*; RIMSKY-KORSAKOW (4) records it from *Agrion-* and *Lestes*-eggs in the underside of *Nymphæa-* and *Nuphar*-leaves and in *Calla*-stalks. The eggs placed in the underside-tissue of Nymphæacean leaves originate, as reiterated Danish rearings (by Dr.

(1) *Entomol. Meddel.*, XII, 1918, pp. 137-251.
(2) *Deutsche Entom. Zeit.*, 1908, p. 141.
(3) *Zeit. wiss. Insektenbiol.*, IX, 1913, p. 82.
(4) *Revue Russe d'Entom., XVI,* 1917, pp. 22-225.

WESENBERG-LUND and by myself) have shown, in *Agrion pulchellum*, which thus may be regarded as the normal host of *subfuscus*.

GANIN (1) in his well-known paper upon the development of several parasitic Hymenoptera has described the larval stages of a « Polynema », which, according to his drawing (13-jointed antennae a.o.), must belong to the genus *Anagrus*. As it was reared by GANIN from *Agrion virgo*-eggs in the underside tissue of *Nymphæa*-leaves (i.e. from *Agrion pulchellum*), and as I have followed the development of the second aquatic *Anagrus*-species viz. *Brocheri* and found the larval aspect of this latter not to be identic with the form described by GANIN, I feel quite sure that the species of GANIN belongs to *subfuscus*.

Anagrus Brocheri SCHULZ was reared by BROCHER (2) from Agrionid-eggs inserted in a piece of *Phragmites* found floating on the water, and also from *Agrion pulchellum*-eggs in *Nymphæa*-leaves.

In the peduncle of the Brandy-bottle (*Nuphar luteum*) the oviposition of the zygopteron *Erythromma najas* is often found in Denmark. These eggs are very often parasitized (1 parasite in each egg), generally by *Prestwichia*, but in one locality, Funkedam at Hillerod, also by an *Anagrus* which is quite agreeing with *Brocheri*, except in two characters viz. the ovipositor not being darker colored than the body, and the scutellum being whitish; but I do not think these two characters alone sufficient for establishing a new species, and thus I regard my specimens as true *Brocheri*.

I have followed the development of this species and find it to be in the general features agreeing with that described by GANIN. For comparison, I reprint some of the figures of GANIN together with those representing the larva of *Brocheri*.

Of the 1st larval stage of this latter, I have only seen the final form having the head end lobate separated from the body through a constriction (fig. 2 A) just as in GANIN (fig. 1 C). Length 0,18 mm. The young Histriobdellid stage (fig. 2 B) is very much alike the mature larva of GANIN (fig. 1 F), and not so much

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(1) *Zeit. wiss. Zool.*, XIX, 1869, p. 417.
(2) *Ann. Biol. Lac.*, IV, 1910, p. 177.

alike his younger form (fig. 1 D and E). It will be seen that the antennae are directed forwards and not so much downwards as in the larva of GANIN, they are also relatively shorter than in this, and this especially holds good for the processes from 6th segment which are very short and not much thicker than the antennae, while in the larva of GANIN they are large, broad and auriculate.

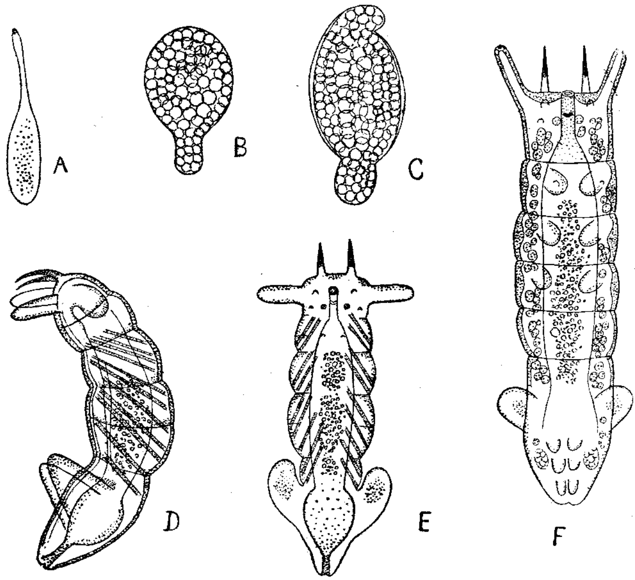

Fig. 1. — *Anagrus ? subfuscus* FÖRST.
A. Egg. — B. 1st. larval stage, newly hatched. — C. The same, head end separated.
D. E. Histriobdellid larval stage. — F. Mature larva. — (Copies from GANIN.)

If we observe through the translucent egg-shell an *Erythromma*-egg, having this stage within itself, the parasite is seen to be very turbulent, it turns and bends in different directions, so that all the contents of the egg will be incessantly circulating around it. It moves its mouth-hooklets, and, in contradistinction to the larva of GANIN the antennae of which are described as immovable, the antennae of *Brocheri* can be moved and shortened, and even quite retracted. The gut fills most of the body (its limits are indicated in fig. 2 B) and opens in the posterior end of the body. In larvæ having reached a size of 0,51 mm (fig. 2 C), I never found any other appendages than the mouth-hooklets. Whether the antennae and the processes from the 6th segment have disappeared on account of a mere distention of the body-wall or after an ecdysis, I have not been able to decide, I however think after an ecdysis. In the interior of the body, the imaginal discs and the shape of the pupal organs now can be seen (fig. 2 D), in the general features as in the larva of GANIN. The largest larva measured had a length of 0,63 mm.

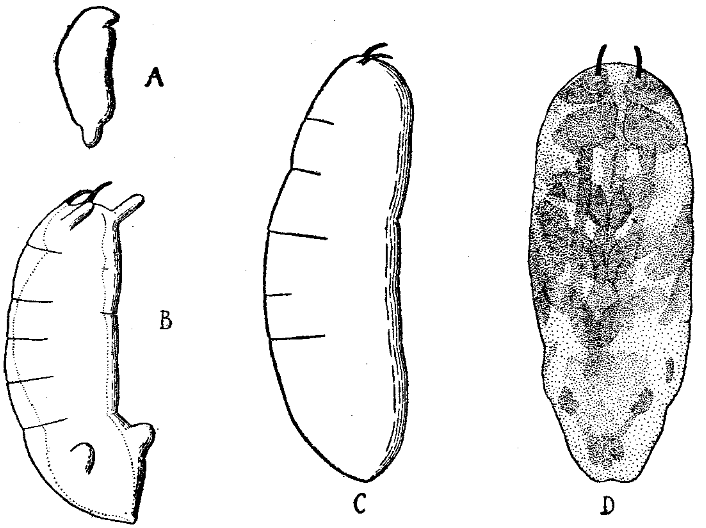

Fig. 2. — *Anagrus Brocheri* SCHULZ.
A. 1st larval stage, head end separated. — B. Histriobdellid stage.
C. D. Mature larva, in the latter the pupal organs are seen. — (All figures enlarged × 100.)

It seems as if the Histriobdellid stage is peculiar to the genus *Anagrus*, as besides the two here mentioned species (*Brocheri* and *subfuscus*) we also are acquainted with a third species, *Bartheli* TULLGR. (1) in which a Histriobdellid larva occurs. The larva of *Bartheli* represents an intermediate form between the two others, in as much as the mature larva has mouth-hooklets and short antennae but no processes from 6th segment.

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(1) *Meddel*, N° 132, Centralanst. försökvâs. jordbruksomr. Stockholm, 1916, p. 9.

When the imagines of *Brocheri* have emerged from the host egg, they will try to get up to the surface of the water walking on the *Nuphar*-stalk or on the glass-side of the aquarium, and they will never try to swim. When they are shaken off from their substratum they will only at last wriggle their bodies without purpose and start with their legs, but no swimming motions can be seen, neither with legs nor wings.

Just as in other known parasites of submerse eggs nor *Anagrus Brocheri* is surrounded by any air-bubble when swimming· this is quite natura las the eggs from which they hatch have no air-supply, and imagines met with in the water must surely (most or all) be considered as newly hatched specimens on passage from the host to the air; when catching chance specimens of these little parasites (*Caraphractus, Anagrus, Prestwichia*) in open air waters I always found males as well as females.

2. *Prestwichia aquatica* LUBB.

Within the genus *Prestwichia* only one species, *aquatica*, is known. Another species, *solitaria*, has certainly been described by RUSCHKA and THIENEMANN (1) morphologically especially characterized through the lacking of wings, biologically through the solitary occurrence in Odonate-eggs, while *aquatica* is reared in numbers from its host eggs.

The species *solitaria* however does not hold good, I have had in hand a great many specimens of *Prestwichia*, reared and caught, and it is quite evident that all belong to one species, yet appearing in three different forms:

The typical form, which most of the former investigators (LUBBOCK, WESTWOOD, ENOCK, WILLEM, ROUSSEAU, HEYMONS, RUSCHKA a. THIENEMANN, USSING, RIMSKY-KORSAKOW) hare had in hand is characterized as follows: *Female*: fullwinged, black brown, the hind-most part of thorax, the ovipositor, antennae und legs yellow. *Male*: with rudimentary wings, quite black-brown. Length 0,5—1,3 mm.

A variety for which I propose the name *var. brevipennis*, differs from the typical form of the female having short wings only partly covering the abdomen. This form is already men-

(1) *Zeit. wiss. Insektenbiol.*, IX, 1913, p. 82.

tioned by BROCHER, in his figured specimen the wings reach midway on 5th segment; this form I have had in a very great number; in my material, the wings are varying in length, when shortest reaching into 1st abdominal segment, when longest reaching into 4th segment. The legs are a little longer than in the typical form. The female colored like the typical form, the male unicolorous, but of a paler brown. Length 0,5—0,8 mm.

The second variety, *var. solitaria* RUSCHKA and THIENEMANN, has been mentioned by these two authors (as a separate species), and by RIMSKY-KORSAKOW (1), and also I have hat it in number. The female differs from the typical form by having just as rudimentary wings as the male; it is a little more clumsy than the typical form, especially the legs a little shorter and the head a little broader. Also more scanty set with bristles. The colour in both sexes paler brown with hind part of thorax, antennae and legs pale. Length 0,4—0,7 mm.

As it will be seen, neither the length of the wings nor the colour are characters allowing the maintenance of *solitaria* as a species, it is only a variety just as *brevipennis*.

Neither does the solitary occurrence in the host egg hold good as a character, as var. *brevipennis* can parasitize singly (in small eggs) and in numbers (in big eggs), the number of parasites thus appearing to depend on the size of the host egg.

As hosts for the typical form are recorded: by ENOCK (2), *Notonecta-*, *Dytiscus-* and *Colymbetes*-eggs; by RIMSKY-KORSAKOW (3), eggs of *Dytiscus* and smaller Dytiscids in *Alisma-* and *Calla*-stalks; by HEYMONS (4), *Ranatra linearis-eggs*; by USSING (5), *Aphelocheirus Montandoni*-eggs.

The number of individuals would amount to 50 in an egg. This form I have reared from a *Dytiscus*-eggs in an *Alisma*-stalk, in Hjorteso near Hillerod; the number of parasites was 9.

Var. brevipennis I have reared from *Agabus*-eggs, in *Ranunculus lingua*-stalk Funkedam at Hillerod (5—8 specimens in each egg), and from *Erythromma najas*-eggs in *Nuphar*-stalks Bagsværd So (1 specimen in each egg)— thus in the large eggs of Dytiscids as well as in the small ones of Odonates.

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(1) *Revue Russe d'Entom.*, XVI, 1917, p. 211-224.
(2) *Ent. Month. Mag.* (2) IX, 1898, p. 152.
(3) *L. c.*, pp. 215-224.
(4) *L. c.*, p. 138.
(5) *Intern. Revue ges. Hydrobiol. und Hydrogr.* III, 1910, p. 115.

Var. solitaria was reared by RUSCHKA and THIENEMANN (1) from Agrionine-eggs in *Stratiotes* (1 specimen from each egg), and I have reared it from *Erythromma najas*-eggs in *Nuphar*-stalks Funkedam, and from *Graphoderes*-eggs in *Alisma* Hjorteso at Hillerod (also one specimen in each egg)— thus only in small Odonate-eggs.

The host eggs can be infested in all developmental stages, yet I have not found parasites in mature host-embryoes, which agrees with the statements of RIMSKY-KORSAKOW. This author remarks that a female can lay up to 50 eggs. I have not seen a *Prestwichia* lay so great a number, and a dissection of the abdomen of newly hatched but fertile females of *var. brevipennis* showed at most only 30 eggs.

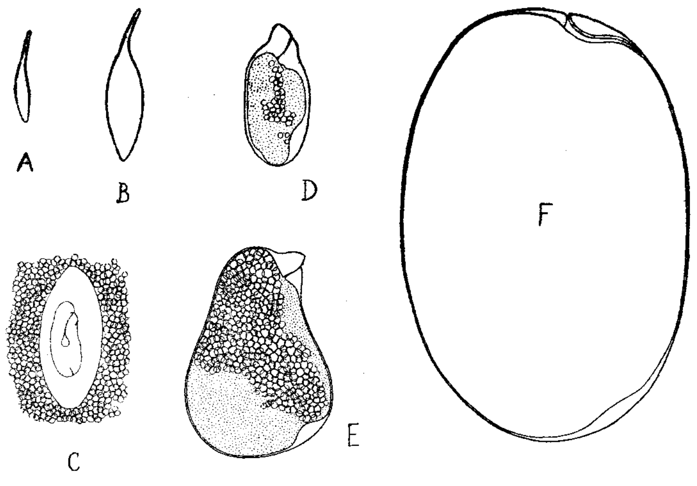

Fig. 3. — *Prestwichia aquatica* LUBB.
A. Ovarial egg. — B. Deposited egg. — C. Egg containing an embryo in the yolk of the host egg D. E. F. Free larvæ in different size, seen from the side. — (All figures enlarged × 60.)

I have followed the development of *var. brevipennis* from egg to imago. The ovarial egg ready for oviposition is fusiform, pedunculate and measuring 0,222 mm. (fig. 3 A). Within a day from the deposition the egg has increased very much in size, up to 0,382 mm (a fact which is already known from the deve-

(1) *L. c.*, p. 83.

lopment of *Smicra sispes*, according to HENNEGUY (1).— Vide fig. 3 B, and 4 A.—A great many nuclei can now be seen lying close to the egg wall while a nucleolus is seen as the large cell in the posterior end of the egg.

The youngest embryo I have seen is figured in fig. 4 B and C; it is 0,192 mm long and simply bag-shaped; only dorsally is seen a furrow separating a head from the rest of the body; on the ventral side, is seen a transversal fissure anteriorly, the mouth, which leads into a narrow gut which terminates in an enlarged midgut without any outlet; on the ventral surface, there is a heartshaped aperture below the mouth, leading into a pair of glandiform organs, surely representing the salivary glands.

RIMSKY-KORSAKOW mentions that no anus is present, but this is an error; as seen on my figure 4, an anus can easily be discovered, and from this anus an endgut leads in between some large body cells where it disappears without having any connection with the midgut. Any other organ is not present in the larva. RIMSKY-KORSAKOW mentions to be sure a little ganglion in front, but I have not been able to confirm this statement.

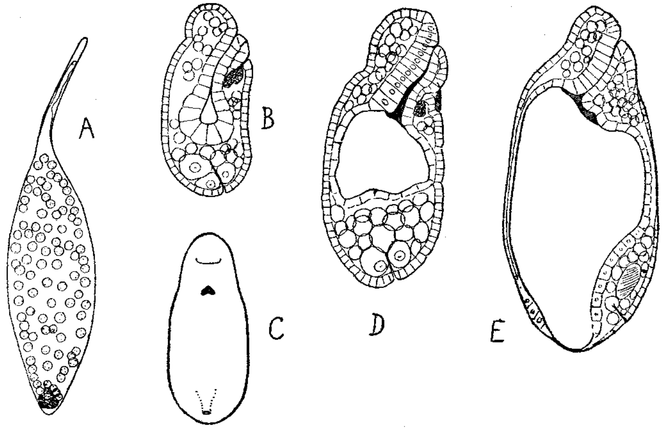

Fig. 4. — *Prestwichia aquatica* LUBB.
A. Egg. — B. C. D. Embryoes. — E. Free larva. — (Fig. C is seen from the ventral side, the others from the side and in cut.) — (All figures enlarged × 150.)

(1) Les Insectes, 1904, pp. 314-337.

This young embryo, when examined on microtomous cuts, is always found liyng in an ovalshaped membrane (see fig. 3 C) which, according to its size, must be the egg shell having taken this regular oval form now. The embryo does not quite fill the egg in its new shape, on the contrary it lies in a very much comminuted medium (yolk) which cannot originate in the egg itself, as this like that of other parasitic Hymenoptera has no yolk. The yolk found in the *Anagrus*-egg therefore must have been absorbed through the membrane from the yolk of the host egg. This latter yolk, however, consists, of large, bright and round globules and nothing else, these yolk globules thus must be resolved in order to pass through the egg-membrane, and most likely the large salivary glands of the parasite will play their parts in this act of resolution.

Little by little the embryo will grow, in fig. 4 D an embryo 0,255 mm in length is figured, the stomach of which has widened considerably from taking up food. When we regard a living embryo (or later on the free larva) lying in its food-mass it will be seen that in contradistinction to the *Anagrus*-larva most of the body is quite immovable, only the head changes its shape, the mouth lips are incessantly seen to move as if reaching for and swallowing more and more of the yolk surrounding the embryo.

I have not seen any embryo of more than 0,255 mm in length lying in the egg membrane; when about of that size it will burst through the membrane and find its way into the yolk of the host egg as a free larva.— Fig. 3 D and 4 E show such a newly hatched larva, 0,297 mm in length. The stomach is now so widened that it takes up most of the body, only posteriorly on the underside there is a thicker part where the end gut and the organs of sex are now to be found. As may be seen from fig. 3 D, we now find in the stomach some not-transformed yolk globules which it now directly can swallow. It must be noted that I have not been able in this stage (and in larger ones) to discover any salivary gland, they have been reduced, surely because no more resolving of the yolk globules is needed.

After this the shape of the larva becomes more and more undistinguishable, the larva only will swallow more and more of the surrounding yolk without making any attempt to digest it at the same time.— Fig. 3 E represents a larva of 0,462 mm size, it still displays a protruding oral part, and most of the body else very much distended. The contents of the stomach are mostly unaltered yolk globules, but some of them have now been decomposed and comminuted. The larva swallows and swallows, increasing in size until it has reached its maximal size at 1,24 mm, mostly resembling a mere bean or egg, the body wall being enormously distended so as to form a very thin membrane, even the head cone cannot be distinguished any more exteriorly, only in cuts (fig. 3 F). Now at length the yolk will be digested, the imaginal discs are formed, and pupation takes place, during which the excrements are deposited in the host egg as whitish masses between the pupae.

The whole developmental process takes place in the course of 11-15 days, of which only few days are taken up by the first stages before the regular bean-form in its maximal size is established. The pupal stage lasts 10-13 days.

ENOCK has recorded that the copula takes place as early as in the host (Dytiscid) egg before the *Prestwichias* have hatched from this; he declares that in all the parasitized Dytiscid eggs found by him (about 12) he has seen I or more pairs in copula. Also RIMSKY-KORSAKOW confirms this statement as he declares to have seen through the egg shell the copulation which will last 10-15 seconds, and seen that one male can fecundate all the females in the same egg little by little, if he is the only one present. Upon the whole the imagines in the host egg are said by RIMSKY-KORSAKOW to be very agile and vivaceous.

This does not agree with my observations which do, on the other hand, agree with those of HEYMONS. In the great material which I had at my disposal (of *brevipennis*) I never saw any copulation take place in the host egg, on the contrary all imagines will lie quite motionless until at last one lying next to the shell will gnaw a hole in it and escape, then after a while the specimen which is now next to the hole—and only tha one—will move, turn round and escape, and thus one by one will successively awake to activity, surely because oxygen from the water will more and more penetrate into the egg from the hole. As HEYMONS states we can scarcely believe that a process as copulation which surely must cause an increased consumption of oxygen should take place in the thick-shelled and oxygen-poor host-egg. ENOCK and RIMSKY-KORSAKOW as well as HEYMONS and I are quite sure of having observed exactly, but it passes my understadig how so widely differing observations can be made.

It is characteristic of *Prestwichia* that much more females than males are present. RIMSKY-KORSAKOW maintains that the differences in number is not great (when three parasites are found in one egg 1 will appear to be a male and two females, and when only t°o parasites are found often one will appear to be a male and one a female), but I have found in my material that the females exceed the males very much in number, in a certain material reared from *Agabus-eggs* I thus ad 75 females and only 4 males, which corresponds with the rearings of ENOCK. These differing numbers surely mean that most of the females will breed parthenogenetically (as in *Rhodites rosae* where, according to ADLER, males are decreasing and parthenogenesis becoming a rule) and this I can confirm, as newly hatched females have oviposited without any copulation in *Agabus*—eggs given them, and larvae have been developed within them (I need not say that I was quite sure that the *Agabus*-eggs used had not been infested before). Also RIMSKY-KORSAKOW states that parthenogenesis takes place, but, according to him, the unfecundated eggs will become males, and the fecundated females. He maintains that males originate in eggs deposited by a female in a host egg in which no male was present and thus without any possibility for copulation (as mentioned before RIMSKY-KORSAKOW says that copulation takes place in the host egg).

My observations do not agree with the above named. As said I bred 75 females and 4 males from a quantity of *Agabus*-eggs, and as 5-8 parasites develop in each egg it may be understood that in most of the eggs only females are present and no male. I have bred more generations in continuity from *Agabus*-eggs and always seen the females greatly surpassing the males in numbers, whereas if RIMSKY-KORSAKOW was right, it should at last have given about mere males. Also in Odonate-eggs where only one parasite is reared from each egg, the surpassing number of females is maintained.

On account of the short developmental time many generations are established in a year, RIMSKY-KORSAKOW states 4 in Northern Russia, I cannot give any statement for Denmark, but 4 is surely the smallest number here. RIMSKY-KORSAKOW mentions that in Russia the 1st generation develops in the large eggs of *Dytiscus*, found in May—June and the 3 other generations in eggs of smaller Dytiscids found later on in the summer. My observations do not allow any statement where the different generations parasitize in Denmark, but it is a fact that eggs of some Dytiscid, bug or Odonate, are always present for each generation of parasites. We might imagine the 3 forms to represent seasonal variations but this does not seem likely as f.i. all 3 forms may be found at the same time (end of July) and at all events the two varieties together through the month of August.

As to the swimming habit of the imago I must state that it does not seem to me to swim cleverly or well. The females use their hind legs, but these long and slender legs having no special adaptations for swimming move just like those of a house fly rubbing and twisting its legs for cleaning purposes.

Var. solitaria which by RUSCHA and THIENEMANN is said to swim ,, sehr geschickt und schnell " is, according to my observations, the poorest in swimming. I often saw it walk along stalks or sides of aquarium with long and eager steps, and it swims by a violent exaggeration of the movements, but it is very unwilling to swim and is upon the whole behind the other two forms in this respect; it wriggles its body and advances much more slowly than the others. The males move distinctly slower than the corresponding females; according to ENOCK they use their middle legs in swimming.

3. *Agriotypus armatus* WALK.

This well known Ichneumon-fly is in Denmark found in Skernaa at Rorbæ so, at Aarhus (both localities in Jutland) and in Lellinge Aa and in a broo near Fonstrup (both in Sealand). The hosts were the Caddis-flies *Silo pallipes* and *Goera pilosa*.

On *Silo*-cases, collected 12/5—15/5, I found when protracting the Silo larvae that 10 of these were furnished with eegs of *Agriotypus armatus*. The egg (fig. 5 A) is 0,7 mm in length, rather elliptical and with a thin peduncle half of which is plunged in the host and thus fixed to him. Around the plunged part is seen a blackish brown sheath of coagulated lymph. Commonly only one egg was found on each larva, but in four instances two eggs were found on the same larva. The spot where the egg was fixed was rather varying, viz:

1. Dorsally right, on the hindmost part of metathorax,
   Ventrally left, between 2. and 3. abdominal segment.

2. Dorsally right on metathorax,
   Ventrally in the median line between 4. and 5. abd. segm.
3. Dorsally right, between metathorax and 1. abd. segment.
4. On the side between metathorax and 1. abd. segm.
   Ventrally right, between 3. and 4. abd. segment.
5. Dorsally right, on 2. abd. segm.
6. Ventrally left, on 2. abd. segment.
7. Dorsally in the median line between 2. and 3. abd. segm.
   Ventrally right, between 5. and 6. abd. segm.
8. Ventrally in the median line between 2. and 3. abd. segm.
9. Dorsally in the median line, on 4. abd. segm.
10. Dorsally left, between 5. and 6. abd. segm.

From this list it can be seen that the oviposition cannot take place, the mother wasp having put the egg in through the anterior opening of the caddis-fly case, surely the caddis-fly larva would defend itself, the head and prothorax can completely cover the opening, and, moreover, the eggs are placed so far backwards on the host larvae that the short ovipositor of *Agriotypus* could not reach so far. The mother wasp thus certainly must penetrate the side wall of the case, the sting is strong indicating that it is used in rather hard work, and the above list shows that most of the eggs are placed on the dorsal side which is of course the easiest to attack.

The young larva (fig. 5 B) of which I have found only one specimen, lives entoparasitically; it is rather hyaline, 13-segmented, on the 10 anterior segments a dorsal row of bristles of which the median ones are the longest. The 3 last segments without bristles and the segments only indistinctly separated. The head seen from above (fig. 5 C) shows two oblique lines ending blindly posteriorly and corresponding to two internal ridges. Posteriorly to them the antennae are seen as two little warts. Seen from below (fig. 5 D) the head appears furnished with two hooklike mandibles which exteriorly will articulate on the fore end of a long chitinous ridge. The gut ends blindly, no tracheae or spiracles can be observed. Length 1,4 mm.

The mature larva already being found very early in summer (my first date is 8/6), the first stage therefore only can be found during a week or at most in the course of a fortnight, and this is surley the reason why I did not succeed in finding more specimens of this stage.

The mature larva, 2nd larval stage (fig. 7 A), which I have found 8/6—20/7, has been described by KLAPALEK (1). When KLAPALEK distinguishes a ,, larva " which for one thing should have the middle segments constricted, from a more barrel-shaped ,, subnymph " this distinction cannot hold good. According to my observations the larva can be astonishing capable

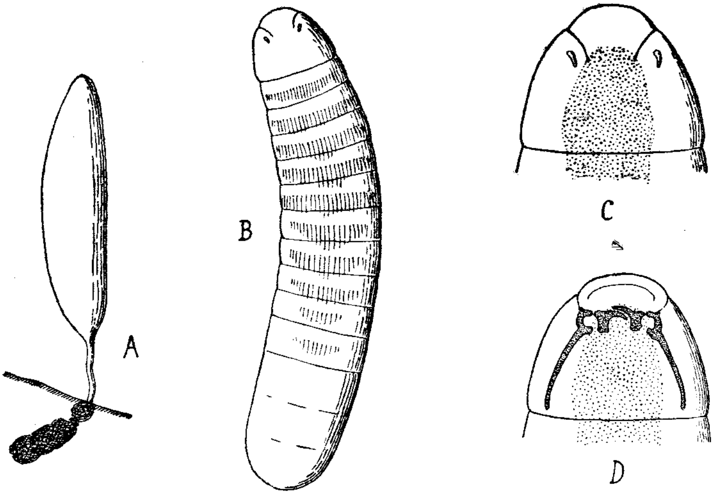

Fig. 5. — *Agriotypus armatus* WALK.
A. Egg. — B. 1st larval stage. — C. Head of this stage seen from above. D. Head from below. — (A and B enlarged × 50. — C and D × 100.)

of changing shape; it can appear rather slender and fusiform, it may be conic with the head end tapering and anal end truncate, or the cone may be the reverse with anal end pointed and head end truncate. The figures C and D of KLAPALEK thus can not indicate two different stages (though fig. D perhaps is a little younger; the segments being a little longer relatively than in fig. C) the apparently characteristic constriction being a quite individual phenomenon, and the mouth parts figured in his fig. F and stated to be those of the larva are identic with those of the 2. larval stage, the subnymph of KLAPALEK, and not with those of (our) 1st larval stage.

(1) *Ent. Month. Mag., XXV*, 1889, pp. 339-434.

The head of the 2nd stage (fig. 6) is relatively small, longish, but most of it is retracted in the thorax and of a whitish color, only few chitinous ridges are seen as a further development of those in the 1st stage. The antennae still are present as little warts. The mouth parts are much better developed than in the 1st stage, a bristle-set labrum is present, the hind part of which is imbedded in epistoma. The mandibles being much stronger and much more strongly chitinized, and their edge now set

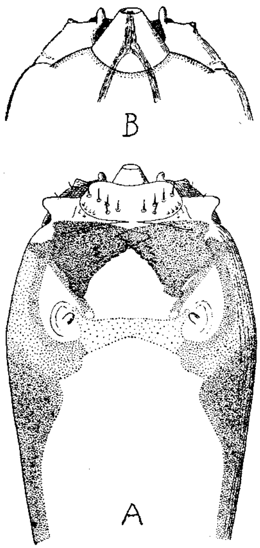

Fig. 6. — *Agriotypus armatus* WALK.
A. Head of 2nd larval stage, seen from above. — B. End of the same seen from below.
(All figures enlarged × 50.)

with more teeth, are situated rather far backwards under the epistoma, but this latter being very feebly chitinized, the mandibles are seen very distinctly from above. The maxillae are softskinned and clumsy, showing a short, wartlike palp and a rather little but somewhat darker lobe. Labium is quite rudimentary and replaced by the big, conic hypopharynx showing the opening for the salivary duct. When KLAPALEK who calls hypopharynx for labium also mentions labial palps, as present, this statement is erroneous. Behind the head are seen 13 body segments of which the uttermost terminates in two hooklike cerci, the function of which I have not been able to discover.

All body segments are set with small chitinous warts, those on 3—7 segments being the strongest and the most densely arranged. In the internal anatomy I only will mention that the salivary glands will appear as 4 long and strong, curled tubes which stretch through most of the length of the larva (compare fig. 7 A and B, figured in the same enlargement), the two tubes on each side unite anteriorly and more anteriorly yet this common tube joins with that from the other side and debouch in the hypopharynx. Tracheae are found, but the spiracles are very small.. Length (distended) 5,5—6 mm.

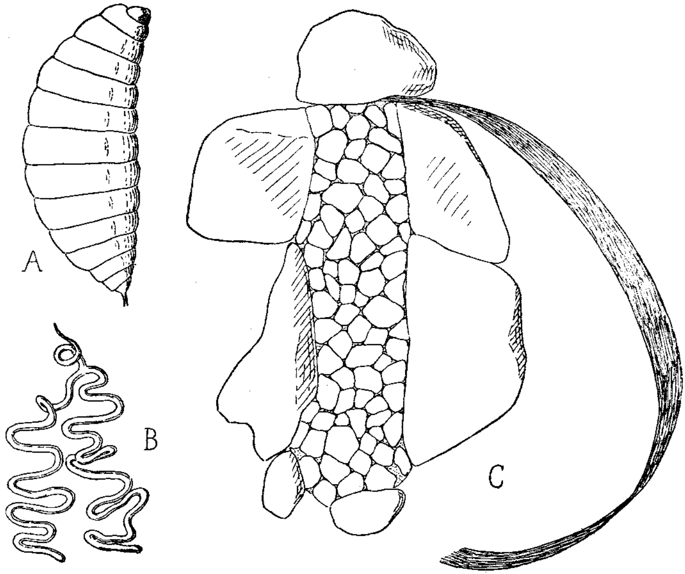

Fig. 7. — *Agriotypus armatus* WALK.
A. Second larval stage. — B. Salivary glands of one side of this.
C. Caddis-fly case showing the band formed by the parasite. — (All figures enlarged × 10.)

This larval stage is easily found in nature as the infested caddis-fly cases display the curious band figured in fig. 7 C. A caddis-fly case containing a mature larva of *Agriotypus* will always appear closed anteriorly as well as posteriorly by the common silk netting and closing stone, which signifies that the parasite has allowed the host to do the last preparations for pupation, but immediately after that the caddis-fly larva has been devoured, so that when the case is opened only the most resistant chitinous remains of the host larva are found amassed in the posterior end of the case outside the cocoon which the parasite now has made and which fills up the rest of the case. In the anterior end of the cocoon, there is an open fissure between the side wall and the end wall, and inside this fissure the mentioned band is superficially attached or stuck to the wall, from which it can easily be removed. Outside the fissure the band penetrates the silk netting (made by the host) and will show a length of until 26 mm (in *Silo pallipes* which is the common host in North Sealand certainly hardly more than 14 mm), its breadth is 1 mm.

As the band penetrates the cocoon and is fastened inside this, and as the cocoon's originating from the parasite is beyond all doubt, it is evident that the band is formed by this latter, and not by the host, as SIEBOLD (1) believed. And when we see the protruding hypopharynx and the enormously developed salivary glands there can be no doubt that the band is formed by secretion from the salivary glands. As the gut is closed posteriorly no other origine can be proposed. When examining a host case having a band still growing I always found that the larva lay with its head directed the same way as the band. When examining a case having a fully developed band I have in some instances found the parasite to be orientated with anal end against band end of the case, this larva thus— after having finished forming the band—must have turned round in the case in spite of the greatly limited room, on account of its very great capability of changing its shape this may be imagined to take place in the same way as fly larvae do (turning round a little of the head end, pumping blood into this part, turning some more segments, pumping blood in these, a.s.f.). The great capability of changing its form surely is of importance in as much as the larval body thus can thrust against the sides of the case when the growing band is to be pushed outwards, and in this act of pressing against the wall the chitinous warts also play their part. Of course the band will grow longer in its proximal end (into the cocoon) which will also always be of a much more whitish and soft consistence than the free part, and

(1) *Stett. Ent. Zeitg.*, XXII, 1861, p. 59.

surely a certain force is needed for the pushing out the band which is growing by and by at its end. When a host case with a still growing band is opened the *Agriotypus*-larva will always be seen to lie close to the anterior end of the case and having the anteriorly truncate and posteriorly pointed form.

In order to elucidate the function of the band G. W. MüLLER (1) cut off the band in a certain material, the result was that 91 % of these bandless specimens died (while the mortality for the intact cases was 38 %). A new experiment of his showed 100 % dead when no band was present (and 47,4 % when the band was intact).

As a supplement to these experiments also I have experimented cutting of bands. Unfortunately I had only 12 cases at my disposal (while MüLLER had 91 and 190), they were arranged by two under 6 different conditions of life in 3 months (between 20/7 and 27/10).

The result was the following:

1. Band intact: aquarium constantly furnished with fresh water (normal conditions): 27/10, the two cases contained 1 *living* imago and 1 *living* pupa about to cast the pupal skin.

2. Band intact; Water in aquarium was stagnant and never changed, at last it smolt very foul and was filled with Saprolegnias: 27/10, 1 *living* young pupa and 1 mature *living* larva were found.

3. Band intact; the cases were kept dry: 27/10, 1 *living* imago and 1 *living* pupa were found.

4. Band cut off: aquarium constantly furnished with fresh water: 27/10, were found 2 *dead* larvae (one dead rather newly, one quite decayed).

5. Band cut off; water in aquarium never changed (as No 2): 27/10, 2 *dead* and decayed larvae were found.

6. Band cut off; the cases were kept dry: 27/10, in one case a larva *dead* long ago, in the other a *living* chitinized imago were found.

As will be seen from the experiments by MüLLER and by me, the band must be of vital importance to the *Agriotypus*-larva, at any rate when the case is lying in water, and no doubt can be that it serves the respiration. When the larvae die during

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(1) *Zool. Jahrb. Abt. Syst.* IV, 1889, p. 1132, und V, 1891, p. 689.

the experiments it can only be on account of wanting air. When the band is moved directly from water to glycerine it will be seen that it is always air-filled between the threads, and when a case having a living *Agriotypus* imago in it is opened in water it will be seen that the imago lies imbedded in a layer of air.

It is a well known fact that the change from larva to pupa for most of the holometabolous insects will be a radical altering in conditions of life, especially in respiration; the larva often respires through gills (many water-insects) or have superficial respiration (parasitic *Hymenoptera*), while the pupae (except those of *Trichoptera*) always have open spiracles and breathe atmosphaerical air. Water-insects whose cocoons or puparia are normally found in the water will therefore always fill their cocoons wit hair in which the pupa can lie. Parasitic Wasps in such forms will break out of the body of their host before pupation which then takes place outside the host when the host has formed its pupal case, and then it is quite unimportant if the host puparium or pupal case is submerged in or floats on the water, the parasite has its air-supply for use until it has moulted for the last time and escapes as imago.

The eggs in which some little wasps, as *Anagrus* or *Preswichia*, will develop, have no such air supply which can be used by the parasites, in these instances the pupae and the not yet escaped imagines must breathe through the skin and economize with the scanty content of oxygen in the egg.

The hosts of *Agriotypus*, the caddis-flies, are differing from the other parasite-hosts which are intested in the larval stage, as the pupae are not airbreathing but use gills like the larvae. Thus the *Trichoptera* do not procure any air-supply in their pupal case, and as the pupa of *Agriotypus* is airbreathing and thus needing air, it must itself take care of the air supply and fill the cocoon with air. And the band is the means to this filling.

The pupation takes places in June—July and in autumn (at any rate from October) the imago is found in the host cases, hibernating there. Next spring the imago escapes and the surrounding air-bubble will take it safely to the water surface.