

EVOLUTION OF NEW RACES OF UNIVOLTINE SILKWORM BY PHYSIOLOGICAL GENETICS

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ABSTRACT

1. With a view to fix improved pure strains of silkworm *Bombyx mori* Linn. suitable for the univoltine regions of India, two breeding plans were drawn up.

2. Out of eighty sublimes isolated only five, viz., S₁₈, S₂₁, S₃₈, S₅₈ and S₇₉ were finally selected on the basis of their peak performances.

These have been christened as Mandakini, Shivalika maid, Himalayan nymph, Doon Crescent and Yamuna respectively.

3. Field trials both at Dehra Dun and Kashmir under village conditions have given encouraging results.

INTRODUCTION

KASHMIR is particularly conducive to the rearing of univoltine races of silkworms on account of its temperate climate and the availability of nutritive mulberry leaves that sprout forth in the warmth of spring after hibernation in the severe winter. Indeed the climatic complex of Kashmir is considered even better than that of Japan for sericulture. Yet production is low and the cost of production higher than that of Japan. As Tazima observes, "Basically Kashmir sericulture suffers for want of its own races of silkworms". In the history of sericultural research extending for more than three decades in India there has not been, as far as can be seen from published literature, a single successful experiment for the evolution of univoltine, bivoltine or multivoltine races of silkworm and unless the scientist harnessed the astonishing advances that genetics has made with in recent years the science and practice of sericulture will remain stagnant in our country.

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MATERIAL AND METHODS

In the spring of 1964 with a view to evolve new univoltine races of silkworms suitable to the climatic complex prevailing in the fair vale of Kashmir nestling in the Himalayas and the valley of Doon lying at the foothills of Sivalika and Himalayan ranges, two plans based on the most recent advances in animal genetics and breeding were drawn up and carried out to a successful conclusion at the Univoltine Sericultural Sub-Station, Premnagar, Dehra Dun. Investigations in the physiological genetics of silkworm by Watanabe (1919) had shown that if genetically bivoltine eggs were incubated at 15° C. after the blastokinesis stage of the embryo the moths that emerged from the cocoons laid non-hibernating eggs. If the eggs, however, were incubated above 24° C. the moths laid hibernating or univoltine eggs. The results obtained in these investigations were applied with suitable modifications in the Plans I and II referred to above. Investigations by Kogure and Kobayashi (1928) had shown that light influenced this characteristic to some extent. The long-day effect for more than sixteen hours was roughly comparable to a high and daily illumination shorter than twelve hours to a low temperature. It may be emphasised that these observations are important only from purely an academic point of view. For variation in temperature which will always be there when the eggs exposed to a long or a shorter illumination will not be as expressive as when the eggs are incubated at constant temperature with the requisite illumination. It was found during the course of these investigations that incubation at constant temperatures always gave satisfactory results.

Three exotic bivoltine races namely Meigetsu, J 122 and Shoka Ginrei that were being maintained in the Central Silkworm Seed Station, Srinagar, were selected for these experiments. The selection was based on their performance over a period of years from the point of view of some important characters like the percentage of hatching, percentage of missing larvae, yield, shell weight, filament length and other minor characters. Table I gives the data of their performance with reference to the characters mentioned above.

1. *Meigetsu*

This is a bivoltine race imported from Japan. It has beautiful oval cocoons and its development was always uniform.

2. *J 122*

This is a Japanese bivoltine race. This is one of the five P₃ races that has been selected, recommended and issued by the Central Silk Board to

various Sericultural States for preparation of hybrid silkworm seed to exploit heterosis.

TABLE I

Sl. No.	Race	Percentage of hatching	Percentage of missing larvae	Yield per 10,000 larvae brushed (kg.)	Shell percentage	Filament length (metres)
1	Meigetsu	80.4±4.3*	19.6±10.3	12.7±1.9	17.9±0.5	926±51
2	J 122 ..	91.5±3.3*	6.9± 1.7	16.9±0.4	17.9±0.8	1065±42
3	Shoka Ginrei ..	84.1±7.6†	5.6± 3.4	15.5±0.7	20.0±0.5	1038±60

* Mean based on five observations.

† Mean based on ten observations.

3. *Shoka Ginrei*

This bivoltine race was imported from Japan and has been giving good results continuously for a number of years. This was probably a hybrid to start with. But due to several generations of inbreeding, it has been breeding true. This race was used in Japan during summer and autumn for commercial rearing due to its being resistant to unfavourable climatic and environmental conditions. In view of these desirable characters *Shoka Ginrei* was utilised as one of its parents (Plate X, Fig. 1).

Breeding Plan I

As mentioned earlier, the details of Breeding Plan I are as follows :

Meigetsu	..	Shoka Ginrei
No. of layings = 5	F ₁	.. Shoka Ginrei
No. of layings = 20	BF ₂	.. Brushing after incubation at 26° C.

Selection for hibernating eggs

No. of layings in two lots = 40	F ₃	Incubation at 24°C.
No. of layings = 40	F ₄	

Subline	Subline	Subline	Subline	Subline
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(Selected promising sublimes to be taken for trials. The characters for selection basing on peak performances after cocoon quality tests.)

EXPERIMENTS, OBSERVATIONS AND RESULTS

F₁ Generation.—In Plan I, Meigetsu female was crossed with Shoka Ginrei male. In the *F₁* generation five layings were selected and reared with meticulous care.

BF₂ Generation (Plate X, Figs. 2, 3).—The *F₁* females were crossed with Shoka Ginrei males. In the *BF₂* generation twenty layings of eggs were selected. At the blastokinesis stage of the embryo these layings were incubated on an average of five days at a constant temperature of 26° C. After incubation the layings were divided into two lots of ten each and brushed to make the rearings more compact, less crowded and to make further selection rational and vigorous. The quantitative characters of the *BF₂* generation are given in Table II.

TABLE II

Programme	Hatch-ability percentage	Larval mortality	Yield of cocoons per 10,000 larvae brushed (kg.)	Mean shell weight (C gm.)	Percent-age shell	Fila-ment length (metres)
<i>A. Breeding Plan I</i>						
(i) Lot A ..	83.6	2.7	18.6	43.6	21.5	1115
(ii) Lot B ..	71.5	2.4	19.1	45.0	21.0	1214
<i>B. Parental Races</i>						
(i) Meigetsu	87.7	8.3	16.3	33.6	17.9	907
(ii) Shoka Ginrei ..	75.0	4.9	16.6	42.6	19.9	1161

F₃ Generation.—In the *BF₂* generation from each of the lots, the best cocoons were selected on the cocoon quality test for seed purposes. One hundred and twenty-five layings were prepared in all. These were incubated at 24° C. at the blastokinesis stage. At this stage itself a number of layings

that did not appear to be good and of uniform colour and of not good hatchability were rejected by the visual method. In this way forty-three layings were eliminated. The remaining eighty-two layings were brushed. Again out of the eighty-two, only forty, viz., S_1 to S_{40} were eventually selected on the basis of hatchability percentage and number of eggs per laying.

These forty sublimes were separately reared in cellular beds to ensure the selection most rigorous. When the worms had spun the cocoons, only those cocoons that were oval with almost no constriction and other desirable characters like the percentage of silk, content of shell, filament length were selected in each bed and desired matings of the best male with the best female effected. Five disease-free layings from each of the line were retained. The rearing data for F_3 generation are given in Table III.

TABLE III

Sl. No.	Selection No.	Total number of eggs in the laying	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	percentage of shell	Filament length (metres)
<i>Plan I, Lot A</i>						
1	S_1	643	74.4	14.8	19.1	1182
2	S_2	779	71.7	15.3	21.4	1024
3	S_3	733	87.8	11.3	20.1	1096
4	S_4	807	85.2	15.4	21.1	1031
5	S_5	729	86.7	15.8	20.9	953
6	S_6	772	77.0	14.2	20.5	1083
7	S_7	737	83.7	14.6	20.9	1080
8	S_8	685	85.3	15.1	21.5	1204
9	S_9	848	81.0	16.0	20.7	1130
10	S_{10}	663	76.2	12.7	21.7	1212
11	S_{11}	630	89.7	17.8	21.1	1008
12	S_{12}	745	70.0	17.8	20.0	1075
13	S_{13}	721	81.5	13.5	21.2	1118
14	S_{14}	787	83.3	17.3	21.6	1138
15	S_{15}	704	74.3	17.0	21.4	1050
16	S_{16}	711	79.0	16.8	20.7	1283

TABLE III—*Contd.*

Sl. No.	Selection No.	Total number of eggs in the laying	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	percentage of shell	Filament length (metres)
17	S ₁₇	745	80.8	16.1	22.2	1035
18	S ₁₈	701	82.1	17.1	22.1	1272
19	S ₁₉	827	82.3	16.0	21.5	1246
20	S ₂₀	693	85.1	15.7	21.6	1143
<i>Plan I, Lot B</i>						
21	S ₂₁	729	74.9	16.6	21.3	1261
22	S ₂₂	788	71.3	12.5	21.0	1367
23	S ₂₃	813	78.0	18.0	20.7	1208
24	S ₂₄	788	78.1	15.1	20.1	1032
25	S ₂₅	755	71.2	12.0	20.5	1014
26	S ₂₆	880	62.5	15.7	21.7	1020
27	S ₂₇	856	78.3	14.6	20.2	1070
28	S ₂₈	851	74.7	15.0	21.3	970
29	S ₂₉	657	80.2	14.5	18.3	114
30	S ₃₀	816	76.4	15.8	20.5	1137
31	S ₃₁	853	71.3	14.9	20.7	1115
32	S ₃₂	702	75.9	16.2	20.3	994
33	S ₃₃	822	83.3	15.8	17.9	1128
34	S ₃₄	796	86.3	13.6	21.8	1131
35	S ₃₅	806	81.2	13.8	18.7	1041
36	S ₃₆	747	76.9	14.3	17.8	1047
37	S ₃₇	778	75.9	12.3	18.8	1246
38	S ₃₈	717	83.5	17.5	17.8	1221
39	S ₃₉	784	75.5	14.6	21.5	1153
40	S ₄₀	702	75.0	13.8	19.0	1145
<i>Parental Races</i>						
1	Meigetsu	630	88.0	13.0	16.7	916
2	Shoka Ginrei	692	75.3	14.8	19.6	1172

F₄ Generation.—Five layings from each of the forty sublimes were incubated at a temperature of 24° C. and after incubation only No. 1 laying, the best among the five was brushed. When these worms spun cocoons, out of forty lines reared in cellular beds, twenty-one sublimes were preliminarily selected in Plan I. The rearing data of these twenty-one sublimes are given in Table IV.

TABLE IV

Sl. No.	Selection number	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	Percentage of shell	Filament length (metres)	Cocoon shape
<i>Plan I, Lot A</i>						
1	S ₅	54.8	16.4	20.9	1101	Oval
2	S ₉	72.1	16.5	20.9	957	Slightly constricted
3	S ₁₀	52.4	17.3	21.8	1018	do.
4	S ₁₁	93.1	16.6	20.3	918	do.
5	S ₁₂	90.3	13.0	20.9	1092	do.
6	S ₁₄	67.7	17.3	20.6	1021	Oval
7	S ₁₅	90.6	16.9	19.9	965	Slightly constricted
8	S ₁₈	93.5	13.7	21.2	1106	Oval
9	S ₂₀	79.8	15.5	20.1	925	Slightly constricted
<i>Plan I, Lot B</i>						
10	S ₂₁	73.1	18.3	20.1	1153	Oval
11	S ₂₃	90.1	16.7	21.3	988	Slightly constricted
12	S ₂₄	59.0	16.9	20.1	1019	do.
13	S ₃₀	93.5	17.1	18.7	1085	Oval
14	S ₃₃	70.6	17.2	19.6	1071	Slightly constricted
15	S ₃₄	87.2	16.4	19.4	955	do.
16	S ₃₅	91.4	16.0	23.8	970	do.
17	S ₃₆	67.8	15.5	22.1	1257	Oval
18	S ₃₇	55.4	15.4	20.5	1052	Oval
19	S ₃₈	84.2	12.0	20.3	1180	Slightly constricted
20	S ₃₉	83.6	17.7	22.0	1076	do.
21	S ₄₀	72.6	16.6	19.9	1095	Oval
<i>Parental Races</i>						
1	Meigetsu	89.1	15.8	19.7	1034	Oval
2	Shoka Ginrei	80.5	9.5	19.3	1059	Slightly constricted

*F*₅ Generation.—It has already been mentioned earlier that twenty-one sublimes for the excellence of their characters at the *F*₄ stage were selected. Two layings from each of these twenty-one sublimes were reared in cellular beds keeping the incubation temperature as in *F*₄ generation with a view that the genetic impact may become stronger. The rearing data of these sublimes is given, with their cocoons shape in Table V. The data given in

TABLE V
(Mean)

Selection No.	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	Percentage of shell	Filament length	Cocoon shape
S ₅	60.7	16.2	16.1	1001	Oval
S ₉	75.6	16.0	19.9	1014	Slightly constricted
S ₁₀	79.2	16.5	19.7	1058	do.
S ₁₁	64.9	16.4	19.0	1101	do.
S ₁₂	81.4	13.9	19.0	1116	do.
S ₁₄	63.4	16.6	18.8	1066	Oval
S ₁₅	90.1	16.0	19.3	1041	Slightly constricted
S ₁₈	89.8	17.3	20.2	1220	Oval
S ₂₀	86.6	13.4	17.2	1001	Slightly constricted
S ₂₁	80.4	16.1	18.9	1312	Oval
S ₂₃	54.7	15.6	18.8	1179	Slightly constricted
S ₂₄	88.8	13.4	16.1	1042	do.
S ₃₀	86.4	14.6	18.2	1128	Oval
S ₃₃	87.1	14.4	17.7	955	Slightly constricted
S ₃₄	65.1	14.4	18.8	1144	do.
S ₃₅	72.6	15.1	20.2	1164	do.
S ₃₆	76.8	15.9	19.4	1143	Oval
S ₃₇	71.4	15.7	20.1	1041	Oval
S ₃₈	86.4	16.1	18.2	1192	Slightly constricted
S ₃₉	59.9	17.8	19.1	1406	do.
S ₄₀	84.5	16.1	19.6	1151	Oval
Total ..	1607.8	327.5	394.3	23475	..
Mean ..	76.5	15.6	18.9	1118	..
S.D. ..	10.9	1.2	1.2	108	..

Table V were screened critically, with the cocoons in front and on this basis only three namely S_{18} , S_{21} and S_{36} were finally selected (Plate X, Figs. 4-6). These have been christened as Mandakini, Shivalika Maid and Himalayan Nymph respectively.

F₂ Generation.—The three sublimes namely S_{18} , S_{21} and S_{36} were reared in four batches. Parallel rearing of the two parental races, *viz.*, Meigetsu and Shoka Ginrei were carried out in two batches. The analysis of variance showed that the new races gave significantly higher yield than two parental races ($P < .05$). However there was no significant difference in hatchability and shell percentage. The mean values of these characters are given in Table VI.

TABLE VI

Sl. No.	Selection No.	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	Shell percentage
1	S_{18}	88.6	21.8	20.7
2	S_{21}	.. 96.2	21.4	21.2
3	S_{36}	.. 94.5	22.7	20.1
4	Meigetsu	.. 96.9	16.5	18.8
5	Shoka Ginrei	.. 88.7	19.6	19.5

These three sublimes (Plate X, Figs. 4-6) finally selected have been added to the germ plasm stock maintained at Srinagar.

Breeding Plan II

The details of Breeding Plan II are as follows:

Shoka Ginrei	..	J_{122}
No. of layings = 5	F_1	.. Shoka Ginrei
No. of layings = 20	BF_2	.. Brushing after incubation at 26° C.

Selection for hibernating eggs.

No. of layings
in two lots = 40 F₃ .. Incubation at 24°C.

No. of layings
in two lots = 40 F₄

Subline	Subline	Subline	Subline	Subline
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(Selected promising sublimes to be taken for trials. The characters for selection basing on peak performances after cocoon quality tests).

The rearings of the F₁, F₂, F₃ and F₄ were carried out in regard to the number of layings, incubation, rearing and the selection of cocoons and subsequent matings, exactly in the same manner as in Plan I.

F₁ Generation.—In Plan II, Shoka Ginrei female was crossed with J₁₂₂ male. In the F₁ Generation five layings were selected and reared.

BF₂ Generation (Plate X, Figs, 7-8).—The F₁ females were crossed with Shoka Ginrei males and twenty layings were brushed in two lots as in Plan I.

The quantitative characters of the BF₂ generation of Plan II are given in Table VII.

TABLE VII

Programme	Hatch-ability percentage	Larval mortality	Yield of cocoons per 10,000 larvae brushed (kg.)	Mean shell weight (Cgm.)	Percent-age shell	Fila-ment length (metres)
<i>(A) Breeding Plan II</i>						
(i) Lot A ..	67.3	2.4	18.4	43.6	20.6	1192
(ii) Lot B ..	60.8	4.2	18.5	44.0	21.0	1261
<i>(B) Parental Race</i>						
(i) Shoka Ginrei ..	75.0	4.9	16.6	42.6	19.9	1161
(ii) J 122 ..	54.7	8.3	14.9	35.3	19.5	813

F₃ Generation.—In the BF₂ generation from each of the two lots, the best cocoons were selected on the cocoon quality test for seed purposes as in Plan I. Here again one hundred and twenty-five layings were prepared. They were incubated at 24° C. at the blastokinesis stage. At this stage fifty-seven layings that did not appear to be good or uniform in colour and were not of good hatchability were rejected, again by the visual method, the remaining sixty-eight were brushed. Out of these sixty-eight, forty, viz., S₄₁ to S₈₀ were selected on the basis of hatchability percentage and number of eggs per laying. The rearing of these forty layings and the selection of cocoons were carried out exactly in the same manner as was carried out in Plan I. The rearing data of F₃ generation is given in Table VIII.

TABLE VIII

Sl. No.	Selection No.	Total number of eggs in the laying	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	percentage of shell	Filament length (metres)
<i>Plan II, Lot A</i>						
1	S ₄₁	759	71.8	13.3	21.0	1009
2	S ₄₂	697	77.1	13.1	22.5	1033
3	S ₄₃	637	77.7	9.3	21.7	957
4	S ₄₄	834	90.9	14.8	19.0	1250
5	S ₄₅	843	76.4	13.5	21.1	1020
6	S ₄₆	815	93.1	13.8	21.0	1323
7	S ₄₇	809	86.5	13.5	20.0	1309
8	S ₄₈	710	87.0	14.2	21.5	964
9	S ₄₉	696	72.1	11.1	20.5	1124
10	S ₅₀	705	74.4	13.1	21.7	1118
11	S ₅₁	740	78.3	12.2	21.1	990
12	S ₅₂	763	92.4	13.1	18.5	1222
13	S ₅₃	731	92.8	15.2	20.5	976
14	S ₅₄	803	90.1	13.5	18.6	1067
15	S ₅₅	765	84.0	14.6	19.1	1159
16	S ₅₆	719	95.8	10.7	19.6	1106
17	S ₅₇	665	97.7	16.3	19.1	1264

TABLE VIII—Contd.

Sl. No.	Selection No.	Total number of eggs in the laying	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	percentage of shell	Filament length (metres)
18	S ₅₈	740	84.4	12.7	18.9	1159
19	S ₅₉	707	93.0	14.0	20.1	1240
20	S ₆₀	796	92.5	13.9	20.1	1254
<i>Plan II, Lot B</i>						
21	S ₆₁	739	81.1	12.7	20.8	1147
22	S ₆₂	685	82.6	12.6	21.0	1075
23	S ₆₃	562	77.6	15.9	22.9	1064
24	S ₆₄	715	77.5	11.3	20.6	1055
25	S ₆₅	806	73.0	12.8	20.3	1260
26	S ₆₆	751	77.1	12.2	19.0	1105
27	S ₆₇	706	70.0	15.1	22.0	1289
28	S ₆₈	700	72.8	12.0	21.4	1117
29	S ₆₉	682	70.7	9.3	21.6	1123
30	S ₇₀	682	61.6	17.1	21.5	1154
31	S ₇₁	711	61.1	13.3	22.1	1179
32	S ₇₂	606	72.3	13.0	19.2	1133
33	S ₇₃	661	65.6	12.0	23.8	1134
34	S ₇₄	896	62.2	14.3	18.8	1101
35	S ₇₅	776	81.4	12.7	19.4	1203
36	S ₇₆	773	75.7	13.0	19.1	1008
37	S ₇₇	725	76.2	14.8	19.0	1170
38	S ₇₈	664	84.2	10.9	19.7	1087
39	S ₇₉	710	84.7	14.2	20.1	1150
40	S ₈₀	696	91.3	13.0	20.1	1082
<i>Parental Races</i>						
1.	ShokaGinrei	692	75.3	14.8	19.6	1172
2.	J 122	567	76.9	10.9	19.0	1007

F₄ Generation.—In the *F₄* generation five layings from each of the forty lines were incubated at a temperature of 24° C. as in Plan I and after incubation only No. 1 laying that was the best among the five was brushed. When these worms spun cocoons, out of forty lines reared in cellular beds, seventeen lines were preliminarily selected. The rearing data of these seventeen sublimes are given in Table IX.

TABLE IX

Sl. No.	Selection number	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	Percentage of shell	Filament length (metres)	Cocoon shape
<i>Plan II, Lot A</i>						
1	S ₄₂	58.1	12.4	21.6	1228	Constricted
2	S ₄₅	95.6	16.3	18.6	958	Slightly constricted
3	S ₄₇	95.2	15.5	21.5	948	do.
4	S ₅₁	84.5	14.3	21.8	1169	do.
5	S ₅₄	71.4	16.6	19.8	1000	do.
6	S ₅₅	87.0	16.0	19.7	960	do.
7	S ₅₈	84.9	14.3	20.3	1051	Oval
<i>Plan II, Lot B</i>						
8	S ₆₃	71.8	17.2	19.0	970	Oval
9	S ₆₅	92.8	13.8	19.1	1099	do.
10	S ₆₆	79.9	15.4	19.7	973	Slightly constricted
11	S ₇₀	74.3	13.7	18.6	976	Oval
12	S ₇₁	76.5	12.9	19.5	1138	Slightly constricted
13	S ₇₂	69.8	13.9	20.0	1106	do.
14	S ₇₅	93.5	15.1	18.7	1278	Oval
15	S ₇₆	57.5	15.2	19.0	962	do.
16	S ₇₉	75.1	14.8	19.8	1414	do.

*F*₅ Generation.—Two layings from each of these seventeen sublimes, selected at *F*₄ stage, were reared in cellular beds keeping the incubation temperature as in *F*₄ generation. The rearing data of these sublimes are given with their cocoon shape as in *F*₄, in Table X. The data given in Table X were

TABLE X

Selection No.	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	Percentage of shell	Filament length (metres)
S ₄₂	82.4	10.4	19.7	1214
S ₄₅	89.7	13.7	18.2	1117
S ₄₇	79.5	14.2	18.0	941
S ₅₁	68.6	15.5	19.7	1440
S ₅₄	80.3	14.5	20.4	1061
S ₅₅	70.0	14.6	18.2	1036
S ₅₈	75.1	15.2	20.2	1172
S ₆₀	78.6	12.8	20.1	1110
S ₆₃	64.8	16.0	20.1	1211
S ₆₅	90.6	11.8	19.4	1159
S ₆₆	79.1	13.3	19.1	1006
S ₇₀	77.2	11.4	16.5	1046
S ₇₁	80.4	12.6	18.7	1107
S ₇₂	77.9	11.8	18.4	915
S ₇₅	59.1	13.0	19.1	1177
S ₇₆	60.2	14.4	18.7	1277
S ₇₉	79.0	14.6	19.5	1150
Total ..	1292.5	229.8	324.0	19139
G. Mean	76.0	13.5	19.1	1126
S.D. ..	8.9	1.6	1.0	126

screened critically with the cocoons, in front and on this basis, only two, viz., S₅₈ and S₇₉ were finally selected (Plate XI, Figs. 9, 10). These have been christened as Doon Crescent and Yamuna respectively.

F₆ Generation.—The two sublimes, viz., S₅₈ and S₇₉ were reared in four batches. Parallel rearing of the two parental races, viz., the Shoka Ginrei and J 122 were carried out in two batches. The analysis of variance showed that the new races gave significantly higher yield than two parental races ($P < .05$). However, there was no significant difference in hatchability and shell percentage. The mean values of these characters are given in Table XI.

TABLE XI

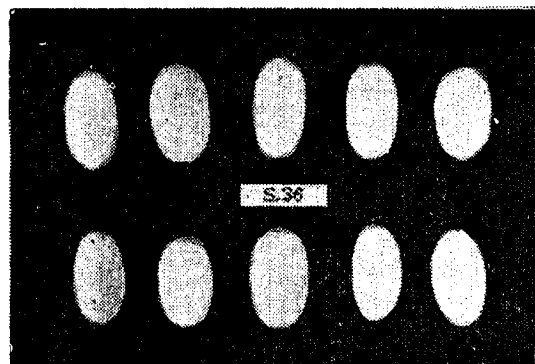
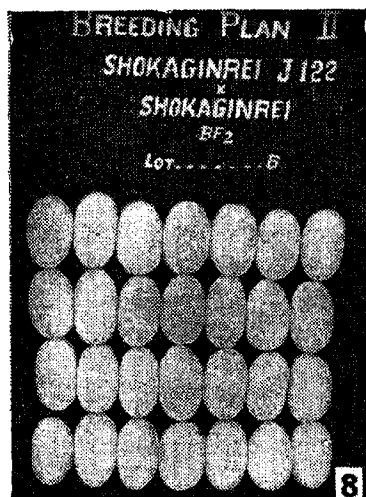
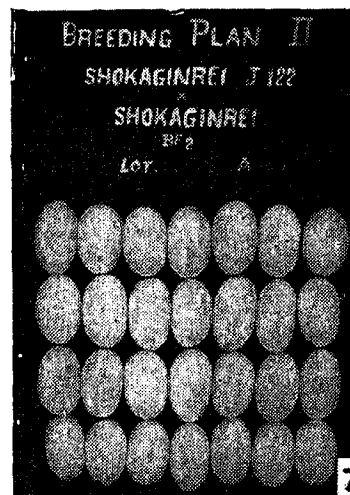
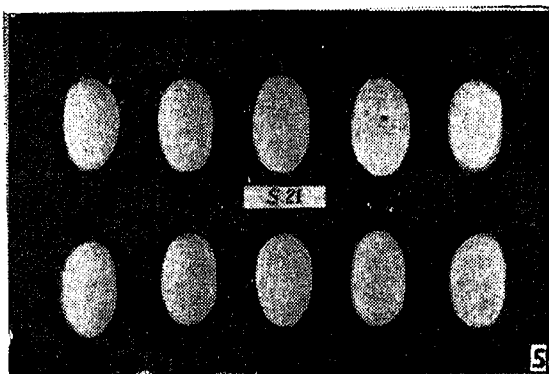
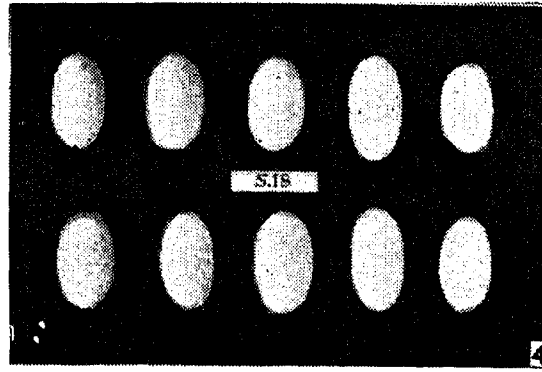
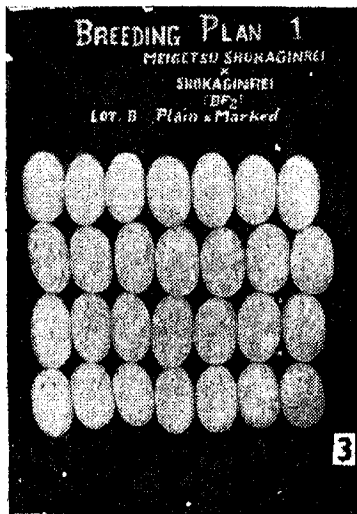
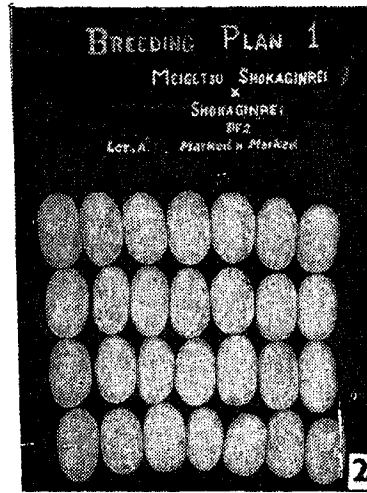
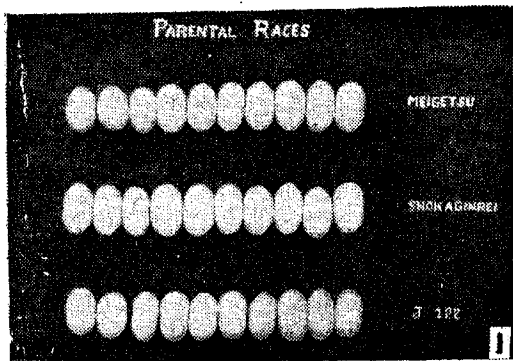
Sl. No.	Subline No.	Hatchability percentage	Yield of cocoons per 10,000 larvae brushed (kg.)	Percentage of shell
1	S ₅₈	90.9	19.2	19.9
2	S ₇₉	92.9	18.0	19.4
3	Shoka Ginrei	88.7	19.6	19.5
4	J 122	83.3	14.4	18.9

These two sublimes (Plate XI, Figs. 9–10) finally selected have been added to the germ plasm stock maintained at Srinagar.

FIELD TRIALS OF THE NEW RACES IN DEHRA DUN AND KASHMIR

The second stage in any biological research work leading to the fixation of new races with superior characters in plants or animals, is their performance under natural field conditions. So with this view field trials of S₁₈, S₂₁, S₃₆, S₅₈, and S₇₉ were carried out in a village Jajra in Dehra Dun in March 1967.

Two of the sublimes, viz., S₁₈ and S₅₈ were further tried in village Kandizal, Pampore (Kashmir). The environmental conditions of the village on the



FIGS. 1-8