The Hormonal Control of Larval Diapause in the Rice Stem Borer, *Chilo suppressalis*.

II. The Activity of the Corpora Allata during the Diapausing Period.

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In the previous paper (FUKAYA and MITSUHASHI, 1957), it was roughly indicated that the activity of the corpora allata in diapausing *Chilo* larva is still maintained, because the prothetely was generally induced instead of pupation when the active prothoracic gland from prepupa of *Barathra* or active brain from *Chilo* larva was implanted into the diapausing larva.

On the other hand, the active prothoracic gland as well as the active brain was able to cause the immediate termination of diapause only when it was implanted into the decapitated larva. From the facts above mentioned, it was suggested that the corpora allata may be playing an important role in the larval diapause.

In attempt to make more sure of this point, a series of experiments on the activity of the corpora allata during the diapausing period has been performed.

MATERIALS AND METHOD

The diapausing larvae used as materials belong to the Saigoku strain. They were gathered from a paddy field at the end of November and kept under room condition until January, when most of the experiments were begun.

In regard to the donor, the active prothoracic glands taken from prepupae of *Barathra* which were reared at 25°C were used.

Extirpation of the corpora allata were made under binocular microscope; first the head was split along epicranial suture and they were taken off with pincette (Figs. 1~2).

Immediately after the operation the wounded head of larva was entirely sealed with paraffin (Figs. 5~6).

In such an operation, the corpus cardiacum was compelled to be extirpated with the corpus allatum, because they are very closely connected with each other.

On the other hand, the extirpation of both brains and suboesophageal ganglia was successfully undertaken with less surgical effects, as they were easily taken through the pinholes made just behind head capsules (Fig. 3) or at the ventral side of prothorax respectively.

The active prothoracic glands were implanted with a minute drop of Ringer's solution into abdomen of the hosts (Fig. 4).

After the operation the materials were transferred to a favourable condition at 25°C, and observed every day. As soon as the pupation occurred, the material was tested to ascertain if the operation was well conducted.

EXPERIMENTAL RESULTS

i. *Effect of implantation of active prothoracic gland into allatectomized, diapausing larva.* The surgical effect of allatectomizing or wounding the head is so severe that a large number of larvae died in the first 10 days, but some individuals which received the active prothoracic glands succeeded in pupating in a comparatively short period (Table 1, Figs. 5~6). As shown in Table 1, the extirpation of the corpora allata seems to facilitate the termination of diapause in the rice stem borer larvae which received the active prothoracic glands. Contrary to this result,

in case where the said prothoracic glands were implanted into diapausing larvae which keep the corpora allata intact, the prothetely occurred immediately after the operation.

In this case, it matters little whether the brain or suboesophagial ganglion is extirpated or not.

ii. *Change of corpora allata activity in post diapausing period.* It was clearly indicated in the preceding experiment that the

corpora allata were active during the diapausing period, but, from the theoretical view point, this activity should be decreased gradually with the advance of the diapause development. To this end, the active brains from the rice stem borer larvae were implanted into the larvae which were approaching to the finish of diapause.

From Table 2, it is ascertained that when the larvae pass their critical period the prothetely can occur no further. This may be

Table 1. Effect of implantation of active prothoracic glands into allatectomized, diapausing larvae.

Test preparation	Implantation of prothoracic glands	No. of experiments	No. of prothetely obtained *	Days required for prothetelic moulting at 25°C.	No. of pupae obtained (%)	Days required for pupation at 25°C.
Diapausing <i>Chilo</i> larvae without corpora allata	1 from <i>Barathra</i> prepupa	80 (♂ ♀)	0 (0)	...	8 (10.0)	5, 6, 6, 6, 11, 12, 14, 14.
Diapausing <i>Chilo</i> larvae without brains	Do	52 (♂ ♀)	9 (17.5)	4, 4, 4, 4, 5, 5, 5, 12.	0 (0)	...
Diapausing <i>Chilo</i> larvae without suboesophagial ganglia	Do	32 (♂ ♀)	7 (21.9)	4, 4, 6, 6, 6, 6, 6.	0 (0)	...
Diapausing <i>Chilo</i> larvae wounded at heads.	Do	100 (♂ ♀)	13 (13.0)	4, 4, 4, 5, 5, 5, 5, 6, 6, 6, 6, 7, 8.	1 (1.0)	30
Diapausing <i>Chilo</i> larvae non-operated	Do	21 (♂ ♀)	5 (17.9)	4, 4, 4, 5, 11	0 (0)	...
Do	None	20 (♂ ♀)	0 (0)	...	4 (20.0)	47, 73, 87, 91.

* Showing heavy abnormalities in morphological characteristics (FUKAYA and HATTORI, 1958).

Table 2. Effect of implantation of active brains into larvae in various degrees of diapause development.

Section	Date of experiment	Implantation of active brains	No. of experiments	No. of prothetely obtained *	Days required for prothetelic moulting at 25°C.			No. of pupae obtained (%)	Days required for pupation at 25°C.		
					Min.	Max.	Aver.		Min.	Max.	Aver.
Exp.	Dec. 10	1 from <i>Chilo</i> larva	20 (♀ ♀)	3 (15.0)	14	17	16.0	3 (15.0)	31	42	36.0
Cont.	Dec. 10	None	50 (♀ ♀)	0 (0)	...	...	...	7 (17.5)	47	91	74.2
Exp.	Feb. 10	1 from <i>Chilo</i> larva	28 (♀ ♀)	4 (14.3)	23	40	32.0	1 (3.6)	...	...	39.0
Cont.	Feb. 10	None	20 (♀ ♀)	0 (0)	...	...	...	14 (70.0)	36	62	47.3
Exp.	Apr. 10	1 from <i>Chilo</i> larva	20 (♀ ♀)	1† (5.0)	...	...	10.0	5 (25.0)	20	42	29.8
Cont.	Apr. 10	None	30 (♀ ♀)	0 (0)	...	...	...	12 (60.0)	12	29	16.8
Exp.	Apr. 25	1 from <i>Chilo</i> larva	20 (♀ ♀)	0 (0)	...	...	...	4 (20.0)	13	20	16.8
Cont.	Apr. 25	None	30 (♀ ♀)	0 (0)	...	...	...	27 (90.0)	6	23	14.6

* Showing slight abnormalities in morphological characteristics (FUKAYA and HATTORI, 1957).

† Pupated after 21 days.

attributed to the decrease of the corpora allata activity which causes the prothetelic moulting responding to the hormone release from the prothoracic glands.

DISCUSSION

As has often been pointed out by many investigators, the activities of brains and prothoracic glands of the diapausing pupae of Lepidopterous insects fail temporarily, but in that case, no attention has been given to the role of the corpora allata. Concerning the larval diapause in the rice stem borer, however, the induction of normal pupation is scarcely undertaken by implantation of the active brain or prothoracic gland presumably due to the fact that the activity of the corpora allata is still sustained during diapause period.

Thus, the result of the experiment that the implantation of the active prothoracic glands into allatectomized, diapausing larvae accelerates the pupation may be worthy of consideration. In other words, the inactiveness of the brain as well as prothoracic glands accompanied with the high activity of the corpora allata seems to be an essential characteristic in larval diapause.

Further, it is theoretically suggested that the termination of larval diapause can not occur, so far as the activity of the corpora allata is maintained. This was proved in the experiment where the activity of the corpora allata during the post diapause period has

been tested (Table 2). The critical period of the corpora allata, at least in regard to diapause, seems to come about 20-30 days prior to pupation at 25°C. Having passed this critical period, the brain-prothoracic glands system should be activated day after day.

SUMMARY

When the active prothoracic glands from *Barathra* prepupae were implanted into diapausing larvae, prothetely occurred in considerable percentage instead of normal pupation. But in the cases where the corpora allata were removed from diapausing larvae and active prothoracic glands were then implanted, the majority of the larvae pupated normally without a prothetelic moult.

From the experimental results hitherto obtained, it may be concluded that the larval diapause is characterized in the temporary failure in the activities of brain-prothoracic glands system accompanied with the high activity of the corpora allata.

The activity of the corpora allata, however, seems to decrease gradually with the lapse of time during post diapause period.

LITERATURE CITED

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 FUKAYA, M. and I. HATTORI (1958) Ibid., 2: 50~52.

摘 要

ニカメイチュウの幼虫休眠におけるホルモン支配

II. 休眠期のアラタ体活性

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ヨトウムシの前蛹からとったいわゆる活性化した前胸腺を休眠幼虫に移植すると、脳や食道下神経節の在、不在に関係なく、アラタ体の存在するかぎり正常な蛹化は起らないでプロセテリーを生ずる。しかしアラタ体を摘除して同様処理すると休眠幼虫の蛹化は著しく促進される。

これまでの実験結果から、ニカメイチュウの幼虫休眠はアラタ体の高い活性を伴う脳～前胸腺系活力の一時的喪失ということによって特徴づけられているように考えられる。

なおアラタ体は後休眠期を通じ次第にその活力を低下する。

EXPLANATION OF PLATE

(Br, brain; CC & CA, corpus cardiacum and corpus allatum; HC, head capsule; I, injector; L, Larva; LC, larval cuticle; Par, paraffin)

Fig.1. Process of extirpating corpus cardiacum and corpus allatum. Before extirpation. $\times 60$.

Fig.2. Do. After extirpation. $\times 60$.

Fig.3. Extirpation of brain. $\times 15$.

Fig.4. Implantation of structures. $\times 1.5$.

Fig.5. Allatectomized prepupa induced by implantation of active prothoracic gland. Showing the head sealed with paraffin. $\times 4$.

Fig.6. Pupa followed prepupa shown in Fig.5. $\times 4$.

抄 録

ナガカメムシにおける生殖のホルモンによる調節

JOHANSSON, A. S. (1958) Hormonal regulation of reproduction in the milkweed bug *Oncopeltus fasciatus* (DALLAS). Nature 181(4603): 193~199.

若い成虫で脳の pars intercerebralis にある α -細胞を摘出すると、卵の発育はさまたげられないが蔵卵数がへり、アラタ体は小さくなった。

羽化後第1日目の成虫からアラタ体を摘出すると、正常の卵発育がおこらず輸卵管中には分泌物がみられない。そういう虫に成熟した成虫からとったアラタ体を移植すると卵は発育した。

飢餓状態は卵の発育をさまたげるが、飢餓状態の成虫で、アラタ体と脳または食道下神経球の神経連絡を切ると、卵は発育した。

したがって、卵の発育にはアラタ体ホルモンが必要であるが、アラタ体は中枢神経系によって支配されていると考えられる。(農技研 三橋 淳)

白蟻における脱皮の実験的解明

LÜSHER, M. und P. KARLSON (1958) Experimentelle Auslösung von Häutungen bei der Termiten *Kaloterms flavicollis* (FABR.). J. ins. Physiol. 1(4): 341~345.

白蟻の幼虫と若虫に前胸腺ホルモン (α -Ecdyson) を注入あるいは摂食させたところ、両方の実験区で脱皮が誘起された。そして、与えたホルモンの量と脱皮に要した平均日数の間にはある関係があり、量が少ない時は脱皮がいくらかおくれた。また、期待に反して脱皮によって生じた幼虫も若虫もまったく成虫分化を示さず、卵細胞の大きさにも変化がなかった。

それゆえ、白蟻では前胸腺ホルモンは単に脱皮ホルモンとして働くのであり、生長と分化の過程にはまったく影響を及ぼさない。

このような例がふえるならば、前胸腺ホルモンに對し従来用いられていた“生長および分化のホルモン”という名称は不適当になるだろう。(農技研 三橋 淳)