

The Comparative Studies on Hatched Silkworm Dominance Separation against Sex Separation to meet Silk Promotion

Byong Hee Choe; College of Agr. Seoul National Univ.

蠶繭生産性 改善을 爲한 蟻蠶優劣分離와 雌雄分離의 比較研究

서울大學校 農科大學
崔 炳 熙

摘 要

本 報告는 養蠶方法改善을 爲하여 蟻蠶의 優劣分離效果와 雌雄分離效果를 比較研究한 것이 다. 交雜種에는 强健한 누에가 있는가하면 虛弱한 누에가 있으리라는 것은 쉽게 推測될수 있는 問題이며 養蠶時에 特別 掃蠶時에 强健한 누에와 虛弱한 누에를 分離할수 있게 된다면 蠶業增産에 莫大한 寄與가 되는것으로 確信한다.

筆者는 이러한 目的에서 蠶兒優劣分離劑(Better Hybrid Controller ……BHC)를 開發함에 이르렀고 本劑에 對한 基礎調査와 實用結果를 다음과 같이 報告한다.

1. BHC 處理時의 基礎調査

- a) BHC 處理를 한 누에는 交雜種은 原種보다 甬을 먹기 始作하는 速度가 빨랐다.
- b) BHC 處理한 原種은 U字型으로 配列하여 甬을 먹기 始作했으나 交雜種은 L字型으로 配列하여 甬을 먹기 始作했다.
- c) BHC 處理時間이 길어질수록 上記分布가 鈍化되었다.
- d) 交雜種에서 BHC 處理로 二區分되었을때 먼저 攝食分離된 區分은 强健性蠶으로 認定되었으며 優劣分離比는 約 2:1이었다.
- e) 本劑는 減蠶比率를 惡化시키는 일이 없었다.

2. 優劣分離와 雌雄分離結果 比較

- a) 雌雄分離時의 雄蠶 繭層比率는 雌蠶 繭層比率보다 不過 0.4%의 差異를 보였다.
- b) 優劣分離時는 兩者間의 繭層比率 差異가 0.7%였다.
- c) 優劣分離時에는 繭層比率이 對照區보다 1.6~2.4%나 增大하였으며 비록 劣區라 하여도 對照區보다 큰 差를 보였다.
- d) 이와같이 期待以上の 結果를 招來한 理由로서는 BHC 劑가 蠶體生理에 어떠한 좋은 作用을 한 탓으로 풀이 하였다.
- e) 한편 雌雄分離時의 結果는 期待에 어긋나는 繭層比率를 보였다.
- f) 그러나 生絲比率에 있어서는 雄蠶區가 雌蠶區보다 1%나 增大되었는데, 이는 雄蠶區의 關係生絲量比率이 87.4%나 된 結果에 起因하였다고 생각된다.
- g) 反面에 雄蠶區는 解舒率이 63%로서 各試驗區中 最下位를 차지하고 있었다.
- h) 雌雄分離나 優劣分離나 間에 原料繭 品位를 變化시키는 일은 없었고 다만 優劣分離時는 繭絲長이 約 100m 씩 增大되므로서 生産性を 向上시키고 있었다.
- i) 養蠶收益性を 分析한 結果로서는 優劣分離效果가 約 10%의 增收을 할수있음을 알았고

雌雄分離効果는 오히려 負의 增收效果를 보였는데 그 主原因은 雄蠶區의 生絲比率增大가 蛹 體重 低下로 增收效果를 發効하지 못했기 때문이라고 생각된다.

j) 結果的으로 蠶蠶時에 BHC 處理한 것이 蠶業增産에 큰 寄與를 하는 事實을 알게 되었다.

k) BHC 處理는 優劣 兩區로 分離하여도 좋지마는 兩區間 成績이 그렇게 크지 않았으므로 處理後 全體를 飼育하여도 無妨하다고 보았다.

3. 本試驗에서는 雄蠶飼育은 所期の 增産目的을 達成할수 없음을 알았고 또한 蠶蠶雌 雄分離의 必要性을 認定할수 없었다.

4. BHC 處理는 蠶蠶을 密閉器中에서 1~2分間 放置하는 사이에 本劑 蒸發氣體의 作用으로 神經이 鈍化되는 탓으로 攝食時間에 差異가 發生하므로 優劣이 區分되는 것이며 作業이 極히 容易하여 養蠶農家에서 쉽게 處理할 수 있는 方法이므로 고치 10% 增收가 可能한 革新的인 養蠶技術의 契機가 된다고 생각된다.

I. Introduction

It has been several ten years longing if we could work on sex separation during the fetching stage of silkworm, it would be a great success on the sericultural industry.

This report, however, is going to comment that there is no need to work out such a method in future because the necessary chance has passed away already. Such dream could happen in old silkworm varieties or pure lines but not for new varieties because the silk yield of both sex cocoons approach together.

In stead of such method, the author has developed a better hybrid seperating method to select better worms during in the fetched worm stage. Such a method is named as Better Hybrid Control (BHC) by the author. This method brought about much better result than the sex separation result which will be a great contribution for the industry.

II. Materials and Methods

Through out many basic reseaches, the author has developed a chemical reagent useful for better worm selection during in the ant stage or at the chance of fetching. The reagent was named as Better Hybrid Controller (BHC) by the author.

The applied silkworm varieties are S103×104 and sex limited pure line in this final report. After fetching of silkworms, he waited until the worms spread all over on a pice of paper. Then the worms with the paper were put in a compact chamber which was already vapor saturated with BHC everporation in the

chamber for one or three minutes with room temperature. Care was paid the put paper should not touch directly to the treat chemical.

After taken out the worms from the chamber, carbonized rice hull was spread over the fetched worms and next put a young worm seperating net over it. Then some mulberry leaves were put on the net to invite the silkworms under neath through the net.

Watched the mulberry leaves until first worm adapt it, then measured time for one minute, then the transfered worms with net and mulberry were removed from the place and put it in silk worm tray. Now, the worms are seperated in two parts.

In case repeat of such netting method, there will be many parts separation for various check services.

For the commercial worm separation, the sample worms were seperated in two groups, but repeated several netting seperations to check the distribution of every minute adaptation on mulberry with pure line (sex limited) and hybrid (S103×104).

Each seperated worm group was raised by standard rearing method until cocooning. Some of the produced cocoons were used for basic investigation and majority cocoons were reeled as raw silk to check cocoon qualities as of material.

On the other hand, silkworm sex separation has been carried out by visual method during the first day of fifth instar from the treat or Control group of the worms to be good many enough for the comparison with the above separation. With the obtained results, productivity analyses were carried out to reach management evaluation.

III. Results and Discussion

It has been many years problem how to develop sex separation on hybrid silkworms so that the use of only male worms is to be commercial cocoon production.

If male worms could be use in the start of silkworm rearing, it has been told that many merits would be expected than the current mixed sexes rearing method because,

- (a) male worms eat less mulberry leaves than female worms during their larbae stage,
- (b) male larba stage last sooner than female,
- (c) male worms are stronger than female which may bring about better worm missing result,
- (d) male cocoons produce better silk yieldability than female about two per cent,
- (e) such single sex cocoons provide better uniformity as silk reeling material than normal sexes mixed cocoon.

Such effects have been told through out sericultural field for many years. Who ever succeed on this matter, the result may be expected as a big events on technical promotion.

This expectation, however, is forgotten one thing that there are many silk worms vary from average data or evaluation. The above statements may be acceptable as average talking, but we have to realize also there are many diversed worms which bring about

variable distribution result. For instance, women are not always weaker than men. There are many women stronger than weak men, so do silk worms are. Another word, the above statement was come from only average result aspect and we did not pay attention to many varied worms who play an important role on the practical result.

If we could select better silkworms regardless with sexes, that would be also big success on the technical promotion. That was why, the author has changed his working line to select better worms during at fetching silkworm stage or hatched worm to meet silk production.

In the previous report,⁽¹⁾ the author has worked a new method to separate or select worms by using anesthetic. However, he has found that such an anesthetic is not available on commercial silkworms because such an anesthesia brought about fairly poor silkworm missing result, in spite of fact he has found a possibility to work out sex separation.

He finally reached to develop a special chemical reagent to be useful for hybrid silkworm separation named as Better Hybrid Controller (BHC) which happened to be the same with author's name initial.

1. Basic investigation results

In order to see how the BHC treated worms start to adapt mulberry, the adapting interval distributions were investigated as shown in Table 1.

Table 1. Mulberry adapting interval distribution after BHC treat(%)

class; min	1	2	3	4	5	6	7	8	total	distributing pattern
pure line; 1 min	33%	8%	7%	9%	9%	8%	5%	21%	100%	U type
pure line; 3 min	30	12	14	6	3	7	4	24	100	U type
hybrid; 1 min	62	11	10	9	5	3	100	L type
hybrid; 3 min	58	12	11	8	6	5	100	L type

There was interesting distributing pattern between pure line variety and hybrid variety. The former one showed rather dull U type pattern, but the latter one showed sharp L type or Poisson's distribution. In case they show just Normal distribution as we see in general statistical analysis, there is no meaning of separation follow after silkworm health and hard to separate in practical service. Such specific pattern

explains why we can separate superior part and inferior part from a given group sample worms. It should be beared in mind that silkworms do not work like this distribution against any kind of chemicals. On the other hand, treating period extension did not show much change on its pattern but rather dull form, and hybrid worms transfered to mulberry earlier than pure line worms.

Table 2. Sexes ratio and cocoon weight after seperation (S103×104)

check item	comparation treat	Sexes seperated		B.H.C treat 1min		B.H.C. treat 3 min		notice	
		CON-TROL	female	male	No. 1	No. 2	No. 1		No. 2
% of female	47.5	100	0	48.4	47.0	49.6	47.9	No. 1...transferred	
% of male	52.5	0	100	51.6	53.0	50.4	52.1	worm in first min.	
total (%)	100	100	100	100	100	100	100	No. 2...the rest	
wt/100 cocoons(g)	171	176	156	183	182	172	172	part of treat	

The sexes ratio after seperation did not change much, but showed fairly different cocoon weight by such grouping as shown in Table 2.

According to Table 2, every BHC treated group shows better cocoon weight than the Control group.

It is deemed that the BHC treat itself works to help silkworm physiology in some aspect.

While the cocoon weight similar with No. 1 and No. 2, the cocoon shell percentage or cocoon layer ratio showed different result as shown in Table 3. Another word, No. 2 group showed better silk yield than No. 1. And the numeral ratio of silkworms between No. 1

Table 3. Cocoon shell percentage distribution after sexes or BHC seperation

group	C O N T R O L	sexes seperated		BHC treat 1 min		BHC treat 3 min	
		female	male	No. 1	No. 2	No. 1	No. 2
15%	1	1					
16	1	0					
17	2	1	2	1		2	1
18	7	3	2	2	1	3	2
19	4	9	7	2	3	1	1
20	8	5	10	5	4	2	2
21	10	16	7	11	4	9	2
22	3	5	5	8	4	4	11
23	2	5	10	5	9	7	4
24	3	2	4	3	9	6	5
25	2	1	0	2	4	4	5
26	1	0	2	2	4	1	2
27	4	2	1	4	6	4	12
28	1			1	0	2	1
29	2			4	2	5	1
30							1
<i>n</i>	50	50	50	50	50	50	50
\bar{X}	21.5	20.9	21.3	22.8	23.5	23.3	23.9
S_x	3.43	2.24	2.23	3.08	2.63	3.29	2.97
\bar{X} range		0.4%		0.7%		0.6%	

group and No. 2 group is about 2 : 1.

It was surprising matter that the difference of cocoon shell percentage between sexes was found as only 0.4%. It has been informed that the difference used to be about two per cent for many years. This talking was come from old varieties and we used to believe it because many pure line varieties, nowadays, still show such difference. There was no sexual separate data concerning cocoon shell percentage using recent varieties. Since several years ago, genetical studies have improved silkworm varieties very much which the effort brought about such difference to be small.

On the other hand, the Better Hybrid Controller (BHC) treated groups show better cocoon shell percentage than the Control or sex seperated group about 1.6~2.4% as shown in Table 3. Such results are over expectation which might come from some desirable effect on silkworm physiology. Even though, there are superior group and inferior group in a treat of BHC, the inferior group still shows better result than the Control group. Also, the difference of cocoon shell percentage between No. 1 and No. 2 group shows larger amount than sexes seperated result about 0.6~0.7% according to Table 3.

The longing about silkworm sex seperation for many years seems to be a similar story with the dream about perfect cross section of fibers. Because natural fibers have irregular cross section, we used to longing it as to be circular cross section which would be a great help for textile quality.

After it was succeeded with some synthetic fibers to have circular cross section since 1945, we have found a fact that such cross section created too strong lustre from textile fabrics. Therefore, we had to bring it back to irregular cross section again.

According to the obtained result from sex separation, there is no reason why we have to work on it. It should be forgotten about by now. In stead, the better hybrid controlling (BHC) method showed much better result than the sex separation after all.

In case silkworm sexes are separated, they might be unhappy with such condition. They may feel some thing about other sex by some sexual body secretion or flavor which may be appreciated each other. The mixed sexes rearing method seems to be matched into a biological philosophy.

Silkworm pupa is, however, quite different between sexes as shown in Table 4. The more pupa weight is, the more silk yield may be expected in new varieties recently. This will call attention that the pupa weight distribution shows better uniformity than cocoon shell percentage according to Table 3 and 4.

In case extend the BHC treat, the author did not find any specific change until three minutes. The treating period should be considered from practical application point of view which may need to save time.

There was no danger with BHC application for one or two minutes in practical services.

Table 4. Silkworm pupa weight distribution after sex separation and BHC separation.

pupa weight	group CONTROL	sexes separated		BHC treat 1min		BHC treat 3min	
		female	male	No. 1	No. 2	No. 1	No. 2
		0.7g					
0.8	1						
0.9	3				1		3
1.0	8		6	10	3	6	9
1.1	6	4	18	9	14	4	14
1.2	4	1	18	7	9	4	7
1.3	10	6	5	5	7	4	3
1.4	7	13	2	10	6	8	9
1.5	8	15	1	7	6	18	3
1.6	3	9		2	1	6	1
1.7		2			1		
n	50	50	50	50	50	50	50
\bar{X}	1.25	1.44	1.16	1.25	1.24	1.37	1.17
S \bar{x}	0.213	0.147	0.107	0.188	0.173	0.194	0.190
\bar{x} range		0.28g		0.01g		0.20g	

2. Silk reeling results after sex separation and dominance separation.

The final result for the comparison between sex separation and better hybrid control (BHC) separation should be discussed with the obtained silk reeling result.

A special result was obtained on the sex separation. The silk per cent per male cocoon happened to be much better than female cocoon group as much as one per cent difference between sexes. Such result was come from superior silk yield per cocoon shell as 87.4% as shown in Table 5. It is peculiar phenomenon which the male cocoon holds such a predominance than female cocoon. In stead, the non breaking reelable ratio of male cocoon is shown as poor than the other one. When we remind about the difference of cocoon shell per cent as we discussed in the previous section, there must be some thing not clearable.

Both groups of sex separation and BHC separation show better cocoon have length than the Control group about hundred meters. When we see the cocoon salable coefficient, there is no quality difference between the treated groups and the Control. This result explains that the cocoon grade it self does not change in any cases, but shows difference for silk per cent per cocoon or silk yield by increase of cocoon have length. Specially, BHC separated groups show better silk yield than the others which is deemed to come from increase of cocoon shell per cent by such treatment.

According to Table 5, No. 1 groups show better silk reeling result than No. 2 groups regardless BHC treating period. The former group is believed as healthy one than the latter and happened to be held better silk yield after all, but the difference between No. 1 and No. 2 group seems to be a little which may not require BHC separation as No. 1 and No. 2. It would be better to rear silkworms all together after BHC treat when we think about silkworm egg price.

The reason of longer result on cocoon have length for sexes separated groups than the Control, is caused by the difference of taken sample cocoons which were drafted from BHC separated (four) groups and the

Control group, then separated sexes by visual method during at first day of fifth instar to prepare female and male groups. Another word, the sexes separated

groups include the Control cocoon only one fifth of weight, so the sample cocoons are independent from the Control group.

Table 5. Cocoon quality analysis after sex separation and BHC separation

item group	repeat	cocoon bave length	cocoon bave size	non breaking reelable length	non breaking reelable ratio	silk percent per cocoon	salable coefficient (won/ 10kg)	silk yield per cocoon shell %	
control cocoon	1	1,062 m	2.36d	826 m	78%	17.54%		%	
	2	1,064	2.36	857	81	17.62			
	3	1,084	2.28	886	82	17.49			
	\bar{X}	1,064	2.33	856	80	17.55			10,160
sexes seperated	female	1	1,172	2.37	787	68	17.35		
		2	1,167	2.42	784	68	17.33		
		3	1,184	2.29	800	68	17.03		
		\bar{X}	1,174	2.36	790	68	17.24		
	male	1	1,109	2.31	709	64	18.96		
		2	1,118	2.25	694	63	18.52		
		3	1,108	2.31	694	63	18.58		
		\bar{X}	1,111	2.29	699	63*	18.62		
BHC seperated 1min, treat	No. 1	1	1,101	2.39	860	78	17.38		
		2	1,138	2.37	898	79	17.83		
		3	1,145	2.33	875	77	17.65		
		\bar{X}	1,128	2.36	877	78	17.62		
	No. 2	1	1,128	2.37	832	74	17.46		
		2	1,123	2.38	805	72	17.57		
		3	1,107	2.43	807	73	17.49		
		\bar{X}	1,119	2.39	815	73	17.51		
BHC seperated 3min, treat	No. 1	1	1,197	2.33	897	75	18.81		
		2	1,194	2.36	934	78	18.92		
		3	1,156	2.34	921	80	18.38		
		\bar{X}	1,182	2.34	960	78	18.70		
	No. 2	1	1,116	2.35	867	78	18.85		
		2	1,122	2.34	871	78	18.73		
		3	1,125	2.31	887	79	18.71		
		\bar{X}	1,121	2.33	875	78	18.76		

3. Productivity analyses after sex separation and dominance separation.

Commercial cocoon should have good productivity so that cocoon producers may join with the services. Another word, financial income is the best factor for the cocoon production. In this case, the cocoon pro-

duction amount from one box silkworm eggs, cocoon salable coefficient or cocoon grade, and silk yield of cocoon are the factors to figure out cocoon price. There are two different test systems for the calculation of cocoon price, visual test and mechanical test as shown in Table 6.

In case of silkworm sex separation, male cocoon

group showed poor production weight per box eggs, which the cocoon price happen to be lowest among the groups and ended with lower productivity. Here again, there is no reason to separate silkworms by sexes for cocoon promotion.

On the other hand, BHC separated groups showed much better cocoon price income than the Control group or sexes separated group. In case of cocoon visual test, BHC separated groups showed better income than the case of mechanical test about 12-13%. It seems to be the main factors which the cocoon

production per box eggs and silk yield of cocoon had brought such predominance with BHC treat group. So, the BHC treating method brings about ten per cent income promotion regardless separation of superior and inferior group.

When we want to discard female group or inferior group separation, we have to figure the necessary silkwormegg price in double because normal silkworm eggs are composed with same rate of sexes or different quality. Such extra cost for cocoon production should be beared in mind before decide any separation.

Table 6, Cocoon productive analyses after separation for one box silk worm eggs

item		cocoon wt per box eggs	salable coefficient	silk percent per cocoon	cocoon price	treat income
I. In case of visual test						
control cocoon		34.2kg	10,000	17%	58,140won	standard
sexes separated	female	35.2	10,000	16	56,320	-3.1%
	male	31.6	10,000	16	50,560	-13.0
BHC separated 1min, treat	No. 1	36.6	10,000	18	65,880	+12.4
	No. 2	36.6	10,000	18	65,880	+12.4
BHC separated 3 min, treat	No. 1	34.4	10,000	19	65,360	+13.3
	No. 2	34.4	10,000	19	65,360	+13.3
II. In case of mechanical test						
control cocoon		34.2	10,160	17.55	60,981	standard
sexes separated	female	35.2	10,160	17.24	61,655	+ 1.1
	male	31.6	10,000	18.62	58,839	- 3.6
BHC separated 1min, treat	No. 1	36.6	10,160	17.62	65,521	+ 7.4
	No. 2	36.6	10,160	17.51	65,111	+ 6.7
BHC separated 3 min, treat	No. 1	34.4	10,320	18.70	66,386	+ 8.8
	No. 2	34.4	10,160	18.76	65,566	+ 7.5

(notice; 1 \$ = 400 won, standard cocoon salable coefficient = 10,000 won/10kg)

IV. Summary

This report is prepared to promote cocoon natures for the use of silk reeling material. It is easily understandable that there must be disuniformity composed with superior group and inferior group in commercial silkworms. If such different groups be separated by some method, it would be a great contribution for the cocoon production.

For a comparative purpose, silkworm sex separation

carried out because male silkworms produce more silk than female worms.

The author has developed a new chemical reagent available for the separation of superior group and inferior group from commercial silkworms, which he has named it as Better Hybrid Controller (BHC). The obtained comparative results are summarized as followings.

1. Basic investigation of BHC application

a) In case BHC applied with hybrid worms and

pure line, the former one starts to adapt mulberry leaves earlier than pure line variety.

b) The mulberry adapting interval distribution of pure line worms after BHC application showed U type distribution, but hybrid worms showed L type or Poisson's distribution.

c) In case of BHC application with silkworms, the longer period application is, the duller distribution was formed.

d) When silkworms are separated in two groups by use of BHC application, the earlier mulberry adapted group is seemed as stronger than the other part and the group ratio is 2 : 1.

2. Comparison between sex separation result and better hybrid control (BHC) separation result.

a) The cocoon shell per cent of male worm group showed better result than the female group but only 0.4% difference between sexes.

b) The cocoon shell per cent of superior group, separated by BHC, showed 0.7% more than the inferior group.

c) The average cocoon shell per cent of BHC treated cocoons showed much more than the Control group as 1.6~2.4% increase. Even the inferior group showed better result than the Control.

d) Such unexpected result is considered to be the result that BHC application is activating some thing with silkworm physiology.

e) On the other hand, the result of sexes separated groups or male worm group did not show desirable conclusion as far as cocoon shell per cent is concerned.

f) However, when the male group was reeled as silk, it showed much better silk yield or silk per cent of cocoon than the female group as much as one per cent difference between by sexes. Such result was

brought by superior silk yield from cocoon shell as much as 87.4%.

g) On the other hand, the male group showed lowest non breaking reelable ratio (63%) among all group comparison.

h) When we compare cocoon qualities by sex separation and BHC separation against the Control, there is no qualitative change, but BHC group showed quantitative promotion with cocoon have length as much as about hundred meters.

i) In case of calculation for productive income of cocoon production, BHC applied group showed about ten per cent income promotion more than the Control. The sexes separated group, however, showed rather negative result because the male cocoon produced poor weight per box eggs which could not cover it by the increase of silk yield of it.

j) So, the BHC application with the fetched worm stage brought about big promotion for cocoon production.

k) BHC method may be used either for separation purpose or quantitative promotion with whole silkworms.

3. Only male silkworms rearing did not show desirable productivity, so there is no reason to work out it in the fetching stage of worm.

V. Literature cited

1) Byong Hee Choe (1971), studies on silkworm selection by use of anesthetic (1), *Seri. J. Korea Vol. 13* (2) P123—133.

2) Byong Hee Choe (1973), studies on silkworm selection by use of anesthetic (2), *Seri. J. Korea Vol. 15*(2)