Genetic Analysis of Body weight and Conformation traits in Vanaraja and Gramapriya birds and their crosses



THESIS

SUBMITTED TO THE BIHAR AGRICULTURAL UNIVERSITY

(FACULTY OF VETERINARY SCIENCE AND ANIMAL HUSBANDRY)
Sabour, (Bhagalpur), BIHAR

In partial fulfillment of the requirements
FOR THE DEGREE OF
Master of Veterinary Science

IN
(ANIMAL GENETICS AND BREEDING)

Md. Ali Wafa

Registration No – M/AGB/81/BVC/2012-13

(P.G. Deptt. of Animal Genetics and Breeding)

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2014



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CERTIFICATE-I

This is to certify that the thesis entitled "GENETIC ANALYSIS OF BODY WEIGHT AND CONFORMATION TRAITS IN VANARAJA AND GRAMAPRIYA BIRDS AND THEIR CROSSES" submitted in partial fulfillment of requirement for the degree of Master of Veterinary Science (Animal Genetics & Breeding) of faculty of Post-Graduate Studies, Bihar Agricultural University, Sabour, Bhagalpur, Bihar is the record of bonafide research carried out by Dr. Md. Ali Wafa under my supervision and guidance. No part of the thesis has been submitted for any other Degree or Diploma.

It is further certified that such help or information received during the course of this Investigation and preparation of the thesis have been duly acknowledged.

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Place <u>Potna</u>

Date 07.06.2014

Md Aliwafa (Md. Ali Wafa)



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CHAPTER -1

INTRODUCTION

Poultry is one of the fastest growing segments of the agricultural sector in India. India has emerged on the world poultry map as the third largest egg and fifth largest poultry meat producer. Per capita consumption has grown from 1.22 kilograms in 2001 to 2.26 kilograms in 2010. Broiler production grows at an annual percentage growth rate of 8.35%. The current strength of layers and broilers in India is estimated to be 230 million and 2300 million respectively (USDA's Agricultural Marketing service report, 2008). Poultry sector has been growing at around 8-10 percent annually over the last decade with broiler meat volumes growing at more than 10 percent (Information and Credit Rating Agency, ICRA, May 2014).

Domestic poultry meat production in India is estimated to have remained at 3.5 million tons in calendar year 2013 with per capita consumption of 2.8 kg per annum, while table egg production is estimated to have increased from 66 billion eggs in 2012 to 70 billion eggs in 2013, with per capita egg consumption at 57 eggs per annum. Total poultry market size is estimated at \$ 9.93 billion at the wholesale price level indicating value growth of 8% over 2012. Average revenue growth for key poultry integrators for fiscal year 2013-14 is expected to be 15% supported majorly by

increase in realizations and continued expansion in integration activities (ICRA, May 2014).

In India the rank of Bihar is 6th in poultry population and 9th in poultry meat production. The poultry meat production in Bihar is 37000 tonnes in 2010 and it was 1.69% of total poultry meat production in India (Deptt. of A.H., Govt. of India, 2010-11). Bihar lags behind many southern states in poultry meat production. In Bihar there is wide gap between per capita availability of animal protein and its requirement. This gap can be bridged by genetic manipulation and improving feeding and managemental systems.

Backyard poultry with improved genetic variety of birds and liking characteristics of rural people can be very helpful in increasing the poultry production in India. Backyard poultry farming is helpful in increasing income, preventing malnutrition, empowering rural women and generating employment. But indigenous breeds have low egg production and slower growth rate. Hence, efforts have been made to produce simply housed, dual purpose hybrids of backyard variety with improved production profiles. These improved hybrids are readily accepted by the rural farmers due to their similarity with local birds and very low operational cost with significant returns under the existing methods of rearing in rural areas. For this purpose different

crossbreds like Vanaraja, Gramapriya, Hitcari and Upcari have been introduced in backyard farming. These crossbreds resemble indigenous fowl in body conformation, plumage colour, dull shanks, pink skin etc. These improved birds have more economically viable characteristics which are of great importance for village production of eggs and meat.

Vanaraja chicken, a dual purpose backyard variety, are preferred by farmers for their coloured plumage, better growth rate and more egg production. Vanaraja has been developed by crossing random bred meat control population as the female line and Red Cornish population as the male line by Project Directorate on poultry, Hyderabad (Chandra et al., 2004).

Gramapriya is an egg type bird preferred by farmers for their coloured plumage, better growth rate, more egg production, larger egg size and brown egg shell. This bird is suitable for free range system and backyard farming provided with low cost inputs in nurseries to deliver optimal performance in village condition (Niranjan and Singh, 2005). Gramapriya has been developed by crossing random bred meat control population and White Leghorn by PDP, Hyderabad.

A breeder requires improvement in body weight as well as simultaneous improvement of conformation traits. Body

weight trait is good indicator of growth. Body conformation, which constitutes bone structure may be considered a better measure of body capacity of laying hens. Shank and Keel lengths are indicators of skeletal growth and associated with egg production of laying hens. Feed efficiency is an important trait for economic body growth.

Heterosis may be defined as the increased vigour of F_1 hybrid over the mean of the parents or over the better parents. It is the phenomenon in which the crosses between inbred lines or purebred population are better than the average of the two populations.

Crossing two or more breeds not only helps in combining two divergent sets of characters for maximum production but also endows heterosis of varying magnitude in the performance of broiler traits. The degree of heterosis, however, depends upon the population studied and traits examined.

Very few information of body weight and conformation traits of Vanaraja, Gramapriya and their crosses are available. These traits are influenced by breed, strain, system of rearing and climatic conditions. The proposed study was aimed at evaluating body weight and conformation traits in Vanaraja and Gramapriya birds and their crosses in agro-climatic region of patna, with the following objectives:

- 1. To estimate the mean, standard error and coefficient of variation percentage of various body weight and conformation traits in different genetic groups.
- 2. To study the effect of sex on various body weight and conformation traits in different genetic groups.
- 3. To study the effect of different genetic groups on various body weight and conformation traits.
- 4. To evaluate the percentage of heterosis for various body weight and conformation traits.
- 5. To estimate the coefficient of phenotypic correlations among various body weight and conformation traits.

CHAPTER -2 REVIEW OF LITERATURE

REVIEW OF LITERATURE

AVERAGE BODY WEIGHT AT DIFFERENT WEEKS OF AGE IN VARIOUS BREEDS OF POULTRY

Body weight is an important indicator of general health of birds. A broiler bird must have optimum body weight during growing periods. Various genetic and non-genetic factors affect growth of birds. A breeder increases the body weight of birds to its maximum level by exploiting genetic and non-genetic factors. Reddy *et al.* (2001) reported that the birds having higher body weight at 4 weeks have early commencement of egg production and better livability during the laying period.

The average body weight at different ages in various breeds of poultry as reported by various research workers are summarized and tabulated below:-

Table-1: Average body weight(g) at various ages in different breeds of poultry

| Age | Breed of poultry | Average body weight(g) | Authors |
|---------|------------------|------------------------|--------------|
| 1 | 2 | 3 | 4 |
| Day old | Strains of WLH | | Gupta et al. |
| | MM | 27.99 | (1999) |
| | NN | 27.26 | |
| | PP | 28.94 | |
| | MN | 29.75 | |
| | MP | 29.07 | |
| | NP | 29.65 | |
| | NM | 27.17 | |
| | PM | 28.23 | |
| | PN | 27.94 | |
| | | | |

| D11 | | | г | |
|---------|-----------------|---------------------------|---------------------|----------------------|
| Day old | Aseel | M | 32.50 <u>+</u> 0.30 | Singh et al. |
| | | F | 33.49 <u>+</u> 0.47 | (1999b) |
| | Naked Neck | M | 34.21 <u>+</u> 0.36 | |
| | | F | 33.47 <u>+</u> 0.39 | |
| | Dahlem Red | M | 38.61 <u>+</u> 0.53 | |
| | | F | 35.67 <u>+</u> 0.44 | |
| | D × A | M | 34.90 <u>+</u> 0.41 | |
| | | F | 36.06 <u>+</u> 0.47 | |
| | AXD | M | 45.65 <u>+</u> 0.38 | Singh et al. |
| | | F | 46.44 <u>+</u> 0.40 | (1999b) |
| | DXN | M | 36.52 <u>+</u> 0.57 | , , |
| | | F | 39.00 <u>+</u> 0.57 | |
| | NXD | M | 45.72 <u>+</u> 0.77 | |
| | | F | 44.41 <u>+</u> 0.65 | |
| | Synthetic Broil | ler | 43.98+0.82 | Padhi <i>et al.</i> |
| | Naked neck cr | | | (1999b) |
| | Synthetic broil | er | 37.15 <u>+</u> 1.70 | () |
| | Naked Neck | | 32.91 <u>+</u> 0.81 | |
| | Synthetic broil | er(SB) | 04.51_0.01 | |
| | | M | 36.6 <u>+</u> 0.36 | Padhi <i>et al</i> . |
| | | F. | 38.3±0.31 | (1999a) |
| | Black Nicobari | _ | 00.0_0.01 | (1000a) |
| | Black Webbarr | . (<i>Б</i> 1 ч) | 33.1 <u>+</u> 0.53 | |
| | | F | 32.6±0.29 | |
| | White Nicobari | - | 32.0 <u>+</u> 0.29 | |
| | Willie Medial | M | 36.8 <u>+</u> 0.43 | |
| | | F | _ | |
| | SB X BN | Г | 35.9 <u>+</u> 0.33 | |
| | SD X DIV | M | 26.210.62 | |
| | | F | 36.3 <u>+</u> 0.63 | |
| | OD V WM | r | 36.1 <u>+</u> 0.69 | |
| | SB X WN | 3.6 | 27.2.0.05 | |
| | | M | 37.3 <u>+</u> 0.85 | |
| | | F | 38.0 <u>+</u> 0.81 | |
| | Red Cornish | | 40.27 <u>+</u> 0.08 | Sati <i>et al.</i> |
| | | | | (1999) |
| | Naked neck de | si | 35.7 | Haque and |
| | Rhode Island F | Red | 39.5 | Howlider |
| 1 | White Leghorn | | 41.2 | (2000) |
| | Fayoumi(Fy) | | 34.4 | . , |
| | NaDRIR | | 39.9 | |
| | NaDWL | | 36.2 | |
| | NaDFy | | 35.3 | |
| | - 3 | | | |
| | | | | |

| Day old | Red Cornish | M | 41.30 | Singh et al. |
|----------|----------------------------|---------------|-----------------------|----------------------|
| _ | (control line) | F | 40.20 | (2000) |
| | overall | - | 40.75 | (2000) |
| | White Leghorn | | 34.9+0.12 | Chaudhary et al. |
| | Zognom | | 04.9 <u>1</u> 0.12 | (2009) |
| | Vanaraja | | 38.13+0.33 | Padhi et al. |
| | | F | 36.98+0.42 | (2012a) |
| | | P | 37.63+0.26 | (2012a) |
| | Vanaraja | | 38.89±0.002 | Padhi <i>et al</i> . |
| | 3 | F | 38.53±0.003 | (2012b) |
| | | P | 38.74±0.001 | (20120) |
| | Vanaraja | - | 35.91+0.26 | Jha and Prasad |
| | Gramapriya | | 33.24±0.31 | |
| | Aseel | | 29.32±0.20 | (2013) |
| | Hazra | | 31.48±0.28 | Jha et al. |
| | Aseel | | 29.72±0.21 | |
| | Kadaknath | | 28.54+0.33 | (2013) |
| 4th week | WR(M)XRC(F) | M | 222.50 | Ob(1004) |
| WCCK | W K(W)XKC(F) | F | 202.67 | Sharma(1984) |
| | | C | | |
| | Overall mean | | 209.56 | D 11: 4 1 |
| | | F | 738.96 | Padhi et al. |
| | (OBNP,IC-3, SML-2,IR-3) | r | 661.76 | (1997) |
| | IC-3 | | 470.00 | D 11 |
| 1 | IR-3 | | 472.00 | Reddy et al. |
| | | | 514.57 | (1998) |
| | IC-3XIR-3 | | 516.67 | |
| | Strains of WLH | 3 63 6 | 150.78 | |
| | | MM | 128.83 | |
| | | NN | 163.53 | · |
| | | PP | 148.33 | |
| | | MN | 187.43 | Gupta et al. |
| | | MP | 188.93 | (1999a) |
| | | NP | 135.93 | |
| | | NM | 146.68 | |
| | | PM | 157.48 | |
| | Cymthotic busile | PN | 094 00:15 07 | Da 41a4 -41 |
| | Synthetic broile | | 284.00 <u>+</u> 15.27 | Padhi <i>et al.</i> |
| | Naked neck cro | | 100 66 : 0.50 | (1999) |
| | Synthetic broile | er | 129.66 <u>+</u> 9.53 | |
| | Naked neck | | 94.03 <u>+</u> 5.03 | |

| 4 th week | Synthetic broile | er M | 228.0+6.98 | |
|----------------------|------------------|--------|----------------------|-------------------------------|
| | (SB) | F | _ | |
| | Black Nicobari | | 215.3 <u>+</u> 5.45 | D- 41.1 4 1 |
| | (BN) | F | 96.65 <u>+</u> 3.02 | Padhi et al. |
| | White Nicobari | _ | 87.8 <u>+</u> 1.66 | (1999b) |
| | (WN) | F | 111.6 <u>+</u> 3.38 | |
| | SB X BN | _ | 94.3 <u>+</u> 2.03 | |
| | SD V DN | M | 178.3 <u>+</u> 7.21 | |
| | SB X WN | 3.4 | 168.7 <u>+</u> 6.06 | |
| | SD X WIN | M | 147.8 <u>+</u> 8.4 | |
| | 3371-14- T - 1 | F | 144.9 <u>+</u> 12.4 | |
| | White Leghorn | | 181.9 <u>+</u> 1.10 | Chaudhary <i>et</i> al.(2009) |
| | CARI Shyama | · | 235.88 <u>+</u> 9.47 | Malik et al. |
| | | | | (2009) |
| | White Leghorn | | 141.73 <u>+</u> 1.54 | Jaya Laxmi et al. |
| | | | | (2010) |
| | White Leghorn | | 138.55 <u>+</u> 1.51 | Jaya Laxmi et al. |
| | | | | (2011) |
| | Coloured broile | er dam | 668.57 <u>+</u> 7.08 | Malik(2011) |
| | line | | | |
| | Black Rock | | 455.87 <u>+</u> 8.87 | Debata et al. |
| | Red Cornish | | 456.61 <u>+</u> 6.56 | (2012) |
| | Vanaraja | | 448.46 <u>+</u> 7.32 | |
| | Vanaraja | M | 364.86 <u>+</u> 5.11 | Padhi <i>et al</i> . |
| | | F | 343.95 <u>+</u> 5.16 | (2012a) |
| | | P | 355.80 <u>+</u> 3.73 | |
| | Vanaraja | M | 327.37 <u>+</u> 0.03 | |
| | | F | 302.81 <u>+</u> 0.04 | Padhi <i>et al</i> . |
| | | P | 316.72 <u>+</u> 0.02 | (2012b) |
| | Vanaraja | | 316.47 <u>+</u> 2.47 | Jha and |
| | Gramapriya | | 168.85 <u>+</u> 1.53 | Prasad(2013) |
| | Aseel | | 127.83 <u>+</u> 1.18 | |
| | Hazra | | 162.45 <u>+</u> 2.48 | Jha et al. |
| | Aseel | | 127.43 <u>+</u> 1.28 | (2013) |
| | Kadaknath | | 114.86 <u>+</u> 1.63 | |
| 6 th week | Synthetic | M | 1057.92 | Malik et al. |
| | Broiler | F | 956.97 | (1997) |
| | Overall | M | 1368.80 | Padhi et al. |
| | (OBNP,IC-3, | F | 1171.98 | (1997) |
| | SML-2,IR-3) | С | 1268.7 | |
| | Broiler | | 631.75 <u>+</u> 3.52 | Bhushan and |
| | | | _ | Singh(1998) |
| | | | | |

| 6 th week | Strains of WLH | | | |
|----------------------|------------------|--------|-----------------------|---------------------------|
| | MM | | 259.40 | |
| | NN | | 225.14 | |
| | PP | | 247.39 | |
| | MN | | 255.09 | Gupta <i>et al</i> . |
| | MP | | 267.24 | (1999) |
| | NP | | 269.59 | (1999) |
| | NM | | 237.09 | |
| | PM | | 252.89 | |
| | PN | | 244.89 | |
| | Synthetic Broile | er | 553.60+41.01 | |
| | Naked Neck cro | | | Padhi <i>et al.</i> |
| | Synthetic Broile | er | 227.28+22.90 | (1999a) |
| | Naked neck | | 161.45+11.10 | (====, |
| | Synthetic Broile | er M | 520.4 <u>+</u> 13.6 | |
| | (SB) | F | 456.4 <u>+</u> 11.3 | |
| | Black Nicobari | M | 143.5 <u>+</u> 6.4 | |
| | (BN) | F | 134.7 <u>+</u> 2.8 | |
| | White Nicobari | M | 170.3 <u>+</u> 4.9 | Padhi <i>et al</i> . |
| | (WN) | F | 141.5 <u>+</u> 3.4 | (1999b) |
| | SB X BN | M | 259.5 <u>+</u> 14.4 | |
| | | F | 291.7 <u>+</u> 13.9 | |
| | SB X WN | M | 250.2 <u>+</u> 11.8 | |
| | | F | 241.2 <u>+</u> 20.6 | |
| | CARI Shyama | M | 387.63 <u>+</u> 1.64 | |
| | | F | 302.26 <u>+</u> 6.08 | Malik <i>et al</i> . |
| 1 | | С | 324.97 <u>+</u> 15.06 | (2009) |
| | White Leghorn | | 234.61 <u>+</u> 2.55 | Jaya Laxmi et al. |
| | | | | (2010) |
| | DO8 chicken | M | 455.88 <u>+</u> 10.91 | |
| | Variety | F | 411.06 <u>+</u> 5.63 | Malik et al. |
| | | С | 422.59 <u>+</u> 5.21 | (2011) |
| | Coloured broiler | dam | 1360 <u>+</u> 0.008 | Malik(2011) |
| | line | | , | |
| | White Leghorn | | 238.04 <u>+</u> 2.36 | Jaya Laxmi <i>et al</i> . |
| | , | | | (2011) |
| | Vanaraja | M | 538.45 <u>+</u> 9.92 | Padhi et al. |
| | | F | 496.42 <u>+</u> 11.01 | (2012a) |
| | | P | 520.24 <u>+</u> 7.51 | |
| | Vanaraja | M | 589.43 <u>+</u> 0.06 | Padhi et al. |
| | | F | 533.77 <u>+</u> 0.07 | (2012b) |
| | | P | 565.67 <u>+</u> 0.03 | |

| 6 th week | | | |
|----------------------|----------------------|------------------------|--|
| o week | Vanaraja | | Padhi and |
| | vanaraja | 568 <u>+</u> 0.20 | Chatterjee |
| | 77 | | (2012) |
| | Vanaraja | 629.23 <u>+</u> 3.02 | Jha and Prasad |
| | Gramapriya | 357.48 <u>+</u> 2.97 | (2013) |
| | Aseel | 186.71 <u>+</u> 2.54 | |
| | Hazra | 276.73 <u>+</u> 3.12 | Jha et al. |
| | Aseel | 186.78 <u>+</u> 2.55 | (2013) |
| | Kadaknath | 152.42 <u>+</u> 2.87 | , , |
| 8 th week | Synthetic Broiler M | 725.9 <u>+</u> 28.5 | |
| | (SB) F | 698.3 <u>+</u> 19.9 | |
| | Black Nicobari M | 236.5 <u>+</u> 9.1 | |
| | (BN) F | 206.2 <u>+</u> 3.8 | |
| | White Nicobari M | 252.0 <u>+</u> 0.76 | Padhi <i>et al</i> . |
| | (WN) F | 212.1 <u>+</u> 4.6 | (1999b) |
| | SB X BN M | 463.4 <u>+</u> 30.6 | · |
| | F | 449.0 <u>+</u> 24.6 | |
| | SB X WN M | 444.1 <u>+</u> 22.6 | |
| | F | 370.6 <u>+</u> 28.8 | |
| | Red Cornish | 1353.44 <u>+</u> 0.48 | Sati <i>et al.</i> (1999) |
| | Red Cornish M | 1680.40 | Singh et al. |
| | (Control line) F | 1602.52 | (2000) |
| | Overall | 1641.46 | |
| | White Leghorn | 473.1 <u>+</u> 2.40 | Chaudhary <i>et</i> <i>al.</i> (2009) |
| | CARI Shyama M | 545.50 <u>+</u> 17.97 | |
| | F | 414.54 <u>+</u> 9.03 | Malik <i>et al.</i> |
| | C | 460.29 <u>+</u> 7.66 | (2009) |
| | DO8 chicken M | 707.14 <u>+</u> 19.66 | |
| | F | 626.94 <u>+</u> 7.89 | Malik <i>et al</i> . |
| | С | 646.91 <u>+</u> 7.97 | (2011) |
| | Coloured broiler dar | n 1760 <u>+</u> 0.001 | Malik(2011) |
| | Black Rock | 974.19 <u>+</u> 21.43 | Debata et al. |
| | Red Cornish | 1039.17 <u>+</u> 21.29 | (2012) |
| | Vanaraja | 1003.08 <u>+</u> 20.28 | |
| | Hazra | 384.54+4.23 | Jha et al. |
| | Aseel | 273.72 <u>+</u> 3.52 | (2013) |
| | Kadaknath | 238.86 <u>+</u> 3.76 | ` ' |
| | Vanaraja | 832.51 <u>+</u> 4.53 | Jha and |
| | Gramapriya | 498.76 <u>+</u> 3.86 | Prasad(2013) |
| | Aseel | 273.78 <u>+</u> 3.57 | |
| | | | |

| 10thweek | CARI Shyama | M | 601 22 01 00 | 3.6-121. |
|-----------------------|------------------|----------|------------------------|----------------------|
| | orac onyuma | F | 691.33 <u>+</u> 21.20 | Malik et al. |
| | | C | 575.43 <u>+</u> 23.85 | (2009) |
| | White Leghorn | | 628.62 <u>+</u> 16.79 | |
| | writte regitorii | | 495.48 <u>+</u> 3.93 | Jaya Laxmi et al. |
| | DO8 chicken | 1. | | (2010) |
| | DO8 chicken | M | 870.79 <u>+</u> 17.16 | |
| | | F | 759.37 <u>+</u> 11.03 | Malik <i>et al</i> . |
| | 7771 ' T 1 | <u>C</u> | 786.16 <u>+</u> 10.62 | (2011) |
| | White Leghorn | | 507.10 <u>+</u> 4.08 | Jaya Laxmi et al. |
| | D: | | | (2011) |
| | Rajasree chicks | M | 629.6 | Daida <i>et al</i> . |
| 10ah 1 | | F | 531.8 | (2012) |
| 12 th week | CARI Shyama | M | 873.34 <u>+</u> 22.70 | |
| | | F | 725.59 <u>+</u> 27.09 | Malik et al. |
| | | С | 793.39 <u>+</u> 19.00 | (2009) |
| | DO8 chicken | M | 1096 <u>+</u> 30 | Malik et al. |
| | | F | 1013 <u>+</u> 16 | (2011) |
| | | С | 969.5 <u>+</u> 19 | |
| | Rajasree chicks | M | 765.7 | Daida et al. |
| | | F | 697.8 | (2012) |
| | Black Rock | | 1376.31 <u>+</u> 26.17 | |
| | Red Cornish | | 1438.16 <u>+</u> 29.56 | Debata et al. |
| | Vanaraja | | 1399.83 <u>+</u> 27.8 | (2012) |
| | Hazra | | 614.83 <u>+</u> 5.39 | Jha et al. |
| | Aseel | | 416.25 <u>+</u> 4.78 | (2013) |
| | Kadaknath | | 372.98 <u>+</u> 4.85 | , , |
| | Vanaraja | | 1072.63±5.59 | Jha and |
| | Gramapriya | | 824.68 <u>+</u> 4.75 | Prasad(2013) |
| | Aseel | | 416.25 <u>+</u> 4.72 | , |
| 14thweek | CARI Shyama | M | 1055.32 <u>+</u> 28.40 | Malik et al. |
| | | F | 867.52 <u>+</u> 21.61 | (2009) |
| | | С | 958.84+19.37 | , , |
| | DO8 chicken | M | 1339+33 | Malik et al. |
| | | F | 1208+19 | (2011) |
| | | С | 1253+17 | (/ |
| | Rajasree chicks | M | 867.3 | Daida <i>et al.</i> |
| | _ | F | 786.8 | (2012) |
| 16thweek | White Leghorn | | 1000+4.02 | Chaudhary et al. |
| | | | | (2009) |
| | CARI Shyama I | VI | 1225 <u>+</u> 27 | Malik et al. |
| | I | <u>ਜ</u> | 999 <u>+</u> 24 | (2009) |
| | | | 1108 <u>+</u> 20 | |

| 16thweek | White Leghorn | | 000 57 5 56 | Town Towns 1 |
|-----------------------|------------------|-----|------------------------|---------------------------|
| | Willie Begiloffi | | 909.57 <u>+</u> 5.56 | Jaya Laxmi et al. |
| : | | | | (2010) |
| | DO8 chicken | M | 1611 <u>+</u> 29 | Malik <i>et al.</i> |
| | | F | 1460±19 | (2011) |
| | | C | 1519+16 | (2011) |
| | White Leghorn | | 907.46±4.92 | Jaya Laxmi <i>et al.</i> |
| | | |) 507.10 <u>-</u> 4.92 | _ |
| | Rajasree chicks | M | 920.9 | (2011) Daida <i>et</i> |
| | | F | 851.0 | 1 |
| | Black Rock | | 1681.32 <u>+</u> 31.64 | al.(2012) Debata et al. |
| | Red Cornish | | 1827.54 <u>+</u> 38.26 | 1 |
| | Vanaraja | | 1725.75 <u>+</u> 32.48 | (2012) |
| | Vanaraja | | | Y1 1 |
| | Gramapriya | | 1567.85 <u>+</u> 6.38 | Jha and |
| | Aseel | | 1263.46 <u>+</u> 5.90 | Prasad(2013) |
| | Hazra | | 628.36 <u>+</u> 5.35 | 71 |
| | Aseel | | 1056.82±6.31 | Jha et al. |
| | Kadaknath | | 678.37 <u>+</u> 5.36 | (2013) |
| | | 3.6 | 624.56 <u>+</u> 5.80 | |
| 18 th week | CARI Shyama | M | 1421 <u>+</u> 31 | Malik et al. |
| | | F | 1167 <u>+</u> 24 | (2009) |
| | D00 1:1 | C | 1289 <u>+</u> 22 | |
| | DO8 chicken | M | 1951 <u>+</u> 26 | Malik et al. |
| | | F | 1604 <u>+</u> 24 | (2011) |
| | | С | 1733 <u>+</u> 24 | |
| | Rajasree chicks | M | 1050.7 | Daida <i>et al.</i> |
| | | F | 925.0 | (2012) |
| | | • | 520.0 | (2012) |
| | White Leghorn | | 1115 <u>+</u> 5.0 | Chaudhary <i>et</i> |
| | | | 1110 - 0.0 | al.(2009) |
| | CARI Shyama | | 1594+24 | Malik et al. |
| | | F | 1195 <u>+</u> 21 | (2009) |
| | | C | 1386+23 | (200) |
| | White Leghorn | | 1143.83+6.64 | Jaya laxmi <i>et al.</i> |
| | | | 1110.00 <u>-</u> 0.01 | (2010) |
| 20 th week | DO8 chicken | M | 2292 <u>+</u> 36 | Malik et al. |
| | | F | 1760 <u>+</u> 35 | (2011) |
| | | c | 1976 <u>+</u> 35 | (/ |
| | | - | | |
| | White Leghorn | | 1155.56 <u>+</u> 5.99 | Jaya Laxmi et al. |
| | | | 1100.00_0.55 | (2011) |
| | Vanaraja | | 2036+0.57 | Padhi and |
| | , azaraja | | 2000_0.07 | |
| | | | j | Chatterjee |

| | | (2012) |
|-------------------|------------------------|----------------|
| Rajasree chicks M | 1160.6 | Daida et al. |
| F | 1006.9 | (2012) |
| Black Rock | 1976.31 <u>+</u> 39.29 | Debata et al. |
| Red Cornish | 2202.30 <u>+</u> 44.32 | (2012) |
| Vanaraja | 2040.54 <u>+</u> 41.27 | , |
| Vanaraja | 2103.39 <u>+</u> 7.39 | Jha and Prasad |
| Gramapriya | 1574.31 <u>+</u> 6.87 | (2013) |
| Aseel | 1038.75 <u>+</u> 6.83 | , |
| Hazra | 1294.38 <u>+</u> 7.35 | Jha et al. |
| Aseel | 1038.72 <u>+</u> 6.73 | (2013) |
| Kadaknath | 957.45 <u>+</u> 6.84 | • |

M=Male, F=Female, C=Combined sex, WL=White Leghorn, WC=White Cornish, RC=Red Cornish, WPR=White Plymouth Rock, NH=New Hampshire, RIR=Rhode Island Red, PB=Pure Bred, RC=Red Cornish, WR=White Rock.

AVERAGE CONFORMATION TRAITS AT DIFFERENT WEEKS OF AGE IN VARIOUS GENETIC GROUPS OF POULTRY

Body Conformation, which constitutes bone structure is considered a better measure of performance of birds. Conformation traits like Shank length, Keel length etc. are indicator of skeletal growth. In addition to this, incorporation of some of the conformation traits in a selection index along with body weight would give better result than selection based on body weight alone.

Shank Length

Chhabra et al. (1972) studied the shank length, growth in different broiler breeds of poultry and their crosses. They reported the mean shank length to be 6.98cm,

7.16cm, 7.07cm and 7.20cm in WR X WR, WR X WC, WC X WC and WC X WR crosses respectively at 10th week of age.

Aggarwal et al. (1979) evaluated the shank length in a 4 X 4 complete diallel cross involving 4 broiler strains of chicken belonging to Rock and Cornish breeds. They reported that mean shank lengths at 10th week of age among different genetic groups ranged from 69.0±0.5 mm to 81.0±0.5 mm in males, 67.0±0.4 mm to 76.0±0.6 mm in females and 68.0±0.4 mm to 78.01±0.4 mm in combined sexes.

Verma *et al.* (1979) used shank length at early ages as a predictor of 12 week body weight and reported the mean shank lengths in White Leghorn X Rhode Island Red birds to be 2.40 cm, 3.30 cm, 4.40 cm and 4.95 cm at dayold, 4th, 6th and 8th week of age respectively in males. The corresponding values in females were noted as 2.39 cm, 3.16 cm, 3.85 cm and 4.61 cm.

Mahapatra *et al.* (1983) studied the shank length at 10th, 11th, and 12th week of age in Aseel Peela, Aseel kagar and their crossbred. They found the average shank lengths pooled over ages to be 6.24 cm, 6.88 cm and 6.79 cm in Aseel Peela, Aseel Kagar and their crossbred birds respectively.

Sharma (1984) studied the shank length in White Plymouth Rock (WPR) and Red Cornish (RC) breeds of poultry and their reciprocal crosses at 8th week of age. He reported the mean shank lengths in WR (M) X WR (F), RC (M) X RC (F), RC (M) X WR (F) and WR (M) X RC (F) genetic groups to be 6.71 cm, 6.85 cm, 7.13 cm, 6.90 cm respectively. The corresponding values in females were observed to be 6.04 cm, 6.17 cm, 6.56 cm and 6.25 cm, whereas the corresponding values of shank length in combined sex were noted as 6.25 cm, 6.34 cm, 6.82 cm and 6.48 cm.

Venkatesh (1985) studied the effect of sex on shank length of White Plymouth Rock and Red Cornish crosses in poultry. He reported the mean shank length at 8th week of age to be 6.67 cm, 6.46 cm and 6.64 cm in males of RC (M) X WR (F), WR (M) X RC (F) and pooled over crosses respectively. The corresponding values in females were observed to be 6.25 cm, 6.11 cm and 6.20 cm.

Malik *et al.* (1997) studied the inheritance of shank length in a synthetic strain of broiler chicken and reported the mean shank lengths at 6th week of age to be 7.08 cm and 6.89 cm in males and females respectively.

Reddy et al. (1998) studied the broiler traits in Red Cornish and shank lengths in IC-3 strain of Red Cornish, IR-3 strain of White Rock and their crosses pooled over

sexes to be 5.60 cm, 5.85 cm, and 5.75 cm respectively at 6th week of age.

Padhi *et al.* (1999a) reported the average shank lengths at 8th week of age in normal, homozygous and heterozygous birds for Naked Neck gene to be 4.3 cm, 4.65 cm and 4.89 cm respectively.

Padhi et al. (1999b) compared the performance of Nicobari fawls, Synthetic broiler and their crosses and observed the average shank lengths of male Black Nicobari (BN), White Nicobari (WN), Synthetic Broiler (SB), SB X BN and SB X WN to be 4.09 cm, 4.09 cm, 5.75 cm, 5.27 cm and 4.27 cm respectively at 8th week of age. The corresponding values in females were found to be 3.70 cm, 3.83 cm, 5.46 cm, 5.06 cm and 3.88 cm.

Singh *et al.* (1999a) studied the genetic effect on conformation traits in pure and crossbred chicken. They reported the average shank lengths in Aseel (A), Naked Neck (N) and Dahlem Red (D) males at 5th week of age to be 4.65 cm, 4.66 cm and 5.01 cm respectively. The corresponding values in females were obtained as 4.51 cm, 4.39 cm and 4.79 cm. The average shank lengths at 5th week of age in D X A, A X D, D X N, N X D males were obtained to be 4.93 cm, 4.95 cm, 4.84 cm and 4.93 cm respectively, whereas the corresponding values in females were found to be 4.83 cm, 4.76 cm, 4.65 cm and 4.45 cm.

Singh et al. (2000) reported the average 8th week shank lengths in control line of Red Cornish breed of poultry to be 6.37 cm, 6.01 cm and 6.24 cm in male, female and combined sexes respectively.

Khurana *et al.* (2006) studied the shank length, shank diameter, keel length, Abdominal span and pubic span in White Leghorn. They reported the mean shank length to be 2.77±0.02 cm, 3.82±0.02 cm, 5.40±0.02 cm, 7.18±0.03 cm, 7.31±0.03 cm, 7.59±0.03 cm, 7.50±0.03 cm, 7.53±0.04 cm, 7.51±0.04 cm respectively at 2nd, 4th, 8th, 16th, 24th, 32th, 40th, 46th, 52nd week of age.

Kalita *et al.* (2011) studied the different traits of Vanaraja reared under intensive system of management. Mean shank length at 40th week of age were recorded as 52.59±4.32 mm during the study.

Padhi et al. (2012a) reported the average 6th week shank lengths in males of PD-1, Vanaraja and control broiler to be 70.70±0.40 mm, 73.30±0.62 mm and 81.62±0.73 mm respectively and 68.04±0.33 mm, 70.20±0.52 mm and 78.49±0.63 mm in females respectively.

Padhi et al. (2012b) studied the juvenile traits in Vanaraja male line. They reported the mean shank length to

be 72.29±0.003 mm in male and 68.93±0.004 mm in female at 6th week of age.

Padhi and Chatterjee (2012) studied the inheritance of shank length in PD1(Vanaraja male line). They reported the mean shank lengths to be 71.93±0.01 mm, 106.57±0.01 mm, 106.58±0.01 mm, 106.66±0.01 mm and 108.01±0.24 mm respectively at 6th, 20th, 22nd, 40th and 72nd week of age.

Jha and Prasad (2013) studied the production performance of Vanaraja, Gramapriya and Aseel birds in Jharkhand. They reported the mean shank length to be 87.43±0.67 mm, 79.86±0.73 and 71.95±0.85 mm respectively in Vanaraja, Gramapriya and Aseel birds at 40th week of age.

Keel length

Mahapatra *et al.* (1983) reported the average keel lengths pooled over 10th, 11th and 12th weeks of age in Aseel Peela, Aseel Kagar and their crossbreds to be 7.04 cm, 7.72 cm and 7.61 cm respectively.

Sharma (1984) observed the average 8th week keel lengths in WR (M) X WR(F), RC (M) X RC (F), RC (M) X WR (F) and WR (M) X RC(F) genetic groups to be 8.02 cm, 8.20 cm, 8.67 cm and 8.30 cm respectively in males. The corresponding average values in females were noted as 7.05 cm, 7.20 cm, 7.79 cm and 7.37 cm, whereas the

corresponding values of keel length in combined sexes were found to be 7.35 cm, 7.45 cm, 8.18 cm and 7.67 cm.

Venkatesh (1985) examined the effect of age, sex and breed on carcass characteristics of White Rock and Red Cornish crosses in poultry and observed the mean keel lengths at 8th week of age to be 7.68 cm, 7.56 cm and 7.62 cm in males of RC (M) X WR (F), WR (M) X RC (F) and pooled over crosses respectively. The corresponding values in females were found to be 7.29 cm, 7.04 cm and 7.14 cm.

Malik et al. (1997) studied the genetic and phenotypic parameters of keel length in a synthetic broiler strain of chicken and observed the average 6th week keel lengths to be 8.09 cm and 7.89 cm in males and females respectively.

Singh et al. (1999a) studied the effect of different genetic groups on conformation traits in poultry and observed the mean keel lengths in Aseel (A), Naked Neck (N) and Dahlem Red (D) males at 5th week of age to be 5.60 cm, 5.67 cm and 5.87 cm respectively. The corresponding values in females were found to be 5.44 cm, 5.36 cm and 5.53 cm. They further observed the average keel lengths at 5th week of age in D X A, A X D, D X N and N X D males to be 5.94 cm, 6.06 cm, 5.87 cm and 6.04 cm respectively, whereas the corresponding values in females were found to be 5.84 cm, 5.85 cm, 5.79 cm and 5.60 cm.

Singh et al. (2000) studied the genetic and phenotypic parameters of broiler traits in different lines of Red Cornish and observed the average keel lengths at 8th week of age to be 8.23 cm, 7.81 cm and 8.02 cm in control line of male, female and combined sexes respectively.

Khurana *et al.* (2006) studied the conformation traits in White Leghorn. They reported the mean keel length to be 7.22±0.03 cm, 10.25±0.05 cm, 10.43±0.10, 10.23±0.12 cm, 10.49±0.12 cm, 10.40±0.12 cm and 10.52±0.12 cm respectively at 8th, 16th, 24th, 32nd, 40th, 46th, and 52nd week of age.

Kalita *et al.* (2011) studied the different traits of Vanaraja reared under intensive system of management. They recorded the mean keel length at 40th week of age to be 72.58+9.56 mm.

Feed efficiency

Feed efficiency is percent increase in body weight by supplying 1 kg feed to chickens. The term is related to feed conversion ratio (FCR), which is ratio of total amount of feed consumed to total body weight. Feed efficiency is moderately heritable. Improvement in feed efficiency in commercial stock has been achieved as a correlated response to selection for high growth rate or egg production.

Rama Rao *et al.*(2006) conducted the study to evaluate the effect of dietary protein level on performance of Vanaraja chicks. They reported the FCR at 3rd, 5th and 7th week to be 2.15, 2.54 and 2.69 respectively, by feeding 14.5% crude protein in diet.

Dhage *et al.* (2009) studied the FCR in different treatment groups of broiler chicks. They reported FCR to be 2.02, 2.15, 2.46 and 2.17 in T₀, T₁, T₂, and T₃ treatment group respectively.

Rajpura *et al.* (2010) studied the growth and feed efficiency in coloured crossbred broilers of various genetic groups reared on different dietary energy and protein levels. They reported the FCR at 8th week of age in BBRIR, BRIRB, BBNN, BBK, BBWLH, BBAK, BBAP and BBF to be 2.86 \pm 0.08, 2.85 \pm 0.06, 2.86 \pm 0.05, 2.89 \pm 0.08, 2.74 \pm 0.05, 2.62 \pm 0.06, 2.58 \pm 0.02 and 2.65 \pm 0.12 respectively with treatment diet of CP 20% and ME 2700 K Cal/Kg.

Effect of sex on body weight at different weeks of age

Literature reveals sexual dimorphism for body weight in chicken. Males, in general, have heavier body weight than their female counterparts at different weeks of age. The reports given by various authors are reviewed as below:

Verma et al. (1981) found that the mean body weights of males of WL X RIR cross was higher than females by 0.7

g, 8.26 g and 36.2 g at day old, 4 and 8 weeks of age respectively.

Gupta (1983) observed that the average body weights of White Rock male chicks were heavier than their female counterparts by 23.36 g and 41.80 g at 4th and 6th week of age respectively.

Padhi et al.(1999b) studied the sexual dimorphism for body weights in different genetic groups of poultry and reported that the males of Black Nicobari(BN) were heavier by 8.85 g, 8.80 g and 30.3 g than females at 4th, 6th and 8th week of age respectively. The corresponding increment in males of White Nicobari(WN) breed was observed to be17.3 g, 28.8 g and 39.9 g, whereas in Synthetic Broiler strain(SB) it was observed to be 12.7 g, 64.3 g and 27.6 g.

Singh *et al.* (2000) reported that the average body weights of Red Cornish male chicks were heavier than females by 1.10 g, 49.45 g and 77.88 gm at day old, 5th and 8th week of age respectively.

Padhi *et al.* (2012) reported that Vanaraja males were significantly (P<0.05) heavier than females by 0.36g, 7.58g, 24.56g and 55.66g at day old, 2ndweek, 4thweek and 6thweek of age respectively.

Singh *et al.* (2012) reported that PB-2 males were significantly (P<0.05) heavier than PB-2 females by 60.83 g

and 216.94g at 3rdand 5thweek of age respectively, but in control line sex differences were found to be non-significant.

Sexual dimorphism in Conformation traits Shank length

Sharma (1984) observed significantly (P<0.05) lengthier shank in males than those of females in pure White Plymouth Rock(WR) and Red Cornish(RC) breeds of poultry as well as in WR(F) X RC(M) and RC(F) X WR(M) genetic groups.

Malik *et al.*(1997) reported the mean shank length of males to be lengthier by 0.19 cm than their female counterparts at 6th week of age in synthetic broiler chicks.

Padhi et al.(1999b) found that the average shank lengths of the males of Black Nicobari (BN), White Nicobari (WN), Synthetic Broiler(SB), SB X BN and SB X WN were lengthier than their female counterparts by 0.39 cm, 0.26 cm, 0.29 cm, 0.21 cm and 0.39 cm respectively at 8th week of age.

Singh *et al.*(2000) observed the average shank of males of Red Cornish breed to be lengthier than females by 0.36 cm at 8th week of age.

Padhi *et al.* (2012) observed the average shank of males of Vanaraja to be significantly (P<0.05) lengthier than females by 0.31 cm at 6th week of age.

Singh *et al.* (2012) observed the average shank of males of PB-2 lines (Broiler chickens) to be lengthier than females by 0.22 cm and .034 cm at 3rd and 5th week of age respectively.

Keel length

Sharma (1984) studied the effect of sex on various genetic groups in poultry and observed that males of White Plymouth Rock(WR), Red Cornish(RC), WR(F) X RC(M) and RC(F) X WR(M) had significantly (P<0.05) longer keels than their female counterparts by 0.97 cm, 1.00 cm, 0.88 cm and 0.93 cm respectively at 8th week of age.

Malik *et al.*(1997) reported the average keel length of males to be significantly (P<0.05) lengthier by 0.20 cm than females at 6th week of age in synthetic broiler chicks.

Singh *et al.*(2000) reported the mean keel length of males of Red Cornish breed to be lengthier than females by 0.42cm at 8th week of age.

Heterosis

Bruce (1910) explained heterosis as the combined action of favourable dominant or partially dominant factors. According to Falconer (1960), heterosis or hybrid vigour is complementary to the phenomenon of inbreeding depression. He opined that, in general, the fitness lost on inbreeding tends to be restored on crossing. Therefore,

heterosis on crossing is expected to be equal to the depression on inbreeding. According to him the amount of heterosis shown by the F_1 and F_2 would be measured as the deviation from the mid parent value, i.e. as the differences from the mean of the two parent population. Lasley (1978) suggested the genetic explanation of heterosis to be dominance, over dominance and epistasis.

The superiority of crossbreds over the purebreds with respect to growth and conformation traits have been reported by various research workers.

Sharma (1984) reported the heterosis percentage in the males of WR(F) X RC(M) crossbreds to be2.19, 12.53, 20.19, 29.87, 36.13 and 38.53% at day old, 4th, 5th, 6th, 7th and 8th week of age respectively. The corresponding positive heterosis percentages in female crossbreds were obtained as 0.66, 3.02, 7.56, 11.30, 13.80 and 13.65 % suggesting an increase in the heterosis % with the advancement of age in both the sexes.

Reddy et al. (1998) studied heterosis for the broiler traits in Red Cornish(IC-3), White Rock(IR-3) and IC-3 X IR-3 genetic groups. They reported that the heterosis percentages were positive and significant (P<0.05) which ranged from 0.50 to 9.87 in IC-3 X IR-3 cross for 1, 3, 4 and 5 weeks body weights.

Gupta et al. (1999) conducted an experiment using three strains (M, N and P) of WLH and found that the average body weights of all the F_1 were superior to purebreds at day old, 2, 4 and 6 weeks of age.

Malik et al. (2005) reported that strain cross pullet were lighter than purebreds at 20 weeks of age.

Singh and Singh (2005) reported that crossbreds were superior to purebreds in body weights at 20 and 40 weeks of age.

Laxmi et al. (2009) conducted an experiment using three White Leghorn strains viz.,IWH, IWI and IWK. The heterosis for body weight at 20 weeks was positive and significant (P<0.01) in all crosses based on mid parent while it was negative for body weight at 40 weeks.

Shank length

Sharma (1984) reported 14.08 and 4.96% heterosis for 8-week shank length in males and females of RC(M) X WR(F) crossbred respectively.

Reddy *et al.* (1998) observed positive heterosis of 0.34% for 6th week shank length in IC-3 X IR-3 cross.

Keel length

Sharma (1984) observed 17.96% and 5.99% heterosis in male and female respectively for 8-week keel length in RC(M) X WR(F).

Padhi *et al.*(1998) reported heterosis ranging from - 2.96 to 6.92% for 6-week keel length in a 4 x 4 diallel cross involving SML-2, IC-3, OBNP and IR-3 broiler lines of poultry.

Phenotypic correlations

The association between two characters that can be directly observed is the phenotypic correlation which may be due to genetic, environmental or due to the combination of both the factors (Falconer, 1960).

Correlations among economic traits are one of the key factors in formulating strategies in breeding experiments especially response to selection, as the direction and magnitude of correlations between two traits would determine the genetic changes in principal as well as in the correlated traits.

The estimates of phenotypic correlations among various body weight and conformation traits are summarized as below:

Table-2: Phenotypic correlations among body weight at different weeks of age in pure and crossbred chicken

| Traits | Breed of poultry | Phenotypic correlation coefficient | Authors |
|---|------------------|------------------------------------|-------------------------|
| 1 | 2 | 3 | 4 |
| 4-week body weight x 6-week body weight | White Leghorn | 0.777 | Jaya Laxmi et al.(2010) |
| 4-week body weight x 10-week body weight | | 0.607 | |
| 4-week body weight x 16-week body weight | | 0.377 | |
| 4-week body weight x 20-week body weight | | 0.246 | |
| 4-week body weight x 40-week body weight | | 0.164 | |
| 4-week body weight x 52-week body weight | | 0.169 | |
| 4-week body weight x 64-week body weight | | 0.155 | |
| 6-week body weight x 10-week body weight | | 0.642 | |
| 6-week body weight x 16-week body weight | | 0. 144 | |
| 6-week body weight x 20-week body weight | | 0.224 | |
| 6-week body weight x 40-week body weight | | 0.195 | |
| - | | 0.175 | |
| 6-week body weight x 52-week body weight | | 0.175 | |
| • | | | |
| 6-week body weight | | 0.140 | |
| x 64-week body weight | | | |
| 1 | 2 | 3 | 4 |

| 10-week body weight | White | 0.542 | Jaya Laxmi et |
|-----------------------|----------|-------|------------------|
| x 16-week body weight | Leghorn | | al.(2010) |
| 10-week body weight | | 0.296 | |
| x 20-week body weight | | | |
| 10-week body weight | | 0.256 | |
| x 40-week body weight | | | |
| 10-week body weight | | 0.223 | : |
| x 52-week body weight | | | |
| 10-week body weight | | 0.170 | |
| x 64-week body weight | | | |
| 16-week body weight | | 0.306 | |
| x 20-week body weight | | | |
| 16-week body weight | | 0.313 | |
| x 40-week body weight | | | |
| 16-week body weight | | 0.256 | |
| x 52-week body weight | | | |
| 16-week body weight | | 0.235 | |
| x 64-week body weight | | | |
| 20-week body weight | | 0.278 | |
| x 40-week body weight | | | |
| 20-week body weight | | 0.273 | |
| x 52-week body weight | | | |
| 20-week body weight | | 0.235 | |
| x 64-week body weight | | | |
| 40-week body weight | | 0.489 | |
| x 52-week body weight | | | |
| 40-week body weight | | 0.457 | |
| x 64-week body weight | | | |
| 52-week body weight | | 0.724 | |
| x 64-week body weight | | | |
| 20-week body weight | Vanaraja | 0.36 | Padhi and |
| X 40-week body weight | | | Chatterjee(2012) |

Table-3: Phenotypic correlations among body weight and conformation traits at different weeks of age in pure and crossbred chicken

| Traits | Breed of poultry | Phenotypic correlation coefficient | Authors |
|---|------------------|--|--------------------------------|
| 1 | 2 | 3 | 4 |
| 20-week body weight x 16-week shank length | | 0.22 | |
| 20-week body weight x 32-week shank length | | 0.24 | |
| 20-week body weight x 40-week shank length | White Leghorn | 0.27 | Khurana <i>et</i> al.(2006) |
| 40-week body weight x 16-week shank length | | 0.25 | |
| 40-week body weight x 32-week shank length | | 0.29 | |
| 40-week body weight x 40-week shank length | | 0.34 | |
| 40-week body weight x 20-week shank length | | 0.10 | |
| 40-week body weight x 22-week shank length | Vanaraja | 0.19 | Padhi and Chatterjee (2012) |
| 40-week body weight x 40-week shank length | | 0.36 | |
| 20-week body weight x 20-week shank length | | 0.30 | |
| 20-week body weight x 22-week shank length | Vanaraja | 0.16 | Padhi and Chatterjee (2012) |
| 20-week body weight x 40-week shank length | | 0.24 | |

| 1 | 2 | 3 | 4 |
|---|---------------------|----------------------|--------------------------------|
| 3-week body weight x 3-week shank length | Broiler chickens | 0.457 <u>+</u> 0.014 | Singh <i>et al.</i> (2000) |
| 5-week body weight x 5-week shank length | | 0.571 <u>+</u> 0.014 | |
| 20-week body weight x 16-week keel length | | 0.33 | |
| 20-week body weight x 32-week keel length | | 0.28 | |
| 20-week body weight x 40-week keel length | | 0.28 | |
| 40-week body weight x 6-week keel length | White Leghorn | 0.15 | Khurana <i>et</i> al.(2006) |
| 40-week body weight x 32-week keel length | | 0.43 | |
| 40-week body weight x 40-week keel length | | 0.45 | |

Table-4: Phenotypic correlations between shank length and keel length at different weeks of age in pure and crossbred chicken

| Traits | Breed of poultry | Phenotypic correlation coefficient | Authors |
|---|------------------|------------------------------------|--------------------------------|
| 1 | 2 | 3 | 4 |
| 16-week shank length x 16-week keel length | | 0.147 <u>+</u> 0.03 | |
| 32-week shank length x 32-week keel length | White Leghorn | 0.244 <u>+</u> 0.03 | Khurana <i>et</i> al.(2006) |
| 40-week shank length x 40-week keel length | | 0.238 <u>+</u> 0.03 | |
| 20-week shank length x 22-week shank length | | 0.44 | |
| 20-week shank length x 40-week shank length | Vanaraja | 0.46 | Padhi and Chatterjee (2012) |
| 22-week shank length x 40-week shank length | | 0.57 | |

CHAPTER -3

MATERIALS AND METHODS

MATERIALS AND METHODS

The experiment was conducted on the genetic stock of poultry involving Vanaraja, Gramapriya and their crosses maintained at I.L.F.C. farm of B. V. College Patna. The four genetic groups from the two breeds were formed in the following manner for the present investigation:

- 1. Vanaraja ♂♂ x Vanaraja ♀♀
- 2. Gramapriya ♂♂ x Gramapriya ♀♀
- 3. Vanaraja ♂♂ x Gramapriya ♀♀
- 4. Gramapriya ♂♂ x Vanaraja ♀♀

Ten males and 50 females under each genetic group were taken. The mating of male and female was done in the ratio of 1:5 in each group on random basis. All the progenies were obtained from single hatch in each group.

The number of male and female progenies at 4th week of age under different genetic groups for body weight, feed efficiency and conformation traits were as below which decreased with the advancement of age.

| Sl. No. | Genetic group | Male | Female | Total |
|---------|-----------------------------|------|--------|-------|
| 1 | VR ♂♂ x VR ♀♀ | 145 | 154 | 299 |
| 2 | GP ♂♂ x GP ♀♀ | 143 | 156 | 299 |
| 3 | VR ♂♂ x GP ♀♀ | 145 | 154 | 299 |
| 4 | GP ♂♂ x VR ♀♀ | 142 | 157 | 299 |
| | Total | 575 | 621 | 1196 |

The birds were maintained on deep litter system. Better uniform management and standard ration and clean water were provided *ad. lib* to all the birds throughout the experiment.

The traits under study were as follow:

A. Body weight traits:

- 1. Day old body weight (g)
- 2. 4 week body weight (g)
- 3. 6 week body weight (g)
- 4. 8 week body weight (g)
- 5. 10 week body weight (g)
- 6. 12 week body weight (g)
- 7. 14 week body weight (g)
- 8. 16 week body weight (g)
- 9. 18 week body weight (g)
- 10. 20 week body weight (g)

B. Conformation traits:

(a) Shank length

- 1. 4 week shank length (cm)
- 2. 8 week shank length (cm)
- 3. 12 week shank length (cm)
- 4. 16 week shank length (cm)
- 5. 20 week shank length (cm)

(b) Keel length

- 1. 4 week keel length (cm)
- 2. 8 week keel length (cm)
- 3. 12 week keel length (cm)
- 4. 16 week keel length (cm)
- 5. 20 week keel length (cm)

C. Feed efficiency

- 1. at 1 week age
- 2. at 2 week age
- 3. at 3 week age
- 4. at 4 week age
- 5. at 5 week age
- 6. at 6 week age
- 7. at 7 week age
- 8. at 8 week age

Measurement of the traits

1. Body weight:-

Body weight of each bird was measured on zero day, 4th, 6th, 8th, 10th, 12th, 14th, 16th, 18th and 20th week of age. It was recorded to the nearest 0.1 g sensitivity.

2. Shank length:-

This was measured with the help of slide caliper at 4th, 8th, 12th, 16th, and 20th week of age on left shank. Shank length was measured as the distance between point of hock and base of foot.

3. Keel length:-

This was also measured with the help of a slide caliper at 4th, 8th, 12th, 16th and 20th week of age. It was measured as the distance from the anterior end to the posterior end of the keel bone.

4. Feed efficiency:-

A measured quantity of feed was offered on first day of every week and the left over feed in the feeders weighted on last day of every week to compute the weekly feed intake. All possible measures were adopted to reduce the feed wastage. Body weight of individual chick and feed intake were recorded at weekly interval. Feed efficiency was calculated by dividing total body weight with total amount of feed consumed multiplied by 100, whereas feed conversion ratio was obtained as total amount of feed consumed divided by total body weight.

Statistical Analysis

All the data were analysed by fitting least squares analysis as per Harvey (1990) in the department of Animal

Genetics & Breeding, BVC, Patna. Some data were analysed by Microsoft excel 2010. Data were standardized before analysis.

Mean, standard error and coefficient of variation:-

The mean, standard error and coefficient of variation for all the body weight and conformation traits in all the genetic group were computed using the formulae given by Snedecor and Cochran(1994).

$$\overline{X} = \frac{\sum_{i=1}^{n} \sum_{i=1}^{\infty} x_{i}}{n}$$

$$S.E = \frac{S}{\sqrt{n}}$$

$$C.V.\% = \frac{S}{\overline{X}} \times 100$$

$$S = \frac{\sum_{i=1}^{\infty} x_{i}^{2} - (\sum_{i=1}^{\infty} x_{i}^{2})^{2}}{n}}{n-1}$$

 $\overline{X} = Mean$

 X_i = Measurement of a trait on ith bird

n = number of Observations

The following linear statistical model was used for studying the effect of sex on various body weight and conformation traits under study

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where,

 Y_{ij} is the measurement of trait on the j^{th} bird of i^{th} sex. μ is the overall population mean

S_i is the effect of ith sex.

 e_{ij} is the random error assumed to be normally and independently distributed with mean 0 and variance σ^2_{e} i.e. NID $(0, \sigma^2_{e})$.

Effect of genetic groups on various body weight and conformation traits.

The following linear statistical model was used to study the effect of genetic groups on various body weight, and conformation traits:

$$Y_{ij} = \mu + G_i + e_{ii}$$

Where,

 Y_{ij} is the measurement of a trait on the j^{th} bird of i^{th} genetic group

 μ is the overall population mean

G_i is the effect of ith genetic group

 e_{ij} is the random error assumed to be normally and independently distributed with mean 0 and variance σ^2_{e} i.e. NID $(0, \sigma^2_{e})$.

Heterosis:-

Heterosis was calculated as below:

Heterosis over the mid parent value (relative heterosis)

$$= \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$$

Where,

 $\overline{F_1}$ = average performance of F_1 (crossbred) \overline{MP} = performance of mid parent values.

Correlation Co-efficient:-

The simple correlation eoefficient on the basis of the phentypic values among different characters were computed by using the formula given by Snedecor and Cochran(1998):

$$r_{xy} = \frac{Covariance \ xy}{sa_x \cdot sa_y}$$

Where,

 χ = represents one trait.

 γ = represents another trait.

 $r_{\chi\gamma}$ = Coefficient of correlation between χ and γ traits.

 sd_{χ} = Standard deviation of the trait χ

 sd_y = Standard deviation of the trait γ

n = paired number of observations.

$$\mathbf{r}_{xy} = \frac{\sum xy - (\sum x) (\sum y)}{n}$$

$$[\sum x^2 - (\sum x)^2] [\sum y^2 - (\sum y)^2]$$

The correlation coefficients were tested for their significance through 't' test as below:

$$t_{(N-2)d.f.} = \frac{r}{S.E.(r)}$$

Where S.E. (r) =
$$\sqrt{\frac{1-r^2}{N-2}}$$

r = Estimate of phenotypic correlation coefficients between two traits

N = Paired number of observations.

CHAPTER -4

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Average body weight at various weeks in different genetic groups:

Least squares means along with CV% of body weight (g) at different weeks of age in males and females of various genetic groups have been depicted in table-5.

The mean body weight at zero day of age in $VR \partial \partial x$ $VR \mathcal{Q} \mathcal{Q}$ males and females were obtained as 39.968 (g) and 34.930 (g) respectively. Padhi *et al.*(2012a) reported the zero day body weight in $VR \partial \partial x VR \mathcal{Q} \mathcal{Q}$ to be 38.13 ± 0.033 (g) 36.98 ± 0.42 (g) respectively. Jha and Prasad (2013) have reported the pooled value of Vanaraja to be 35.91 ± 0.26 (g) at zero day of age. The findings of present study are in close proximity with the findings of above authors. Differences in the body weight might be attributed to managemental and environmental differences.

The average body weight at zero day of age in $GP \circlearrowleft x$ $GP \circlearrowleft \varphi$ was found to be 36.988 (g) and 35.153 (g) in males and females respectively. Jha and Prasad (2013) observed 33.24 (g) pooled body weight at zero day of age which is less than the findings of the present study. Environmental and managemental factors might be, possibly, responsible for the differences in body weight at this age.

Table-5: Mean squares from analysis of variance to test the effect of sex on body weight at different weeks of age in Gramapriya $\Diamond \Diamond$ x Vanaraja $\Diamond \Diamond$.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|---------------------|------|--------------|-----------|
| Zero day | Between sexes | 1 | 586.911 | 39.78** |
| | Error | 456 | 14.753 | |
| 4 th week | Between sexes | 1 | 154675.354 | 685.29** |
| | Error | 297 | 225.705 | |
| 6th week | Between sexes | 1 | 995070.228 | 738.185** |
| | Error | 267 | 1347.996 | |
| 8th week | Between sexes | 1 | 593061.563 | 185.808** |
| | Error | 256 | 3191.802 | |
| 10th week | Between sexes | 1 | 2314068.667 | 583.809** |
| | Error | 244 | 3963.743 | |
| 12 th week | Between sexes | 1 | 4847217.456 | 290.084** |
| | Error | 228 | 16709.694 | |
| 14 th week | Between sexes | 1 | 3229322.832 | 447.153** |
| | Error | 211 | 7221.958 | |
| 16 th week | Between sexes | 1 | 3573044.297 | 335.475** |
| | Error | 208 | 10650.712 | |
| 18th week | Between sexes | 1 | 14337478.325 | 286.665** |
| | Error | 197 | 50014.731 | |
| 20th week | Between sexes | 1 | 8695238.710 | 813.975** |
| | Error | 194 | 10682.434 | |

^{**} Significant at P<0.01

Table-6: Mean squares from analysis of variance to test the effect of sex on body weight at different weeks of age in Vanaraja 33 X Gramapriya 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|---------------------|------|-------------|-----------|
| Zero day | Between sexes | 1 | 204.008 | 17.782** |
| | Error | 456 | 11.472 | |
| 4th week | Between sexes | 1 | 379304.876 | 377.504** |
| | Error | 297 | 1004.769 | |
| 6 th week | Between sexes | 1 | 1562473.810 | 587.067** |
| | Error | 267 | 2661.492 | |
| 8th week | Between sexes | 1 | 2322785.205 | 384.231** |
| | Error | 256 | 6045.285 | : |
| 10 th week | Between sexes | 1 | 641688.137 | 149.530** |
| | Error | 244 | 4291.327 | |
| 12 th week | Between sexes | 1 | 1998692.685 | 293.686** |
| | Error | 228 | 6805.541 | |
| 14 th week | Between sexes | 1 | 3462297.845 | 135.187** |
| | Error | 211 | 25611.096 | |
| 16 th week | Between sexes | 1 | 1072920.812 | 356.325** |
| | Error | 208 | 3011.077 | |
| 18 th week | Between sexes | 1 | 2568640.064 | 186.591** |
| | Error | 197 | 13766.181 | |
| 20 th week | Between sexes | 1 | 5736123.773 | 347.895** |
| | Error | 194 | 16488.099 | |

^{**} Significant at P<0.01

Table-7: Mean squares from analysis of variance to test the effect of sex on body weight at different weeks of age in Gramapriya 33 X Gramapriya 99.

| Traits | Source of | D.F. | Mo | |
|-----------------------|---------------|------|-------------|-----------|
| | variation | D.F. | M.S. | F |
| Zero day | Between sexes | 1 | 377.741 | 25.3** |
| | Error | 456 | 14.93 | |
| 4 th week | Between sexes | 1 | 226241.639 | 508.61** |
| | Error | 297 | 444.82 | |
| 6 th week | Between sexes | 1 | 650199.983 | 196.662** |
| | Error | 267 | 3306.173 | |
| 8th week | Between sexes | 1 | 927293.399 | 180.194** |
| | Error | 256 | 5146.088 | |
| 10 th week | Between sexes | 1 | 1621459.29 | 175.865** |
| | Error | 244 | 9219.92 | |
| 12th week | Between sexes | 1 | 4002990.509 | 163.310** |
| | Error | 228 | 24511.626 | |
| 14 th week | Between sexes | 1 | 1295309.877 | 96.87** |
| | Error | 211 | 13371.194 | |
| 16 th week | Between sexes | 1 | 3280157.334 | 550.48** |
| | Error | 208 | 5958.69 | |
| 18th week | Between sexes | 1 | 6294584.778 | 239.531** |
| | Error | 197 | 26278.826 | |
| 20th week | Between sexes | 1 | 4509555.556 | 258.791** |
| | Error | 194 | 17425.477 | |

^{**} Significant at P<0.01

Table-8: Mean squares from analysis of variance to test the effect of sex on body weight at different weeks of age in Vanaraja 33 X Vanaraja 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|---------------------|------|--------------|-----------|
| Zero day | Between sexes | 1 | 2352.836 | 208.035** |
| | Error | 456 | 11.309 | |
| 4 th week | Between sexes | 1 | 152051.602 | 238.199** |
| | Error | 297 | 638.337 | |
| 6th week | Between sexes | 1 | 1169403.381 | 248.581** |
| | Error | 267 | 4704.315 | |
| 8th week | Between sexes | 1 | 2322785.205 | 384.231** |
| | Error | 256 | 6045.285 | |
| 10 th week | Between sexes | 1 | 1134526.433 | 209.411** |
| | Error | 244 | 5417.692 | |
| 12 th week | Between sexes | 1 | 2920433.908 | 330.138** |
| | Error | 228 | 8846.103 | |
| 14 th week | Between sexes | 1 | 5762657.655 | 268.896** |
| | Error | 211 | 21430.832 | |
| 16 th week | Between sexes | 1 | 5021917.374 | 189.459** |
| | Error | 208 | 26506.592 | |
| 18th week | Between sexes | 1 | 2839116.415 | 58.084** |
| | Error | 197 | 48879.536 | |
| 20th week | Between sexes | 1 | 38838412.411 | 851.582** |
| | Error | 194 | 45607.378 | |

^{**} Significant at P<0.01

Table-9: Least squares means along with C.V % of body weight(gm) at different weeks of age in male and female of various genetic groups of Poultry

| Weeks | | GP ♂♂X | GP 33X VR QQ | VRGG X | VR♂♂ X GP ♀♀ | GP 332 | GP 33X GP 99 | VR 332 | VR 33 X VR 99 |
|-----------|--------|---------|--------------------|-------------------|-------------------|---------|-------------------|-------------------|-------------------|
| | | Male | Female | Male | Female | Male | Female | Male | Female |
| Zero day | Mean ± | 38.327a | 36.056b | 37.547a | 36.008b | 36.988ª | 35.153b | 39.968ª | 34.930b |
| | S.E. | +0.244 | ±0.264 | ±0.316 | ±0.183 | +0.238 | +0.276 | +0.296 | ±0.185 |
| | C.V% | 10.438 | 11.096 | 9.185 | 9.578 | 10.721 | 11.28 | 10.143 | 11.606 |
| 4th week | Mean ± | 314.32ª | 268.77b | 307.34a | 236.07b | 305.88ª | 250.81b | 323.47a | 278.37^{b} |
| | S.E. | +1.26 | + 1.19 | ±2.63 | ±2.55 | ±1.76 | +1.68 | + 2.09 | ±2.04 |
| | C.V% | 8.678 | 10.148 | 15.52 | 20.20 | 11.34 | 13.83 | 10.468 | 12.163 |
| 6th week | Mean ± | 507.74ª | 386.10b | 475.51a | 322.77b | 466.48a | 368.15b | 533.39^{a} | 401.26b |
| | S.E. | ±3.183 | 1 3.148 | 1 4.59 | 1 4.31 | ±4.98 | 1 4.93 | + 6.11 | ±5.74 |
| | C.V% | 14.00 | 18.416 | 19.368 | 28.532 | 16.213 | 20.544 | 17.835 | 23.708 |
| 8th week | Mean ± | 560.76a | 464.69b | 583.17a | 393.38b | 580.83ª | 460.40b | 723.97a | 555.76b |
| | S.E. | +5.14 | 1 4.83 | + 6.89 | - 6.79 | +6.63 | +6.04 | + 6.53 | + 6.28 |
| | C.V% | 13.210 | 15.941 | 21.043 | 31.196 | 16.090 | 20.299 | 15.353 | 20.001 |
| 10th week | Mean ± | 760.02ª | 565.94b | 646.83ª | 544.35b | 708.82ª | 546.10b | 928.11a | 792.25b |
| | S.E. | +5.77 | +5.59 | - 6.16 | +5.68 | +8.96 | + 8.39 | + 6.72 | +6.56 |
| | C.V% | 15.227 | 20.449 | 12.835 | 15.252 | 17.734 | 23.018 | 10.789 | 12.639 |

| Weeks | | GP 33X | GP 33X VR 99 | VR33 | VR♂♂ X GP ♀♀ | GP 33X | GP 33X GP 99 | VR 33 X VR 99 | c VR QQ |
|-----------------------|--------|---------|--------------|-------------------|---------------------|-------------------|---------------------|-------------------|---------------------|
| | | Male | Female | Male | Female | Male | Female | Male | Female |
| 12 th week | Mean ± | 1175.5ª | 884.80b | 917.10a | 730.55 ^b | 1012.4ª | 747.79b | 1425.9a | 1200.5 ^b |
| | S.E. | ±12.38 | ±11.75 | ±7.83 | + 7.56 | ±15.21 | +14.06 | - 8.85 | 1 8.70 |
| | C.V% | 16.54 | 21.975 | 13.577 | 17.044 | 20.214 | 27.368 | 10.29 | 12.23 |
| 14 th week | Mean ± | 1515.1ª | 1268.8b | 1047.1a | 791.05b | 991.13a | 834.96b | 1658.7a | 1328.9b |
| | S.E. | +8.33 | +8.14 | ±16.25 | ±14.86 | ±11.51 | ±10.93 | ±14.72 | ±13.71 |
| | C.V% | 9886 | 11.80 | 19.531 | 25.852 | 14.06 | 16.689 | 13.278 | 16.573 |
| 16th week | Mean ± | 1735.7a | 1474.8b | 1185.8ª | 1042.3 ^b | 1278.2ª | 1028.2 ^b | 1962.6a | 1652.6 ^b |
| | S.E. | ±10.17 | +9.98 | 1 5.60 | +5.14 | + 7.64 | ±7.43 | ±16.45 | ±15.38 |
| | C.V% | 9.588 | 11.284 | 7.60 | 8.651 | 11.504 | 14.302 | 11.44 | 13.586 |
| 18th week | Mean ± | 2024.3ª | 1486.4b | 1353.5ª | 1125.3 ^b | 1525.9ª | 1169.9b | 2226.1a | 1987.2 ^b |
| | S.E. | ±23.19 | ±21.72 | ±12.37 | +11.24 | ±16.55 | ±15.97 | ±22.22 | + 22.10 |
| | C.V% | 17.267 | 23.516 | 12.065 | 14.513 | 15.775 | 20.574 | 11.272 | 12.628 |
| 20th week | Mean ± | 2267.1a | 1845.4b | 1723.2ª | 1380.1b | 1840.8ª | 1536.4 ^b | 2882.7a | 1992.2 ^b |
| | S.E. | ±10.72 | ±10.18 | ±13.46 | ±12.53 | ±13.91 | ±12.82 | ±21.79 | ±21.35 |
| | C.V% | 10.365 | 12.734 | 12.422 | 15.51 | 10.927 | 13.092 | 17.155 | 24.822 |

Means(Row wise) with different superscripts for each genetic group taken separately differ significantly(P<0.01)

The average zero day body weight in males of $GP \circlearrowleft x$ $VR \circlearrowleft Q$ and $VR \circlearrowleft X$ $GP \circlearrowleft Q$ were obtained as 38.327 (g) and 37.547 (g) respectively. The corresponding values in females were noted as 36.056 (g) and 36.008 (g). However, no information in the literature could be made available to compare the findings of the present study.

The mean body weight at 4th week of age of males and females in VR&& x VRPP were obtained as 323.47 (g) and 278.37 (g) respectively. Padhi et al. (2012a) reported the 4th week body weight in VR&& x VRPP to be 364.86±5.11 (g) and 343.95±5.16 (g) respectively. Debata et al. (2012) reported the pooled value of Vanaraja to be 448.46±7.32 (g) at 4th week of age. Jha and Prasad (2013) have reported the pooled value of Vanaraja to be 316.47±2.47 (g) at 4th week of age. The findings of present study are in close proximity with the findings of Jha and Prasad (2013). However, the results obtained in this investigation are lower than the reports of Padhi et al. (2012a) and Debata et al (2012). Differences in the body weight might be attributed to managemental and environmental differences.

The average body weight at 4^{th} week of age in $GP \circlearrowleft X$ $GP \circlearrowleft Y$ was found to be 305.88(g) and 250.81 (g) in males and females respectively. Jha and Prasad (2013) observed 168.85 ± 1.53 (g) body weight at 4^{th} week of age which is less than the findings of the present study. Environmental and managemental factors might be, possibly, responsible for the differences in body weight at this age.

The average 4^{th} week body weight of males in $GP \circlearrowleft x$ $VR \circlearrowleft Q$ and $VR \circlearrowleft Q$ x $GP \circlearrowleft Q$ were obtained as 314.32 (g) and 307.34 (g) respectively. The corresponding values in females were noted as 268.77 (g) and 236.07 (g). However, no information in the literature could be made available to compare the findings of the present study at this age.

The mean body weights of males and females at 6th as 533.39 (g) and 401.26 (g) respectively. Padhi et al (2012a) reported the 6th week body weight in VR♂♂ x VR♀♀ among males and females to be 538.45+9.92 (g) and 496.42+11.01 (g) respectively. Padhi and Chatterjee (2012) reported the pooled body weight of Vanaraja to be 568+0.20 (g) at 6th week of age. Jha and Prasad (2013) have reported the pooled body weight of Vanaraja to be 629.23+3.02 (g) at 6th week of age. The findings of present study are similar to the findings of Padhi et al. (2012a) and of Padhi et al. (2012b). However, the values obtained in present study are lower than the estimates obtained by Padhi and Chatterjee (2012) and Jha and Prasad(2013). Differences in the body weight might be attributed to managemental and environmental variations.

The average body weights at 6^{th} week of age in $GP \circlearrowleft x$ $GP \circlearrowleft \varphi$ were found to be 466.48(g) and 368.15(g) in males and females respectively. Jha and Prasad (2013) observed 357.48 ± 2.97 (g) (sexes pooled) body weight at 6^{th} week of age which is less than the findings of the present study.

Environmental and managemental factors might be, possibly, responsible for the differences in body weight at this age.

The average 6th week body weight among males in GP&& x VRQQ and VR&& x GPQQ genetic groups were obtained as 507.74 (g) and 475.51 (g) respectively. The corresponding values in females were noted as 386.10 (g) and 322.77 (g). However, no information in the literature could be made available to compare the findings of the present study at this age.

The mean body weight of males and females at 8th week of age in VR33 x VRQQ genetic groups were obtained as 723.97 (g) and 555.76 (g) respectively. Debata *et al.* (2012) reported the pooled body weight of Vanaraja to be 1003.08±20.28 (g) at 8th week of age. Jha and Prasad(2013) have reported the pooled body weight of Vanaraja to be 832.51±4.53(g) at 8th week of age. The findings of present study are lower than the findings of above authors. Differences in the body weight might be attributed to managemental and environmental differences.

The average body weight at 8^{th} week of age in $GP \circlearrowleft x$ $GP \circlearrowleft \varphi$ were found to be 580.83 (g) and 460.40 (g) in males and females respectively. Jha and Prasad (2013) observed 498.76 ± 3.86 (g) body weight at 8^{th} week of age, which is less than the findings of the present study. Environmental and managemental factors might be, possibly, responsible for the differences in body weight at this age.

The average 8^{th} week male body weights in $GP \partial \partial x$ $VR \mathcal{P} \mathcal{P}$ and $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic groups were obtained as 560.76 (g) & 583.17 (g) respectively. The corresponding values in females were noted as 464.69 (g) and 393.38 (g). However, no information in the literature could be made available to compare the findings of the present study.

The mean body weight at 10^{th} week of age in males and females of $VR \circlearrowleft \times VR \circlearrowleft \cong \mathbb{R}$ genetic group were obtained as 928.11 (g) and 792.25 (g) respectively. The average body weights at 10^{th} week of age in $GP \circlearrowleft \times GP \circlearrowleft \cong \mathbb{R}$ genetic group were found to be 708.82 (g) and 546.10 (g) in males and females respectively. The corresponding values in $GP \circlearrowleft \times VR \circlearrowleft \cong \mathbb{R}$ and $VR \circlearrowleft \times GP \hookrightarrow \cong \mathbb{R}$ were obtained as 760.02 (g) and 565.94 (g) as well as 646.83 (g) and 544.35 (g) respectively. However, no information in the literature could be made available to compare the findings of the present study.

The mean body weight of males and females at 12^{th} week of age in $VR \circlearrowleft \times VR \circlearrowleft \cong \mathbb{C}$ genetic groups were obtained as 1425.90 (g) and 1200.50 (g) respectively. Debata *et al.*(2012) reported the pooled body weight of Vanaraja to be 1399.83 ± 27.8 (g) at 12^{th} week of age. Jha and Prasad (2013) have reported the sexes pooled body weight of Vanaraja to be 1072.63 ± 5.59 (g) at 12^{th} week of age. The findings of present study are in close proximity with Debata *et al.*(2012). However, the result obtained in this investigation is higher than the reports of Jha and Prasad(2013).

Differences in the body weight might be attributed to managemental and environmental differences.

The average body weights of males and females at 12th week of age in GP $\partial \partial$ x GP $\mathcal{Q}\mathcal{Q}$ genetic group were found to be 1012.40 (g) and 747.79 (g) respectively. Jha and Prasad (2013) observed 824.68±4.75(g) body weight at 12th week of age, which is less than the findings of present study. Environmental and managemental factors might be, possibly, responsible for the differences in body weight at this age.

The average 12^{th} week body weight of males in $GP \partial \partial x$ $VR \mathcal{P} \mathcal{P}$ and $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic groups were obtained as 1175.50 (g) & 917.10 (g) respectively. The corresponding values in females were noted as 884.80 (g) and 730.55 (g). However no information in the literature could be made available to compare the findings of the present study.

The mean body weights of males and females at 14^{th} week of age in $VR \circlearrowleft \circlearrowleft \times VR \hookrightarrow \circlearrowleft$ genetic group were obtained as 1658.70 (g) and 1328.90 (g) respectively. The corresponding values in $GP \circlearrowleft \circlearrowleft \times GP \hookrightarrow \hookrightarrow$ were found to be 991.13 (g) and 834.96 (g). Similarly, the average 14^{th} week body weight in males of $GP \circlearrowleft \circlearrowleft \times VR \hookrightarrow \hookrightarrow$ and $VR \circlearrowleft \circlearrowleft \times GP \hookrightarrow \hookrightarrow$ genetic groups were obtained as 1515.10 (g) and 1047.10 (g) respectively. The corresponding values in females were noted as 1268.8 (g) and 791.05 (g). However, no information in the literature could be made available to compare the findings of the present study.

The mean body weight of males and females at 16th week of age in VR\$\frac{1}{10}\$ x VR\$\frac{1}{10}\$ were obtained as 1962.60 (g) and 1652.60 (g) respectively. Debata *et al.*(2012) reported the pooled body weight of Vanaraja to be 1725.75±32.48(g) at 16th week of age. Jha and Prasad(2013) have reported the sexes pooled estimate of body weight of Vanaraja to be 1567.85±6.38(g) at 16th week of age. The findings of present study are similar to the findings of Debata *et al.*(2012). However, the result obtained in this investigation is higher than the reports of Jha and Prasad(2013). Differences in the body weight might be attributed to managemental and environmental differences.

The average body weight of males and females at 16th week of age in GP\$\frac{1}{2}\$ x GP\$\frac{1}{2}\$ were found to be 1278.20 (g) and 1028.20 (g) respectively. Jha and Prasad (2013) observed 1263.46±5.90 (g) body weight at 16th week of age which is more than the findings of present study. Environmental and managemental factors might be, possibly, responsible for the differences in body weight at this age.

The average 16^{th} week body weight of males in $GP\partial\partial x$ VRQQ and $VR\partial\partial x$ GPQQ genetic groups were obtained as 1735.70 (g) and 1185.80 (g) respectively. The corresponding values in females were noted as 1474.80 (g) and 1042.30 (g). However, no information in the literature was available to compare the findings of the present study.

The mean body weights of males and females at 20^{th} week of age in VR \circlearrowleft \circlearrowleft x VR \circlearrowleft \circlearrowleft genetic group were obtained as 2882.70 (g) and 1992.20 (g) respectively. Debata *et al.* (2012) reported the sexes pooled body weight of Vanaraja to be 2040.54 ± 41.27 (g) at 20^{th} week of age. Jha and Prasad (2013) have reported the pooled value of Vanaraja to be 2103.39 ± 7.39 (g) at 20^{th} week of age. The results obtained in this investigation are higher than the reports of Debata *et al.* (2012) and Jha and Prasad (2013). Differences in the body weight might be attributed to managemental and environmental differences.

The average body weight of males and females at 20th week of age in GP\$\frac{1}{2} \text{ x GP}\$\text{ were found to be 1840.80 (g)} and 1536.40 (g) respectively. Jha and Prasad (2013) observed 1574.31±6.87 (g) body weight at 20th week of age which is less than the findings of present study. Environmental and managemental factors might be,

possibly, responsible for the differences in body weight at this age.

The average 20^{th} week body weight of males in $GP \circlearrowleft x$ $VR \circlearrowleft Q$ and $VR \circlearrowleft Q$ x $GP \circlearrowleft Q$ genetic group were obtained as 2267.10 (g) and 1723.20 (g) respectively. The corresponding values in females were noted as 1845.40 (g) and 1380.10 (g). However, no information in the literature could be made available to compare the findings of the present study.

Average shank lengths at various weeks in different genetic groups

Least squares means along with CV% of shank lengths(cm) at different weeks of age in male and female of various genetic groups have been depicted in table-14.

The mean shank length of males and females at 4^{th} week of age in $VR \circlearrowleft x VR \circlearrowleft \varphi$ genetic group were obtained as 7.37 (cm) and 6.85 (cm) respectively.

The average shank lengths of males and females at 4^{th} week of age in $GP \circlearrowleft x GP \circlearrowleft \varphi$ genetic group were found to be 7.36 (cm) and 6.72 (cm) respectively.

Table-10: Mean squares from analysis of variance to test the effect of sex on shank length at different weeks of age in Gramapriya 33 X Vanaraja 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|------------------------|----------|---------------------|---------------------|
| 4 th week | Between sexes Error | 1 297 | 0.187926 0.12705 | 1.479 ^{NS} |
| 8 th week | Between sexes Error | 1 256 | 45.1106 0.26069 | 173.038** |
| 12 th week | Between sexes Error | 1 228 | 24.3198 10.122 | 2.403 ^{NS} |
| 16 th week | Between sexes Error | 1 208 | 7.7746 6.6135 | 1.176 ^{NS} |
| 20 th week | Between sexes Error | 1 194 | 2.7252 10.6783 | 0.255 ^{NS} |

^{**}Significant at P<0.01

 $^{^{\}rm NS}$ as Non- significant

Table-11: Mean squares from analysis of variance to test the effect of sex on shank length at different weeks of age in Vanaraja 33 X Gramapriya 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|------------------------|----------|--------------------|-----------|
| 4 th week | Between sexes Error | 1 297 | 86.4827 0.1747 | 494.973** |
| 8 th week | Between sexes Error | 1 256 | 109.3832 0.3605 | 303.356** |
| 12 th week | Between sexes Error | 1 228 | 97.1914 5.1120 | 19.012** |
| 16 th week | Between sexes Error | 1 208 | 101.4172 2.6242 | 38.646** |
| 20 th week | Between sexes Error | 1 194 | 100.6564 2.508 | 40.129** |

^{**}Significant at P<0.01

Table-12: Mean squares from analysis of variance to test the effect of sex on shank length at different weeks of age in Gramapriya 33 X Gramapriya 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|------------------------|----------|--------------------|-----------|
| 4 th week | Between sexes Error | 1 297 | 30.37967 0.0651 | 466.122** |
| 8 th week | Between sexes Error | 1 256 | 31.6440 0.3484 | 90.815** |
| 12 th week | Between sexes Error | 1 228 | 77.3340 1.6655 | 46.432** |
| 16 th week | Between sexes Error | 1 208 | 25.9445 6.5363 | 3.969** |
| 20 th week | Between sexes Error | 1 194 | 22.9458 5.055 | 4.539* |

^{**}Significant at P<0.01

^{*}significant at P<0.05

Table-13: Mean squares from analysis of variance to test the effect of sex on shank length at different weeks of age in Vanaraja 33 X Vanaraja 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|---------------------|------|----------|-----------|
| 4 th week | Between sexes | 1 | 20.29157 | 257.894** |
| | Error | 297 | 0.0786 | |
| 8th week | Between sexes | 1 | 0.4034 | 166.482** |
| | Error | 256 | 0.0024 | |
| 12 th week | Between sexes | 1 | 96.3367 | 81.955** |
| | Error | 228 | 1.175 | |
| 16 th week | Between sexes | 1 | 179.9943 | 130.464** |
| | Error | 208 | 1.3796 | |
| 20th week | Between sexes | 1 | 63.5004 | 14.690** |
| | Error | 194 | 4.322 | |

^{**}Significant at P<0.01

Table-14. Least squares means along with C.V % of shank length(cm) at different weeks of age in male and female of various genetic groups of Poultry

| Weeks | | GP&S X VRPP | VR♀♀ | VR♂∜ X | VR♂♂ X GP ♀♀ | GP ♂♂ 2 | GP ởở X GP ՉՉ | VR ♂♂ 3 | VR ởở X VR 99 |
|-----------------------|----------|-------------|--------|--------|--------------------|----------------|-----------------------------|--------------------|-----------------------------|
| | | Male | Female | Male | Female | Male | Female | Male | Female |
| 4th week | Mean_S.E | 7.11 | 7.06 | 7.27a | 6.19b | 7.36a | 6.72b | 7.37a | 6.85b |
| | | +0.029 | ±0.028 | ±0.034 | ±0.034 | ±0.021 | 1+0.020 | 50.0 1 | 10.022 |
| | C.V% | 5.017 | 5.047 | 9.375 | 11.003 | 5.553 | 6.08 | 5.194 | 5.589 |
| 8 th week | Mean-S.E | 8.95a | 8.11b | 8.90a | 409.7 | 9.05a | 8.35b | 8.74 | 8.70 |
| | | +0.046 | +0.043 | +0.053 | ±0.052 | +0.054 | ±0.049 | + 0.028 | +0.027 |
| | C.V% | 7.371 | 8.133 | 9.949 | 11.653 | 7.575 | 8.214 | 4.44 | 4.254 |
| 12 th week | Mean±S.E | 9.05a | 8.40a | 9.04a | 7.74b | 9.61ª | 8.45b | 9.76a | 8.47b |
| | | ±0.077 | +0.073 | +0.060 | +0.058 | ±0.113 | ±0.104 | ±0.047 | +0.046 |
| | C.V% | 8.204 | 9.074 | 7.929 | 8.948 | 11.944 | 13.474 | 5.276 | 5.710 |
| 16 th week | Mean±S.E | 9.27a | 8.89a | 9.19a | 7.80b | 9.72a | 9.02₽ | 10.51a | 8.65b |
| | | ±0.159 | +0.156 | ±0.105 | - 0.096 | ±0.121 | ± 0.117 | - 0.096 | + 0.090 |
| | C.V% | 12.446 | 14.642 | 10.485 | 12.029 | 9.919 | 10.497 | 8.045 | 9.017 |
| 20th week | Mean±S.E | 9.40 | 9.16 | 9.33a | 7.89b | 9.83a | 9.14b | 10.71a | 9.57b |
| | | +0.200 | ±0.19 | ±0.093 | + 0.087 | ±0.200 | ±0.185 | ±0.129 | +0.127 |
| | C.V% | 12.559 | 12.573 | 7.311 | 7.933 | 14.602 | 14.963 | 8.241 | 8.981 |
| | | | | | | | | | |

Means(row wise) with different superscripts differ significantly(P<0.01)

The mean shank lengths of males and females at 8^{th} week of age in $VR \circlearrowleft \times VR \circlearrowleft \hookrightarrow \mathbb{R}$ genetic group were obtained as 8.74 (cm) and 8.70 (cm) respectively. The corresponding values in $GP \circlearrowleft \times GP \hookrightarrow \mathbb{R}$ genetic groups were found to be 9.05 (cm) and 8.35 (cm).

The average 8^{th} week shank lengths of males in $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ and $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic groups were obtained as 8.95 (cm) and 8.90 (cm) respectively. The corresponding values in females were noted as 8.11 (cm) and 7.60 (cm). However, no information in the literature was available to compare the findings of the present study.

The mean shank lengths of males and females at 12^{th} week of age in $VR \circlearrowleft x VR \circlearrowleft \varphi$ genetic group were obtained as 9.76 (cm) and 8.47 (cm) respectively.

The average shank length of males and females at 12^{th} week of age in $GP \circlearrowleft \times GP \circlearrowleft = 0$ genetic groups were found to be 9.61 (cm) and 8.45 (cm) in male and female respectively.

The average 12^{th} week shank lengths of males in $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ and $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic groups were obtained as 9.05 (cm) and 9.04 (cm) respectively. The corresponding values in females were noted as 8.40 (cm) and 7.74 (cm). However, no information in the literature could be made available to compare the findings of the present study.

The mean shank lengths of males and females at 16^{th} week of age in VR ?? ?? genetic group were obtained as

The mean shank lengths of males and females at 20^{th} week of age in $VR \circlearrowleft \times VR \circlearrowleft \otimes \mathbb{C}$ genetic groups were obtained as 10.71 (cm) and 9.57 (cm) respectively. Padhi and Chatterjee (2012) reported 20^{th} week shank length in Vanaraja male line to be 106.57 mm which is very close to the findings of the present study. However, the shank length as reported by Jha and Prasad (2013) at 40^{th} week of age is shorter than the findings of the present study.

 values in females were noted as 9.16 (cm) and 7.89 (cm). However, no information in the literature could be made available to compare the findings of the present study.

Average keel lengths at various weeks in different genetic groups

Least squares means along with CV% of keel lengths(cm) at different weeks of age in male and female of various genetic groups have been depicted in table-19.

The mean keel length in males and females at 4^{th} week of age in $VR \circlearrowleft \times VR \circlearrowleft \hookrightarrow$ were obtained as 5.24 (cm) and 4.99 (cm) respectively.

The average keel lengths at 4^{th} week of age in $GP \circlearrowleft x$ $GP \circlearrowleft \varphi$ were found to be 4.92 (cm) and 4.56 (cm) in male and female respectively.

The average 4^{th} week keel lengths of males in $GP \partial \partial x$ $VR \mathcal{P} \mathcal{P}$ and $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ were obtained as 5.22 (cm) and 5.02 (cm) respectively. The corresponding values in females were noted as 4.99 (cm) and 4.37 (cm). However, no information in the literature could be made available to compare the findings of the present study.

Table-15: Mean squares from analysis of variance to test the effect of sex on keel length at different weeks of age in Gramapriya 33 X Vanaraja 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|---------------------|------|---------|----------|
| 4th week | Between sexes | 1 | 4.2308 | 36.159** |
| | Error | 297 | 0.1170 | |
| 8th week | Between sexes | 1 | 7.7058 | 88.146** |
| | Error | 256 | 0.0874 | |
| 12 th week | Between sexes | 1 | 68.949 | 47.860** |
| | Error | 228 | 1.440 | |
| 16 th week | Between sexes | 1 | 74.6655 | 43.827** |
| | Error | 208 | 1.7036 | |
| 20th week | Between sexes | 1 | 160.192 | 50.835** |
| | Error | 194 | 3.151 | |

^{**}Significant at P<0.01

Table-16: Mean squares from analysis of variance to test the effect of sex on keel length at different weeks of age in Vanaraja 33 X Gramapriya 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|---------------------|------|---------|-----------|
| 4 th week | Between sexes | 1 | 31.3007 | 108.046** |
| | Error | 297 | 0.2896 | |
| 8th week | Between sexes | 1 | 11.9981 | 148.198** |
| | Error | 256 | 0.0809 | |
| 12 th week | Between sexes | 1 | 28.8563 | 36.779** |
| | Error | 228 | 0.7845 | |
| 16 th week | Between sexes | 1 | 67.4765 | 31.131** |
| | Error | 208 | 2.1674 | |
| 20th week | Between sexes | 1 | 66.804 | 35.007** |
| | Error | 194 | 1.908 | |

^{**}Significant at P<0.01

Table-17 : Mean squares from analysis of variance to test the effect of sex on keel length at different weeks of age in Gramapriya $\delta \delta X$ Gramapriya $\varphi \varphi$.

| | 2708.9 71 <i>4</i> 0.0 | I 76Z | Between sexes | _{фр} меск |
|-----------------------|---------------------------|-----------------|------------------------|------------------------|
| **552.49 | 6.5098 | Ţ | Ветмееп зехез | 8 _{tp} week |
| **018.81 | 0.101.0 | J 729 | Error Between sexes | l Σ _{ιμ} week |
| | 8066.0 | 228 | Error | |
| **878. 1 2 | 7 + 09.25 | ī | Between sexes | те _{гр} меск |
| | 9844.I | 208 | Error | |
| ** 1 28.9 | 2489.48 | ī | Between sexes | 70 _{гр} меск |
| | 3.7.5 | 1 61 | Error | |

^{**}Significant at P<0.01

Table-18: Mean squares from analysis of variance to test the effect of sex on keel length at different weeks of age in Vanaraja 33 X Vanaraja 99.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|---------------------|------|----------|-----------|
| 4th week | Between sexes | 1 | 4.4277 | 97.961** |
| | Error | 297 | 0.0451 | |
| 8th week | Between sexes | 1 | 0.4034 | 166.482** |
| | Error | 256 | 0.0024 | |
| 12 th week | Between sexes | 1 | 25.8329 | 15.554** |
| | Error | 228 | 1.6608 | |
| 16 th week | Between sexes | 1 | 16.2909 | 6.560** |
| | Error | 208 | 2.4833 | |
| 20th week | Between sexes | 1 | 107.5024 | 29.807** |
| | Error | 194 | 3.606 | |

^{**}Significant at P<0.01

in male and female of various genetic groups of Poultry

| Weeks | | GP♂3 | GP♂♂ X VR♀♀ | VR♂♂ ≯ | VR33 X GP 99 | GP ♂♂ 2 | GP 33 X GP 99 | VR ♂♂ | VR 33 X VR 99 |
|-----------|----------|--------|-------------|--------|--------------|----------------|-----------------------------|--------|---------------|
| | | Male | Female | Male | Female | Male | Female | Male | Female |
| 4th week | Mean+C F | 5.22a | 4.99b | 5.02a | 4.37b | 4.92a | 4.56b | 5.24a | 4.99b |
| | | +0.029 | +0.027 | +0.045 | +0.043 | +0.017 | +0.016 | +0.017 | +0.017 |
| | C.V% | 6.925 | 7.255 | 12.495 | 14.346 | 5.547 | 5.988 | 4.668 | 4.895 |
| 8th week | Mean+S F | 6.17a | 5.82b | 6.13a | 5.69b | 6.19a | 5.88b | 6.84a | 6.04b |
| | | +0.027 | +0.025 | +0.025 | +0.025 | +0.029 | +0.027 | +0.044 | +0.042 |
| | C.V% | 5.550 | 5.880 | 5.824 | 6.265 | 5.732 | 6.043 | 9.228 | 10.45 |
| 12th week | Mean+S F | 6.97a | 5.88b | 6.43a | 5.72b | 6.45a | 5.92b | 6.90a | 6.22b |
| | | +0.077 | +0.073 | +0.053 | +0.051 | +0.069 | +0.064 | +0.044 | +0.044 |
| | C.V% | 4.652 | 4.887 | 9.475 | 10.829 | 10.895 | 12.239 | 6.781 | 7.383 |
| 16th week | Mean+S E | 7.10a | 5.91b | 6.90a | 5.76b | 6.76a | 5.94b | 6.94a | 6.39b |
| | | +0.027 | +0.026 | +0.032 | +0.030 | +0.079 | +0.077 | +0.047 | +0.044 |
| | C.V% | 3.852 | 4.066 | 6.272 | 6.967 | 10.639 | 12.149 | 5.448 | 5.836 |
| 20th week | Mean+S E | 8.06a | 6.25b | 6.97a | 5.80b | 6.83a | 5.98b | 7.98a | 6.50b |
| | | +0.023 | +0.022 | +0.061 | +0.056 | +0.085 | ±0.079 | ±0.043 | +0.042 |
| | C.V% | 2.833 | 2.956 | 7.584 | 8.483 | 7.98 | 8.239 | 7.082 | 8.092 |

Means(row wise) with different superscripts differ significantly(P<0.01)

The mean keel lengths of males and females at 12^{th} week of age in $VR \circlearrowleft X VR \circlearrowleft Y$ were obtained as 6.90 (cm) and 6.22 (cm) respectively.

The average keel lengths at 12^{th} week of age in $GP \circlearrowleft x$ $GP \circlearrowleft \varphi$ were found to be 6.26 (cm) and 5.97 (cm) in males and females respectively.

The average 12^{th} week keel lengths among males in $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ and $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ were obtained as 6.97 (cm) and 6.43 (cm) respectively. The corresponding values in females were noted as 5.88 (cm) and 5.72 (cm). However, no information in the literature was available to compare the findings of the present study.

The mean keel lengths of males and females at 16^{th} week of age in $VR \partial \partial x VR \mathcal{P} \mathcal{P}$ genetic group were obtained as 6.94 (cm) and 6.39 (cm) respectively. The corresponding values in $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ were found to be 6.76 (cm) and 5.94 (cm).

 6.90 (cm) respectively. The corresponding values in females were noted as 5.91 (cm) and 5.76 (cm). However, no information in the literature could be made available to compare the findings of the present study.

The average 20^{th} week keel lengths of males in $GP \circlearrowleft x$ $VR \circlearrowleft \varphi$ and $VR \circlearrowleft \varphi$ x $GP \circlearrowleft \varphi$ genetic groups were obtained as 8.06 (cm) and 6.97 (cm) respectively. The corresponding values in females were noted as 6.25 (cm) and 5.80 (cm). However, no information in the literature could be made available to compare the findings of the present study at this age.

Kalita *et al.* (2012) reported the mean keel length at 40th week of age in Vanaraja to be 72.58 mm. The trend obtained in the present findings at different ages appear to be like that of Kalita *et al.* (2012).

Effect of sex on body weight:

Analysis of variance to find out the effect of sex on body weight at different weeks of age in all the four genetic group have been presented in table :5-8. All the values of F were found to be highly significant (P<0.01) in all the four

genetic group, reflecting heavier body weight of males than females at all the ages.

Table-5 revealed that the males of $VR \circlearrowleft \times VR \circlearrowleft$, GP ? ? x GP ? ? , VR ? ? x GP ? ? and <math>GP ? ? ? x VR ? ? at zero day of age were significantly (P<0.01) heavier by 5.038 g, 1.835 g, 1.539 g and 2.271 g respectively than their female counterparts. The corresponding increment at 4th week of age was observed to be 45.1 g, 55.07 g, 71.27 g and 45.55 g whereas the corresponding increase at 6th week of age were noted as 132.13 g, 98.33 g, 152.74 g and 121.30 g. The increase in body weight at 8th week of age in VR♂♂ x VR♀♀, $GP \stackrel{?}{\circ} \stackrel{?}{\circ} x GP \stackrel{?}{\circ} \stackrel{?}{\circ} vR \stackrel{?}{\circ} \stackrel{?}{\circ} x GP \stackrel{?}{\circ} \stackrel{?}{\circ} and GP \stackrel{?}{\circ} \stackrel{?}{\circ} x VR \stackrel{?}{\circ} \stackrel{?}{\circ} genetic$ groups were observed to be 168.21 g, 120.43 g, 189.79 g and 96.07 g respectively. The corresponding values at 10th week of age were noted as 135.86 g, 162.72 g, 102.48 g and 194.08 g, and values at 12th week of age were noted as 225.40 g, 264.61 g, 186.55 g and 290.70 g whereas, the corresponding increment at 14th week of age were noted as 329.80 g, 156.17 g, 256.05 g and 246.3 g and at 16th week of age were found to be 310.00 g, 250.00 g, 143.50 g and 260.90 g. The corresponding increment at 18th week of age were noted as 238.90 g, 356.00 g, 228.20 g and 537.9 g. The increment in body weight at 20th week of age in corresponding groups were observed to be 890.50 g, 304.40 g, 343.10 g and 421.7 g. All the increment in body weights among males over females in all the four genetic group at all the ages were found to be statistically highly significant (P<0.01).

Higher body weights of males at different weeks of age in various genetic groups of chicken have also been reported by various authors. Verma et al. (1981) in WL x RIR cross, Gupta (1983) in White Rock, Padhi et al. (1999b) in Nicobari, Singh et al. (2000) in Red Cornish in PB-2 have reported heavier male body weights than their female counterparts in different weeks of age in various genetic groups of poultry which are in agreement with the findings of the present study.

Padhi et al. (2012a) reported significantly (P<0.05) heavier male body weights than their female counterparts in Vanaraja at different age groups which are in conformity with the findings of the present study.

The critical analysis of Table -5 revealed that the sex differences between male and female chicks for body weight increased as age advanced. This might be, possibly, due to differential rate of growth of chicks of either sex to the given common environment. Besides, other physiological factors might also be responsible for this differential rate of growth as suggested by Buckner *et al.* (1949), Gilbreath and Upp (1952) and Roberts (1964).

Effect of sex on Conformation traits

Shank length:

Analysis of variance (Table 10-13) indicates highly significant (P<0.05) effect of sex on shank length in different genetic groups. Least squares means of shank length as

depicted in Table -14 clearly reflects significantly (P<0.01) lengthier shank in males than their counterpart females in all the genetic groups at all the ages except at 4th and 20th weeks in genetic group GP♂♂ x VR ♀♀ and at 8th week of VR 33 x VR ♀♀ genetic group. It was observed that VR 33 x VR \circlearrowleft , $GP \circlearrowleft$ x GP \circlearrowleft and $VR \circlearrowleft$ x GP \circlearrowleft males had significantly (P<0.01) lengthier shank than their female counterparts by 0.52 cm, 0.64 cm and 1.08 cm respectively. Although males of GP♂♂ x VR ♀♀ genetic group had 0.05 cm lengthier shank than their female counterparts at 4th week of age, yet the difference was found to be statistically nonsignificant. At 8th week of age males of GP33 x GP 99, VR33 x GP 99 and GP33 x VR 99 had significantly (P<0.01) lengthier shank by 0.70 cm, 1.30 cm and 0.84 cm than their female counterparts respectively. The increment of 0.04 cm in shank of males than their female counterparts at 8th week of age in VR 33 x VR 99 genetic group was, however, non-significant. The males of genetic groups VR 33 had significantly (P<0.01) lengthier shank by 1.29 cm, 1.16 cm, 1.30 cm and 0.65 cm respectively than their female counterparts at 12th week of age. The corresponding significant (P<0.01) increment at 16th week of age were observed to be 1.86 cm, 0.76 cm, 1.39 cm and 0.38 cm. At 20th week of age males of VR 33 x VR 99, GP33 x GP 99 and VR♂♂ x GP ♀♀ had significantly (P<0.01) lengthier shank by 1.14 cm, 0.69 cm and 1.44 cm respectively than their female counterparts. However, the increase in male shank

length of $GP \circlearrowleft \times VR \hookrightarrow was$ found to be non-significant at this age.

Lengthier shank of males than their female counterparts in various genetic groups of poultry at different ages have also been reported by various authors (Sharma, 1984; Malik et al., 1997; Padhi et al. 1999 b, Singh et al., 2000) which are in conformity with the findings of the present study. Padhi et al. (2012a) also reported lengthier shank of males in Vanaraja than their female counterparts which is similar to the findings of the present study. Padhi and Chatterjee (2012) have also recorded as longer as 106.57 mm shank at 20th of age in PD (Vanaraja male line) which is in close proximity with the findings of the present study.

Differences in shank length of males and females might be attributed to differential rate of growth of chicks of either sex to the given common environment along with other physiological factors.

Keel length:

The values of F of analysis of variance depicted in Table 15-18 reflects highly significant (P<0.01) effect of sex on keel length at different ages in all the four genetic groups under study.

Least squares means of shank length as mentioned in Table -19 indicates that males of all the four genetic groups

had highly significant (P<0.01) lengthier keel than their female counterparts at all the ages under study.

The mean keel of males of VR 33 x VR 99, GP33 x GP significantly (P<0.01) lengthier keel by 0.25 cm, 0.36 cm, 0.65 cm and 0.23 cm respectively than their female week of age. The corresponding counterparts at 4th significant (P<0.01) increment in male keel lengths were noted to be 0.80 cm, 0.31 cm, 0.44 cm and 0.35 cm at 8^{th} of the corresponding significant whereas increment at 12th week of age were found to be 0.68 cm, 0.53 cm, 0.71 cm and 1.09 cm. Similarly, the corresponding significant (P<0.01) increment in male keel lengths over their female counterparts were observed to be 0.55 cm, 0.82 cm, 1.14 cm and 1.19 cm at 16th week of age, whereas the corresponding significant (P<0.01) increases at 20th week of age were observed to be 1.48 cm, 0.85 cm, 1.17 cm and 1.81 cm.

Sharma (1984), Venkatesh (1985), Malik et al. (1997) and Singh et al. (2000) have also reported lengthier keels in males than their female counterparts in different genetic groups of poultry at various ages which are in conformity with the findings of the present study.

Differences in keel length of males and females might be, possibly, due to differential rate of growth of both sexes as well as other physiological factors.

Effect of genetic group on body weight:

Analysis of variance revealed highly significant (P<0.01) effect of genetic group on body weight at different ages (table-20).

Least squares means along with CV% of body weight (g) at different weeks of age in various genetic groups (sexes pooled) have been depicted in table-21.

At zero days it was observed that $VR\partial\partial x VRQQ$ and $GP\partial\partial x GPQQ$ genetic groups had highest and lowest body weights respectively. $VR\partial\partial x VRQQ$ had significantly (P<0.01) 1.38 gm higher body weight than $GP\partial\partial x GPQQ$. However, the zero day body weight of $VR\partial\partial x VRQQ$, VRQQ and $GP\partial\partial x VRQQ$ did not differ significantly.

The body weight at zero day of $GP \circlearrowleft x VR \circlearrowleft \varphi$ and $VR \circlearrowleft x GP \circlearrowleft \varphi$ were observed to be significantly (P<0.01) higher by 1.12 gm and 0.71 gm respectively than $GP \circlearrowleft x$ $GP \circlearrowleft \varphi$ genetic group.

At 4th week also the highest body weight was observed to be in $VR\partial\partial x VRQQ$ genetic group which was significantly higher by 22.59 g, 29.23 g and 9.39 g than $GP\partial\partial x GPQQ$, $VR\partial\partial x GPQQ$ and $GP\partial\partial x VRQQ$ genetic groups respectively.

Besides the average body weight at 4th week of age, $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ genetic group significantly (P<0.01) increased by 19.84 gm and 13.2 gm than $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ and $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic groups respectively. However, the mean body

weight of $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ and $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic groups did not differ significantly.

At 6th week of age the trend of growth of body weight was similar to that of 4th week. The VR \circlearrowleft \circlearrowleft x VR \circlearrowleft \circlearrowleft genetic group was significantly (P<0.01) higher by 50.02, 68.19 and 20.41 g than GP \circlearrowleft \circlearrowleft x GP \circlearrowleft \circlearrowleft , VR \circlearrowleft \circlearrowleft x GP \circlearrowleft \circlearrowleft and GP \circlearrowleft \circlearrowleft x VR \circlearrowleft \circlearrowleft genetic groups respectively. GP \circlearrowleft \circlearrowleft x VR \circlearrowleft \circlearrowleft genetic group had also significantly (P<0.01) 47.78 g and 29.61 g higher body weights than VR \circlearrowleft \circlearrowleft x GP \circlearrowleft \circlearrowleft and GP \circlearrowleft \circlearrowleft x GP \circlearrowleft \circlearrowleft genetic groups respectively. However, the mean body weight at 6th week of age of GP \circlearrowleft \circlearrowleft x GP \circlearrowleft \circlearrowleft and VR \circlearrowleft \circlearrowleft x GP \circlearrowleft \circlearrowleft genetic groups did not differ significantly.

At 8th week of age also the highest body weight was observed to be in $VR \partial \partial x VR \mathcal{P} \mathcal{P}$ genetic group which was significantly higher by 119.24 g, 151.58 g and 127.14 g than $GP \partial \partial x GP \mathcal{P} \mathcal{P}$, $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ and $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ genetic groups respectively. $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ and $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ had significantly (P<0.01) higher body weight than $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic group respectively. However, the average body weight of $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ and $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ did not differ significantly.

At 10^{th} week of age also the highest body weight was observed to be in $VR\partial\partial$ x VRQQ genetic group which was significantly (P<0.01) higher by 232.71 g, 264.58 g and 197.19 g than $GP\partial\partial$ x GPQQ, $VR\partial\partial$ x GPQQ and $GP\partial\partial$ x VRQQ genetic group respectively. $GP\partial\partial$ x VRQQ genetic group had also significantly higher 10^{th} week body weight by 67.39 and 35.52 g than $VR\partial\partial$ x GPQQ and $GP\partial\partial$ x GPQQ

genetic groups respectively. Besides, $GP \circlearrowleft x GP \circlearrowleft \varphi$ had also significantly (P<0.01) 31.87 (g) higher 10^{th} week body weight than $VR \circlearrowleft x GP \circlearrowleft \varphi$ genetic group.

The trend of growth at 12^{th} week of body weight was similar to that of 10^{th} week. Again the highest body weight was observed to be in $VR \circlearrowleft \times VR \circlearrowleft \cong \mathbb{C}$ genetic group which was significantly (P<0.01) higher by 433.15 g, 489.45 g and 283.1 g than $GP \circlearrowleft \times GP \hookrightarrow \cong \mathbb{C}$ x $GP \hookrightarrow \cong \mathbb{C}$ and $GP \circlearrowleft \times VR \hookrightarrow \cong \mathbb{C}$ genetic groups respectively. $GP \circlearrowleft \times VR \hookrightarrow \cong \mathbb{C}$ genetic group had also significantly (P<0.01) 206.35 g and 150.05 g heavier body weight than $VR \circlearrowleft \times GP \hookrightarrow \cong \mathbb{C}$ and $GP \circlearrowleft \times GP \hookrightarrow \cong \mathbb{C}$ genetic groups respectively. Besides, $GP \circlearrowleft \times GP \hookrightarrow \cong \mathbb{C}$ genetic group had also 56.3 g heavier body weight than $VR \circlearrowleft \times GP \hookrightarrow \cong \mathbb{C}$ genetic group.

Table-20: Mean squares from analysis of variance to test the effect of genetic groups on body weight at

various ages.

| Various | 3001 | | | |
|-----------------------|-----------------------|------|--------------|-----------|
| Traits | Source of variation | D.F. | M.S. | F |
| Zero day | Between genetic group | 3 | 69.339 | 5.352** |
| | Error | 1834 | 12.956 | |
| 4th week | Between genetic group | 3 | 53083.566 | 39.584** |
| | Error | 1193 | 1341.0211 | |
| 6 th week | Between genetic group | 3 | 262624.214 | 37.332** |
| | Error | 1089 | 7034.872 | |
| 8th week | Between genetic group | 3 | 1190803.393 | 106.404** |
| | Error | 1034 | 11191.331 | |
| 10 th week | Between genetic group | 3 | 3590676.624 | 301.390** |
| | Error | 991 | 11913.704 | |
| 12 th week | Between genetic group | 3 | 11244960.621 | 385.471** |
| | Error | 916 | 29172.019 | |
| 14 th week | Between genetic group | 3 | 20344751.212 | 616.135** |
| | Error | 858 | 33019.9309 | |
| 16 th week | Between genetic group | 3 | 24257144.826 | 900.61** |
| | Error | 836 | 26934.136 | |
| 18 th week | Between genetic group | 3 | 32008852.791 | 474.931** |
| | Error | 800 | 67396.857 | |
| 20th week | Between genetic group | 3 | 31260424.350 | 323.904** |
| ++0:: | Error | 780 | 96511.266 | |

**Significant at P<0.01

in various genetic groups of poultry (sexes pooled)

| WEEKS | | GP 33 X VR 22 | VR AAX GP OO | GP 33 X GP 00 | CO CLI A FF CIN |
|-----------------------|------------|-------------------|----------------------|---------------|---------------------------|
| Zero day | Mean + S.E | 37.19a ±0.18 | 36.78a +0.18 | 36.07b +0.18 | 37 45a +0 17 |
| | C V % | 10.76 | 9.37 | 10.99 | I α |
| 4th week | Mean ± S.E | 291.54b ±0.87 | 271.70a +1.83 | 278.34ª ±1.22 | 300.93° +1.46 |
| | C V % | 9.35 | 17.55 | 12.45 | 11.25 |
| 6th week | Mean + S.E | 446.92b ±2.24 | 399.14a ±3.15 | 417.31a +3.5 | 467.33° +4.19 |
| | C V % | 15.91 | 23.07 | 18.12 | 20.35 |
| 8th week | Mean + S.E | 512.72a±3.52 | 488.28b ±4.84 | 520.62ª ±4.49 | 639.86° +4.53 |
| | C V % | 14.45 | 25.13 | 17.95 | 17.37 |
| $10^{ m th}$ week | Mean + S.E | 662.98a±4.02 | 595.59b ±4.19 | 627.46° +6.13 | 860.17 ^d +4.69 |
| | C V % | 17.45 | 13.94 | 20.03 | 11.64 |
| $12^{ m th}$ week | Mean ± S.E | 1030.17a±8.53 | 823.82b ±5.44 | 880.12°+10.36 | 1313.274+6.20 |
| | C V % | 18.87 | 15.11 | 23.25 | 11.18 |
| 14th week | Mean + S.E | 1392.01b±5.82 | 919.06a±11.01 | 913.04a +7.93 | 1493.860+10.05 |
| | C V % | 10.76 | 22.25 | 15.26 | 14.74 |
| 16 th week | Mean + S.E | 1605.32b±7.12 | 1114.05a+3.80 | 1153.22a+5.33 | 1807.580+11.2 |
| | C V % | 10.37 | 8.09 | 12.75 | 12.42 |
| 18 th week | Mean + S.E | 1755.33a±15.89 | 1239.394-8.36 | 1347.900+11.5 | 2106.69d+15.67 |
| | C V % | 19.91 | 13.17 | 17.85 | 11.91 |
| 20th week | Mean + S.E | 2056.26a+7.39 | $1551.65^{b} + 9.19$ | 1688.59°+9.46 | 2437.46a+15.2 |
| | C V % | C V % 11.43 13.79 | 13.79 | 11.91 | 00 00 |

At 18^{th} week of age also the highest body weight was observed to be in $VR \partial \partial x VR \mathcal{P} \mathcal{P}$ genetic group which was significantly (P<0.01) higher by 758.79 g, 867.3 g and 351.36 g than $GP \partial \partial x GP \mathcal{P} \mathcal{P}$, $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ and $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ genetic groups respectively.

The 2^{nd} highest 18^{th} week body weight which was observed to be in $GP \partial \partial x VR \mathcal{P} \mathcal{P}$ was significantly higher by 515.94 g and 407.43 g than $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ and $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic group respectively. Besides, the 18^{th} week body weight of $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic group was also significantly (P<0.01) 108.51 g heavier than $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic group. At 18^{th} week of age also the heaviest body weight was observed to be in $VR \partial \partial x VR \mathcal{P} \mathcal{P}$ followed by $GP \partial \partial x VR \mathcal{P} \mathcal{P}$, $GP \partial \partial x GP \mathcal{P} \mathcal{P}$ and $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic groups.

The 20th week body weight of VR \circlearrowleft x VR \circlearrowleft was found to be significantly (P<0.01) heavier by 748.87, 885.81 g and 381.2 g than GP \circlearrowleft x GP \circlearrowleft x GP \circlearrowleft \circlearrowleft x GP \circlearrowleft and GP \circlearrowleft x VR \circlearrowleft genetic groups respectively. The 20th week body weight of GP \circlearrowleft x VR \circlearrowleft genetic group was also observed to be significantly (P<0.01) higher by 504.61g and 367.67g than VR \circlearrowleft x GP \circlearrowleft and GP \circlearrowleft x GP \circlearrowleft genetic groups respectively. Besides, GP \circlearrowleft x GP \circlearrowleft genetic group which ranked 3rd was also significantly (P<0.01) heavier by 136.94 g than VR \circlearrowleft x GP \circlearrowleft genetic group.

 $VR \partial \partial x GP \mathcal{P} \mathcal{P}$ genetic group had lowest body weight at almost all the age groups under study. This might be,

possibly attributed to negative heterotic performance of this group.

At all the ages $GP \circlearrowleft \circlearrowleft x$ $GP \circlearrowleft \circlearrowleft \varphi$ genetic group had significantly (P<0.01) lower body weight than $VR \circlearrowleft \circlearrowleft x$ $VR \circlearrowleft \varphi$ genetic group. This might be due to the fact that basically Gramapriya is an egg type bird developed by crossing random bred meat control population and White leghorn.

Jha and Prasad (2013) reported higher body weight of VR♂♂ x VR♀♀ genetic group than GP♂♂ x GP♀♀ by 2.67 gm, 147.62 gm, 271.75 gm, 333.75 gm, 275.9 gm, 304.39 gm and 529.08 gm at day old, 4th week, 6th week, 8th week, 12th week, 16th week and 20th week of age, the trend of which is similar to be findings of the present study.

Effect of genetic group on shank length:

Mean squares from analysis of variance presented in Table -22 indicated highly significant (P<0.01) effect of genetic group on shank length at various ages. Least squares means at Table -23 reflected that VR $\partial \partial x$ VR $\varphi \varphi$ genetic group had significantly (P<0.01) lengthiest shank followed by GP $\partial \partial x$ GP $\varphi \varphi$ genetic group at 4th week age. The smallest shank length at 4th week was found to be in VR $\partial \partial x$ GP $\varphi \varphi \varphi$ group.

At 4th week of age the mean shank length of VR 33 x VR 99, GP 33 x GP 99 and GP 33 x VR 99 genetic groups were significantly (P<0.01) lengthier by 0.38 cm, 0.31 cm and 0.36 cm respectively than VR 33 x GP 99 genetic group.

However, the mean shank lengths of VR $\partial \partial x$ VR QQ, GP $\partial \partial \partial x$ VR QQ and GP $\partial \partial \partial x$ VR QQ genetic groups did not differ significantly.

The trend of length of shank at 8th week of age was similar to that of 4th week. The lengthiest and shortest shank lengths were obtained in VR \circlearrowleft x VR \circlearrowleft and VR \circlearrowleft x GP \circlearrowleft genetic groups respectively. The mean shank length of VR \circlearrowleft x VR \circlearrowleft QP, GP \circlearrowleft x GP \circlearrowleft and GP \circlearrowleft x VR \circlearrowleft genetic groups were significantly (P<0.01) lengthier by 0.47 cm, 0.45 cm and 0.28 cm than VR \circlearrowleft x GP \circlearrowleft genetic group respectively. However, the mean shank lengths of VR \circlearrowleft x VR \circlearrowleft QP, GP \circlearrowleft x GP \circlearrowleft and GP \circlearrowleft x VR \circlearrowleft genetic groups did not differ significantly.

At 12^{th} , 16^{th} and 20^{th} week of ages also the lengthiest and shortest shank lengths were observed to be in VR $33 \times 10^{10} \times 10^{1$

increment at 16th week of age were noted as 0.88 cm and 0.29 cm, whereas the corresponding increment at 20th week of age were found to be 0.87 cm and 0.20 cm.

The mean shank length of GP $33 \times VR$ 99 ranked third with respect to shank length. The average shank lengths of GP $33 \times VR$ 99 genetic group was found to be significantly (P<0.01) lengthier than VR $33 \times GP$ 99 genetic group by 0.34 gm, 0.59 gm and 0.67 cm respectively at 12^{th} , 16^{th} and 20^{th} weeks of age.

Variation in shank length in different genetic groups of poultry at different ages have been reported by various authors (Chhabra et al. 1972; Aggarwal et al. 1979; Verma et al. 1979; Mahapatra et al. 1983; Sharma, 1984; Padhi et al. 1999 a; Singh et al., 2000; Khurana et al. 2006; Kalita et al. 2012, Padhi and Chatterjee, 2012 and Jha and Prasad, 2013. Padhi et al. (2012 a) have observed mean shank length at 6th week of age in Vanaraja to be 7.33 cm and 7.02 cm in males and females respectively, whereas Padhi and Chatterjee (2012) obtained 10.657 cm mean shank length of Vanaraja at 20 week of age which are similar to the findings of the present study. However, no information could be made available in literature to compare the mean shank lengths of crosses of VR $33 \times GP$ $99 \times GP$ and $GP 33 \times VR$ 99.Variations in shank lengths in different genetic groups at the same environment and same age may, possibly, be attributed to differences in gene combinations of different genotypes.

Table-22: Mean squares from analysis of variance to test the effect of genetic groups on shank length at various ages.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|-----------------------|------|----------|-----------|
| 4 th week | Between genetic group | 3 | 9.9097 | 43.799** |
| | Error | 1192 | 0.22625 | |
| 8th week | Between genetic group | 3 | 42.1652 | 69.006** |
| | Error | 1034 | 0.61103 | |
| 12 th week | Between genetic group | 3 | 72.3027 | 170.928** |
| | Error | 916 | 0.4230 | |
| 16 th week | Between genetic group | 3 | 661.9635 | 292.983** |
| | Error | 836 | 2.593 | |
| 20 th week | Between genetic group | 3 | 654.4533 | 247.352** |
| | Error | 780 | 2.64583 | |

^{**}Significant at P<0.01

Table-23: Least squares means along with C.V. % of shank length (cm) at different weeks of age in various genetic groups of poultry (sexes pooled)

| WEEKS | | GP♂♂ X | VR♂♂ | GP♂♂ X | VR♂♂ X |
|-----------------------|------------|-------------------|-------------------|-------------------|--------------------|
| | | VR ♀♀ | GP ♀♀ | GP ♀♀ | VR♀♀ |
| 4 th week | Mean + S.E | 7.09ª | 6.73 ^b | 7.04ª | 7.11ª |
| | | <u>+</u> 0.02 | <u>+</u> 0.02 | <u>+</u> 0.01 | <u>+</u> 0.016 |
| | C V % | 5.03 | 10.12 | 5.80 | 5.38 |
| 8 th week | Mean + S.E | 8.53ª | 8.25 ^b | 8.70ª | 8.72ª |
| | | <u>+</u> 0.03 | <u>+</u> 0.04 | <u>+</u> 0.04 | <u>+</u> 0.196 |
| | C V % | 7.73 | 10.73 | 7.88 | 53.14 |
| 12 th week | Mean + S.E | 8.73 ^b | 8.39° | 9.03 ^d | 9.11ª |
| | | <u>+</u> 0.05 | <u>+</u> 0.04 | <u>+</u> 0.07 | <u>+</u> 0.03 |
| | C V % | 8.62 | 8.40 | 12.66 | 5.49 |
| 16 th week | Mean + S.E | 9.08ª | 8.49 ^b | 9.37° | 9.58ª |
| | | <u>+</u> 0.11 | <u>+</u> 0.071 | <u>+</u> 0.08 | <u>+</u> 0.06 |
| | C V % | 13.45 | 11.20 | 10.20 | 8.50 |
| 20 th week | Mean + S.E | 9.28ª | 8.61 ^b | 9.48° | 10.14 ^d |
| | | <u>+</u> 0.14 | <u>+</u> 0.06 | <u>+</u> 0.14 | <u>+</u> 0.09 |
| | C V % | 12.56 | 7.60 | 14.78 | 8.59 |

Means(row wise) with different superscripts differ significantly (P<0.01)

Effect of genetic group on Keel length:

Analysis of variance depicted in Table-24 manifested that genetic group had significant (P<0.01) effect on keel length at various ages under study of this experiment.

Least squares means as mentioned in Table-25 reflected that VR $33 \times VR$ $99 \times VR$ and VR $33 \times GP$ $99 \times VR$ had significantly (P<0.01) lengthiest and shortest keel lengths respectively at all the five ages of the present investigation.

At 4th week of age VR $\partial \partial$ x VR QQ genetic group had significantly (P<0.01) lengthier keel by 0.38 cm and 1.03 cm respectively than GP $\partial \partial$ x GP QQ and VR $\partial \partial$ x GP QQ genetic groups. The mean keel lengths of GP $\partial \partial$ x VR QQ genetic group, which ranked second, had significantly (P<0.01) lengthier keel by 0.41 cm and 0.36 cm respectively than VR $\partial \partial$ x GP QQ and GP $\partial \partial$ x GP QQ genetic groups. However, the mean keel lengths of VR $\partial \partial$ x VR QQ and GP $\partial \partial$ x GP QQ genetic groups did not differ significantly.

At 8th week of age the mean keel length of VR $33 \times VR$ 99×0.01 genetic group, which was lengthiest, was significantly (P<0.01) lengthier by 0.40 cm, 0.53 cm and 0.45 cm than GP $33 \times GP$ $99 \times VR$ $33 \times GP$ $99 \times VR$ and GP $33 \times VR$ $99 \times VR$ genetic groups respectively. The mean keel lengths of GP $33 \times GP$ $99 \times VR$ genetic group had also significantly (P<0.01) lengthier keel by 0.13 cm than VR $33 \times GP$ $99 \times GP$ genetic group. However, the mean keel lengths of GP $33 \times GP$ $99 \times GP$ and GP $33 \times VR$ $99 \times GP$ as well as GP $33 \times GP$ $99 \times GP$ and GP $33 \times VR$ $99 \times GP$ genetic groups did not differ significantly.

Table-24: Mean squares from analysis of variance to test the effect of genetic groups on keel length at various ages.

| Traits | Source of variation | D.F. | M.S. | F |
|-----------------------|-----------------------|------|----------|-----------|
| 4th week | Between genetic group | 3 | 15.9215 | 96.646** |
| | Error | 1192 | 0.1647 | |
| 8th week | Between genetic group | 3 | 14.0835 | 72.911** |
| | Error | 1034 | 0.1932 | |
| 12 th week | Between genetic group | 3 | 72.3027 | 170.928** |
| | Error | 916 | 0.423 | |
| 16th week | Between genetic group | 3 | 130.4510 | 309.933** |
| | Error | 836 | 0.4209 | |
| 20th week | Between genetic group | 3 | 129.9061 | 233.425** |
| | Error | 780 | 0.5565 | |

^{**}Significant at P<0.01

Table-25: Least squares means along with C.V. % of keel length (cm) at different weeks of age in various genetic groups of poultry (sexes pooled)

| WEEKS | | GP∂∂ X | VR33 | GP♂♂ X | VR♂♂ X |
|-----------------------|------------|-------------------|-------------------|-------------------|-------------------|
| | | VRΩΩ | GP QQ | GP QQ | VRΩΩ |
| 4 th week | Mean + S.E | 5.10a | 4.69 ^b | 4.74b | 5.12ª |
| | | <u>+</u> 0.02 | <u>+</u> 0.03 | <u>+</u> 0.01 | <u>+</u> 0.012 |
| | C V % | 7.08 | 13.35 | 5.75 | 4.78 |
| 8 th week | Mean + S.E | 5.99ab | 5.91ª | 6.04 ^b | 6.44° |
| | | <u>+</u> 0.02 | <u>+</u> 0.02 | <u>+</u> 0.02 | <u>+</u> 0.030 |
| | C V % | 5.71 | 6.04 | 5.88 | 9.80 |
| 12 th week | Mean + S.E | 6.42ª | 6.07 ^b | 6.18 ^c | 6.56 ^d |
| | | <u>+</u> 0.02 | <u>+</u> 0.04 | <u>+</u> 0.03 | <u>+</u> 0.031 |
| | C V % | 4.77 | 10.11 | 7.06 | 7.07 |
| 16 th week | Mean ± S.E | 6.50ª | 6.33 ^b | 6.35° | 6.67d |
| | | <u>+</u> 0.02 | <u>+</u> 0.02 | <u>+</u> 0.05 | <u>+</u> 0.03 |
| | C V % | 3.95 | 6.60 | 11.34 | 5.66 |
| 20 th week | Mean ± S.E | 7.16 ^b | 6.38ª | 6.40ª | 7.24° |
| | | <u>+</u> 0.01 | <u>+</u> 0.04 | <u>+</u> 0.05 | <u>+</u> 0.03 |
| | C V % | 2.89 | 8.01 | 8.11 | 7.55 |

Means (row wise) with different superscripts differ significantly (P<0.01)

At 12^{th} week of age the mean keel lengths of VR 33 x VR 99 genetic group had significantly (P<0.01) lengthier keel by 0.38 cm, 0.49 cm and 0.14 cm than GP 33 x GP 99, VR 33 x GP 99 and GP 33 x VR 99 genetic groups respectively. Besides, the mean keel length of GP 33 x GP 99 had also significantly (P<0.01) lengthier keel by 0.11 cm than VR 33 x GP 99 genetic group. Apart from these, GP 33 x VR 99 genetic group had also significantly (P<0.01) lengthier keel by 0.24 cm and 0.35 cm than GP 33 x GP 99 and VR 33 x GP 99 genetic groups respectively.

At 16^{th} week of age the mean keel length of VR $33 \times VR$ 99 genetic group had also significantly (P<0.01) lengthier keel by 0.32 cm, 0.34 cm and 0.17 cm than GP $33 \times GP$ 99, VR $33 \times GP$ 99 and GP $33 \times VR$ 99 genetic groups respectively. Besides, GP $33 \times GP$ 99 genetic group had also 0.02 cm lengthier keel than VR $33 \times GP$ 99 genetic group. The mean keel lengths of GP $33 \times VR$ 99 genetic group had also significantly (P<0.01) lengthier keel by 0.15 cm and 0.17 cm than GP $33 \times GP$ $99 \times GP$ and VR $33 \times GP$ $99 \times GP$ genetic groups respectively.

At 20th week of age the average keel length of VR $\partial \partial$ x VR QQ genetic group had significantly (P<0.01) lengthier keel by 0.84 cm, 0.86 cm and 0.08 cm than GP $\partial \partial$ x GP QQ, VR $\partial \partial$ x GP QQ and GP $\partial \partial$ x VR QQ genetic groups respectively. Besides, GP $\partial \partial$ x VR QQ genetic group had also significantly (P<0.01) lengthier keel by 0.78 cm and 0.76 cm than VR $\partial \partial$ x GP QQ and GP $\partial \partial$ x GP QQ genetic groups respectively.

However, the mean keel lengths of VR $\partial \partial x$ GP QQ and GP $\partial \partial x$ GP QQ genetic groups did not differ statistically significant. Variations in keel length in different genetic groups at various ages in poultry have also been reported by many research workers (Mahapatra et al., 1983; Sharma, 1984; Venkatesh, 1985; Singh et al., 1999 a; Singh et al., 2000 and Kalita et al., 2012). Differences in keel lengths of various genetic groups might be, possibly, attributed to different gene combinations and other non-genetic factors.

In the present investigation, lengthiest shank and keel were observed to be in VR $\partial \partial x$ VR QQ genetic groups. It is to be mentioned that heaviest body weight at different ages were also observed to be in this group. Positive correlations among body weight, shank length and keel length might have played significant role on it.

Heterosis:

Percent heterosis of body weight and conformation traits at different weeks of age have been depicted in Table-26.

Table-26: Percent heterosis of body weight and Conformation traits at different weeks of age in Crossbred chicken(sexes pooled)

| | GP | ੀਰ x vr | 22 | VR♂♂ X GP♀♀ | | | |
|-----------------------|------------------|-------------------|----------------|------------------|-------------------|----------------|--|
| Traits | Average purebred | Average crossbred | % Heterosis | Average purebred | Average crossbred | % Heterosis | |
| Body wt.(gn | 1) | | | | | | |
| Zero day | 36.76 | 37.19 | 1.17 | 36.76 | 36.78 | 0.054 | |
| 4 th week | 289.635 | 291.54 | 0.658 | 289.635 | 271.70 | -6.19 | |
| 6 th week | 442.32 | 446.92 | 1.04 | 442.32 | 399.14 | -9.76 | |
| 8 th week | 580.24 | 512.72 | -11.64 | 580.24 | 488.28 | -15.848 | |
| 10 th week | 743.815 | 662.98 | -10.87 | 743.815 | 595.59 | -19.927 | |
| 12 th week | 1096.695 | 1030.17 | -6.066 | 1096.695 | 823.82 | -24.881 | |
| 14 th week | 1203.45 | 1392.01 | 15.668 | 1203.45 | 919.06 | -23.631 | |
| 16 th week | 1480.40 | 1605.32 | 8.438 | 1480.40 | 1114.05 | -24.747 | |
| 18 th week | 1727.29 | 1755.33 | 1.623 | 1727.295 | 1239.39 | -28.247 | |
| 20thweek | 2063.025 | 2056.26 | -0.328 | 2063.025 | 1551.65 | -24.788 | |
| Shank length (cm) | | | | | | | |
| 4 th week | 7.075 | 7.09 | 0.212 | 7.075 | 6.73 | -4.876 | |
| 8 th week | 8.71 | 8.53 | -2.066 | 8.71 | 8.25 | -5.281 | |
| 12 th week | 9.07 | 8.73 | -3.749 | 9.07 | 8.39 | -7.49 | |
| 16 th week | 9.47 | 9.08 | -4.118 | 9.47 | 8.49 | -10.35 | |
| 20 th week | 9.81 | 9.28 | -5.402 | 9.81 | 8.61 | -12.23 | |
| Keel length | (cm) | | | | ·· <u>-</u> | | |
| 4 th week | 4.93 | 5.10 | 3.448 | 4.93 | 4.69 | -4.868 | |
| 8 th week | 6.24 | 5.99 | -4.006 | 6.24 | 5.91 | -5.288 | |
| 12 th week | 6.37 | 6.42 | 0.787 | 6.372 | 6.075 | -4.668 | |
| 16 th week | 6.51 | 6.50 | -0.153 | 6.51 | 6.33 | -2.764 | |
| 20 th week | 6.82 | 7.16 | 4.985 | 6.82 | 6.38 | -6.452 | |

GP $33 \times VR$ 99, whereas all other values of heterosis for shank length and keel lengths were found to be negative. However, no information was available in literature to

compare the findings of present study in these genetic groups.

Negative heterosis might have resulted as the average values of purebreds were higher than the averages of crossbreds. It is worth mentioning here that Vanaraja chicken has been developed by crossing random bred meat control population on the female line and Red Cornish population as the male line whereas Gramapriya has been developed by crossing random bred meat control population and White Leghorn.

Feed Efficiency:

Feed efficiency and FCR of different weeks of age in all the 4 genetic groups have been presented in table -27.

The feed efficiency at 1^{st} week of age in VR $33 \times VR$ $99,GP 33 \times GP 99,VR 33 \times GP 99$ and $99 33 \times VR 99$ were observed to be 130.25%, 130.47%, 130.28% and 130.68% respectively. These values tended to decrease with the advancement of age.

At 8th week of age the feed efficiency in VR $33 \times VR$ 99, GP $33 \times GP$ 99, VR $33 \times GP$ 99 and GP $33 \times VR$ 99 were found to be 34.00%, 31.65%, 30.9% and 29.89% respectively which reflected the highest and lowest feed efficiency in VR $33 \times VR$ 99 and GP $33 \times VR$ 99 genetic groups respectively.

The FCR at 3^{rd} week of age in VR $33 \times VR$ 99, GP $33 \times VR$ 99, VR $33 \times VR$ 99 and GP $33 \times VR$ 99 were found to be

1.431, 1.402, 1.394 and 1.413. The corresponding values at 5th week of age were observed to be 2.08, 2.005, 1.906 and 2.097 whereas the corresponding values at 7th week of age were noted to be 2.728, 2.833, 2.867 and 2.895 and the corresponding values at 8th week of age were found to be 2.94, 3.159, 3.235 and 3.345 which again suggested the lowest and highest FCR to be in VR 33 x VR 34 and GP 33 x GP genetic groups respectively.

Rama Rao *et al.* (2005) evaluated the effect of dietary protein level on performance of Vanaraja chicks and reported the FCR at 3^{rd} , 5^{th} and 7^{th} week of age to be 2.15, 2.54 and 2.69 respectively by feeding 14.5% crude protein in diet. The findings of the present study in VR 33 x VR 99 genetic group at 3^{rd} and 5^{th} week of age are lower than their findings whereas at 7^{th} week of age the findings of the present investigation are in close proximity with their findings.

Table-27: Feed efficiency and FCR at different ages in various genetic groups.

| Gr. | Weeks | Body wt(gm) | Feed consumption weekly(gm) | Feed consumption cumulative (gm) | FCR | Feed efficiency (FE) |
|--------------------------|-------|----------------|-----------------------------------|---|--------|----------------------------|
| | 1 | 64.4 | 49.28 | 49.28 | 0.765 | 130.68 |
| O+ O+ | 2 | 131 | 94.32 | 143.6 | 1.096 | 91.23 |
| VR 9 | 3 | 204 | 144.8 | 288.4 | 1.413 | 70.74 |
| × | 4 | 290.4 | 179.8 | 468.2 | 1.612 | 62.03 |
| उँउ | 5 | 357.2 | 281.2 | 749.4 | 2.097 | 47.67 |
| GP (| 6 | 446.2 | 306.3 | 1055.7 | 2.365 | 42.27 |
| | 7 | 474.2 | 317.5 | 1373.2 | 2.895 | 34.53 |
| | 8 | 508.6 | 328.6 | 1701.8 | 3.345 | 29.89 |
| | 1 | 63.2 | 48.51 | 48.51 | 0.767 | 130.28 |
| 0 † 0 † | 2 | 124.3 | 87.28 | 135.79 | 1.09 | 91.54 |
| GP ♀ | 3 | 195 | 136.16 | 271.95 | 1.394 | 71.71 |
| × | 4 | 270.6 | 166.4 | 438.35 | 1.619 | 61.73 |
| 33 | 5 | 339.5 | 208.8 | 647.15 | 1.906 | 52.46 |
| VR | 6 | 395.28 | 301.3 | 948.45 | 2.399 | 41.68 |
| > | 7 | 438.3 | 308.2 | 1256.65 | 2.867 | 34.88 |
| | 8 | 486.21 | 316.7 | 1573.3 | 3.235 | 30.9 |
| | 1 | 65.3 | 50.05 | 50.05 | 0.766 | 130.47 |
| O † | 2 | 127.9 | 88.45 | 138.5 | 1.0822 | 92.35 |
| | 3 | 197 | 137.87 | 276.37 | 1.402 | 71.28 |
| x GP | 4 | 277.15 | 169.7 | 446.07 | 1.609 | 62.13 |
| 33 × | 5 | 342.4 | 240.5 | 686.57 | 2.005 | 49.87 |
| GP G | 6 | 416.76 | 295.4 | 981.97 | 2.356 | 42.44 |
| 0 | 7 | 458.4 | 316.8 | 1298.77 | 2.833 | 35.29 |
| | 8 | 514.97 | 328.3 | 1627.07 | 3.159 | 31.65 |
| | 1 | 68.2 | 52.36 | 52.36 | 0.767 | 130.25 |
| 0+ | 2 | 140.6 | 100.8 | 153.16 | 1.089 | 91.8 |
| R \$ | 3 | 212.2 | 150.5 | 303.66 | 1.431 | 69.88 |
| x VR | 4 | 300.4 | 186 | 489.66 | 1.63 | 61.35 |
| उँउ र | 5 | 373.3 | 288.8 | 778.46 | 2.08 | 47.95 |
| VR $\dot{\phi}$ | 6 | 464.9 | 345.9 | 1124.36 | 2.418 | 41.35 |
| > | 7 | 544.5 | 361.1 | 1485.46 | 2.728 | 36.65 |
| | 8 | 636.5 | 386.2 | 1871.66 | 2.94 | 34 |

Phenotypic correlations among various body weight and conformation traits in different genetic groups

Interrelationship among body weights at different ages:

The phenotypic correlations along with their standard errors among body weights at different ages in all the four genetic groups have been depicted in Table-28.

It was observed that the estimates of rp between zero day and other body weights in all the four genetic groups were very low and non-significant. Out of 36 estimates of rp only two estimates in GP ♂♂ x VR ♀♀, one estimate in VR ♂♂ x GP QQ, four estimates in GP 33 x GP QQ and only one estimate in VR 33 x VR 99, were significant with low magnitude. Besides, many of the non-significant values were negative also. Twenty eight estimates out of 36 were found to be non-significant. Kaniska (1970), Potemskowska et al. (1970) and Rao (1984) also reported non-significant values of rp between zero day body weight and body weight at higher ages which are similar to the findings of the present study. Besides, it was also observed that the magnitude of phenotypic correlations of day old chick weight, in general, had a declining tendency with that of body weights at subsequent ages. This might be, possibly, due to the dilution of maternal influence as the age advances. The very low and non-significant estimates of rp between zero day and body weights at higher ages might suggest that zero day body weight would not be a suitable criterion for the selection for body weights.

Phenotypic correlation of 4th week body weight with body weights at higher ages revealed that out of 8 estimates in each group 6, 7, 6 and 6 values were observed to be positive in VR $33 \times VR$ 99, GP $33 \times GP$ 99, VR $33 \times GP$ 99 and GP $33 \times VR$ 99 genetic groups respectively. The corresponding number of estimates to be significant were found to be 5, 4, 3 and 1. Thus out of 32 estimates, 25 were positive of which 13 estimates were found to be statistically significant (P<0.01). Similarly, out of 28 estimates of phenotypic correlations between 6th week body weight with body weights at higher ages, 22 estimates were found to be positive of which 10 values were significant (P<0.01). Out of 24 estimates of r_p between 8th week body weight and body weights at higher ages, 17 were positive of which 8 were observed to be significant (P<0.01).

Out of 20 estimates of r_p between body weights at 10^{th} week of age and body weights at higher ages, 14 were found to be positive of which 2 were significant (P<0.01). Out of 16 estimates of r_p between body weights at 12 week of age and body weights at higher ages 13 values were positive of which 7 were found to be significant (P<0.01). Among the estimates of r_p at 14^{th} week, 16^{th} week and 18^{th} week body weights with body weights at higher ages 09, 8 and 4 estimates were observed to be in positive direction. Thus, it was observed that out of 144 estimates of r_p between body weights at 4^{th} week onwards with body weights at higher ages, 112 were found to be in positive direction of which 42 were statistically significant (P<0.01 or P<0.05). Positive

estimates of r_p between 4th week body weight and body weights at higher ages have also been reported by various authors in different genetic groups of poultry. (Gill and Verma, 1983; Sharma, 1984 and Jaya Laxmi *et al.*, 2010) which are in conformity with the findings of the present study. Padhi and Chatterjee (2012) obtained a positive estimate of r_p between 20th week body weight and 40th week body weight in Vanaraja, the trend of which is similar to the findings of the present study. Positive and significant estimates of r_p between body weights at different ages might suggest that selection for body weight at one age would also lead to improvement in body weights at another correlated age.

Table-28: Phenotypic correlations along with their standard errors among body weights at different ages in various genetic groups of poultry

| aits | GP♂♂ X VR♀♀ | VR♂♂X GP♀♀ | GP ♂♂ X GP ♀♀ | VR∂∂X VR ♀♀ |
|--------------------------------|------------------------|-------------------------|-----------------------------|--------------------------------|
| ay old Body wt. | | | | |
| 4thweek body wt. | 0.371* <u>+</u> 0.053 | 0.049 <u>+</u> 0.057 | 0.27** <u>+</u> 0.058 | -0.076 <u>+</u> 0.057 |
| 6thweek body wt. | 0.030 <u>+</u> 0.061 | -0.10 <u>+</u> 0.060 | 0.148* <u>+</u> 0.060 | 0.061 <u>+</u> 0.061 |
| 8thweek body wt. | -0.980 <u>+</u> 0.012 | -0.053 <u>+</u> 0.062 | 0.257** <u>+</u> 0.060 | 0.037 <u>+</u> 0.062 |
| 10thweek body wt. | 0.142* <u>+</u> 0.063 | 0.094 <u>+</u> 0.063 | 0.053 <u>+</u> 0.063 | -0.072 <u>+</u> 0.064 |
| 12 th week body wt. | -0.018 <u>+</u> 0.066 | 0.139* <u>*</u> ± 0.065 | 0.299** <u>+</u> 0.063 | 0.022 <u>+</u> 0.066 |
| 14thweek body wt. | -0.070 <u>+</u> 0.068 | 0.017 <u>+</u> 0.068 | 0.004 <u>+</u> 0.068 | -0.052 <u>+</u> 0.068 |
| 16thweek body wt. | 0.021 <u>+</u> 0.069 | 0.024 <u>+</u> 0.069 | 0.031 <u>+</u> 0.069 | 0.035 <u>+</u> 0.069 |
| 18thweek body wt. | 0.099 <u>+</u> 0.070 | 0.003 ± 0.071 | 0.040 <u>+</u> 0.071 | 0.182* <u>+</u> 0.070 |
| 20thweek body wt. | 0.094 <u>+</u> 0.071 | 0.035 <u>+</u> 0.071 | 0.015 <u>+</u> 0.072 | 0.010 <u>+</u> 0.072 |
| week Body wt. | | | | |
| 6 th week body wt. | 0.005 <u>+</u> 0.061 | 0.261** <u>+</u> 0.059 | 0.153* <u>+</u> 0.060 | 0.216** <u>+</u> 0.059 |
| 8thweek body wt. | 0.204** <u>+</u> 0.061 | 0.116 <u>+</u> 0.062 | 0.298** <u>+</u> 0.059 | 0.369** <u>+</u> 0.058 |
| 10thweek body wt. | 0.051 <u>+</u> 0.064 | -0.013 <u>+</u> 0.064 | 0.092 <u>+</u> 0.063 | -0.001 <u>+</u> 0.064 |
| 12thweek body wt. | -0.041 <u>+</u> 0.066 | 0.180** <u>+</u> 0.065 | 0.265** <u>+</u> 0.064 | 0.295** <u>+</u> 0.063 |
| 14thweek body wt. | 0.098 <u>+</u> 0.068 | -0.036 <u>+</u> 0.069 | 0.125 <u>+</u> 0.068 | -0.013 <u>+</u> 0.068 |
| 16thweek body wt. | 0.045 <u>+</u> 0.069 | 0.103 <u>+</u> 0.069 | 0.012 <u>+</u> 0.069 | 0.311 ** <u>+</u> 0.066 |
| 18thweek body wt. | -0.053 <u>+</u> 0.071 | 0.021 <u>+</u> 0.071 | -0.055 <u>+</u> 0.071 | 0.006 <u>+</u> 0.071 |
| 20thweek body wt. | 0.003 <u>+</u> 0.072 | 0.199** <u>+</u> 0.070 | 0.157* <u>+</u> 0.070 | 0.299** <u>+</u> 0.068 |
| week Body wt. | | | | |
| 8thweek body wt. | 0.128* <u>+</u> 0.062 | 0.084 <u>+</u> 0.062 | 0.192** <u>+</u> 0.061 | 0.455** <u>+</u> 0.055 |
| 10thweek body wt. | 0.068 <u>+</u> 0.064 | 0.073 <u>+</u> 0.064 | 0.035 <u>+</u> 0.064 | 0.018 <u>+</u> 0.064 |
| 12 th week body wt. | -0.043 <u>+</u> 0.066 | 0.137* <u>+</u> 0.065 | 0.249** <u>+</u> 0.064 | 0.409** <u>+</u> 0.060 |
| 14thweek body wt. | -0.047 <u>+</u> 0.068 | 0.076 <u>+</u> 0.068 | -0.096 <u>+</u> 0.068 | 0.078 <u>+</u> 0.068 |
| 16 th week body wt. | 0.209** <u>+</u> 0.068 | 0.120 <u>+</u> 0.068 | 0.103 <u>+</u> 0.069 | 0.177* <u>+</u> 0.068 |
| 18thweek body wt. | 0.069 <u>+</u> 0.071 | -0.065 <u>+</u> 0.071 | -0.051 <u>+</u> 0.071 | -0.068 <u>+</u> 0.071 |
| 20thweek body wt. | 0.126 <u>+</u> 0.071 | 0.195** <u>+</u> 0.07 | 0.088 <u>+</u> 0.072 | 0.376** <u>+</u> 0.066 |
| | | | L | <u> </u> |

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|----------------------------------|------------------------|------------------------|------------------------|------------------------|
| 8 th week Body wt. | | | | |
| X 10 th week body wt. | 0.047 <u>+</u> 0.064 | 0.056 <u>+</u> 0.064 | -0.043 <u>+</u> 0.064 | -0.022 <u>+</u> 0.064 |
| X 12 th week body wt. | -0.018 <u>+</u> 0.066 | 0.181** <u>+</u> 0.065 | 0.350** <u>+</u> 0.062 | 0.460** <u>+</u> 0.058 |
| X 14 th week body wt. | 0.221** <u>+</u> 0.067 | -0.026 <u>+</u> 0.069 | 0.070 <u>+</u> 0.068 | 0.125 <u>+</u> 0.068 |
| X 16 th week body wt. | 0.160* ± 0.068 | 0.081 ± 0.069 | 0.232** <u>+</u> 0.067 | 0.203** <u>+</u> 0.068 |
| X 18 th week body wt. | -0.014 ± 0.071 | 0.052 ± 0.071 | -0.018 ± 0.071 | 0.000 <u>+</u> 0.071 |
| X 20 th week body wt. | 0.042 ± 0.072 | -0.028 <u>+</u> 0.072 | 0.230** <u>+</u> 0.069 | 0.379** <u>+</u> 0.066 |
| 10 th week body wt. | | | | |
| X12 th weekbody wt. | -0.025 <u>+</u> 0.066 | 0.104 <u>+</u> 0.065 | 0.135* <u>+</u> 0.065 | 0.166** <u>+</u> 0.065 |
| X14 th weekbody wt. | 0.090 <u>+</u> 0.068 | -0.047 <u>+</u> 0.068 | 0.045 <u>+</u> 0.069 | -0.038 <u>+</u> 0.069 |
| X16 th weekbody wt. | 0.128 <u>+</u> 0.068 | 0.116 <u>+</u> 0.069 | 0.004 <u>+</u> 0.069 | 0.058 <u>+</u> 0.069 |
| X18 th weekbody wt. | 0.052 <u>+</u> 0.071 | 0.095 <u>+</u> 0.070 | -0.020 <u>+</u> 0.071 | -0.037 <u>+</u> 0.071 |
| X20 th weekbody wt. | 0.071 <u>+</u> 0.071 | -0.061 <u>+</u> 0.071 | 0.039 <u>+</u> 0.072 | 0.092 <u>+</u> 0.071 |
| 12 th week body wt. | | | | |
| X14 th weekbody wt. | 0.111 <u>+</u> 0.068 | 0.048 <u>+</u> 0.069 | 0.000 <u>+</u> 0.068 | 0.145* <u>+</u> 0.068 |
| X16 th weekbody wt. | 0.141* <u>+</u> 0.069 | 0.103 <u>+</u> 0.069 | 0.308** <u>+</u> 0.065 | 0.353** <u>+</u> 0.064 |
| X18thweekbody wt. | -0.053 <u>+</u> 0.071 | -0.023 <u>+</u> 0.071 | 0.040 <u>+</u> 0.071 | 0.027 <u>+</u> 0.071 |
| X20 th weekbody wt. | 0.200** <u>+</u> 0.070 | 0.039 <u>+</u> 0.072 | 0.255** <u>+</u> 0.069 | 0.596** <u>+</u> 0.057 |
| 14thweek body wt. | | | | |
| X16 th weekbody wt. | 0.132 <u>+</u> 0.068 | -0.009 <u>+</u> 0.069 | 0.039 <u>+</u> 0.069 | -0.019 <u>+</u> 0.069 |
| X18thweekbody wt. | 0.087 <u>+</u> 0.070 | 0.082 <u>+</u> 0.070 | 0.019 <u>+</u> 0.071 | 0.069 <u>+</u> 0.071 |
| X20thweekbody wt. | 0.059 <u>+</u> 0.072 | 0.075 <u>+</u> 0.072 | -0.030 <u>+</u> 0.072 | 0.057 <u>+</u> 0.072 |
| 16 th week body wt. | | | | |
| X18thweek body wt. | 0.005 <u>+</u> 0.071 | -0.007 <u>+</u> 0.071 | 0.067 <u>+</u> 0.071 | 0.013 <u>+</u> 0.071 |
| X20 th week body wt. | -0.003 <u>+</u> 0.071 | 0.463** <u>+</u> 0.063 | 0.579** <u>+</u> 0.058 | 0.634** <u>+</u> 0.055 |
| 18 th week body wt. | | | | |
| X20 th week body wt. | 0.105 <u>+</u> 0.071 | 0.055 <u>+</u> 0.071 | 0.060 <u>+</u> 0.071 | 0.043 <u>+</u> 0.072 |

^{*}Significant at P<0.05
**Significant at P<0.01

Interrelationship among body weight and conformation traits at different ages in various genetic groups:

Body weight and shank length

The estimates of r_p along with their standard errors between body weight and shank length at different ages in all the four groups have been presented in Table -29.

Table -29 revealed that all the estimates of r_p between day old body weight and shank lengths at different ages in all the four genetic groups were non-significant. Besides, a few of them had also negative but non-significant correlations. These findings suggested that zero day body weight and shank length at various ages in all the four genetic groups are not phenotypically correlated and zero day body weight would not be the suitable criterion for selection of shank length in any of the genetic group. Sharma (1984) also obtained non-significant phenotypic correlations between zero day body weight and 8-week shank length in Red Cornish and White Plymouth Rock, a trend, which is similar to the findings of the present study.

Out of 45 estimates of r_p between body weights at 4th week onwards and shank length at 4th week onwards (table-29), 31 estimates were observed to be positive and significant (P<0.01) in VR 33 x VR 99 genetic group. The corresponding number in GP 33 x GP 99, VR 33 x GP 99 and GP 33 x VR 99 were noted as 13, 12 and 8. Chhabra *et al.* (1972), Aggarwal *et al.* (1979), Verma *et al.* (1979) and

Sharma (1984) have also obtained positive and significant estimates of r_p between body weight and shank length in different genetic groups in poultry which are similar to the findings of the present study. Padhi and Chatterjee (2010) have also reported positive estimates of r_p of moderate magnitude between body weight and shank length in Vanaraja, the trend of which is similar to the findings of the present investigation.

These findings suggested that body weight and shank length are more correlated in VR $\delta\delta$ x VR $\varphi\varphi$ genetic group than other genetic groups. The 4th week body weight was highly, positively and significantly (P<0.01) correlated with shank length at 4, 8, 12, 16 and 20 weeks of age suggesting 4th week body weight might be one of criteria for selection of shank length at different ages in this genetic group. Besides, selection for 4 week body weight would also bring simultaneous improvement in shank length at different ages.

Body weight x keel length:

The estimates of r_p between body weight and keel length at various ages in all the four genetic groups have been depicted in Table -29.

The trend of phenotypic correlations between zero day body weight x keel length at different ages was similar to that of body weight x shank length. All the estimates were found to be statistically non-significant. Besides, a few nonsignificant negative estimates were also obtained. Sharma (1984) also observed non-significant estimate of r_p between zero day body weight x 8 week keel length in Red Cornish, a trend similar to the findings of the present study. Non-significant estimates of r_p might suggest again that zero day weight might not be a suitable criterion for selection of keel length at any age in any of the genetic group under study.

Table -29 revealed that out of 45 estimates of r_p between body weights at 4th week onwards and keel length at 4th week onwards 28 estimates were observed to be positive and significant (P<0.05 or 0.01) in VR $33 \times VR$ 99genetic group. The corresponding figures in GP 33 x GP 99, VR ♂♂ x GP ♀♀ and GP ♂♂ x VR ♀♀ were obtained as 14, 8 and 10. It was further observed that the estimates of rp between 4th week body weight x keel length at different ages were stronger, of high magnitude with low value of standard error in VR 33 x VR 99 genetic group, as obtained in case of estimates of rp between 4th week body weight x shank length at different ages. Ayoub et al. (1980) and Sharma (1984) also reported positive and significant phenotypic correlation coefficients of high magnitude between body weight x keel length from 4th week of age onwards in crossbreds of similar trend, obtained poultry, a in the investigation. Positive and significant estimates of r_p of high magnitude with low estimate of standard error would reflect that selection for body weight at different ages would also bring simultaneous improvement in the correlated keel length at that age.

ranie-47 : Flictiotypic correlations along with their standard errors among body weight and conformation traits at different ages in various genetic groups of poultry.

| Traits | GP♂♂ X VR♀♀ | VR♂3 X GP♀♀ | GP33 X GP\$\$ | VR33X VR9₽ |
|--------------------------------------|------------------------|---------------------|-----------------------------------|----------------------------------|
| Day old Body wt. | | | | |
| X 4 th week shank length | 0.0641 ± 0.058 | 0.0491 ± 0.057 | -0.080 ± 0.05 | 0.0406 + 0.057 |
| X 8thweek shank length | 0.2109 ± 0.062 | 0.04601 ± 0.062 | -0.101 ± 0.064 | 0.0059 ± 0.062 |
| X 12 th week shank length | -0.1461 ± 0.066 | 0.1293 ± 0.066 | 0.081 ± 0.069 | 0.0484 ± 0.066 |
| X 16thweek shank length | -0.2497 ± 0.069 | 0.0573 ± 0.069 | 0.011 ± 0.071 | 0.0304 ± 0.069 |
| X 20thweek shank length | -0.0483 ± 0.071 | 0.0064 ± 0.072 | -0.052 ± 0.058 | 0.0829 ± 0.072 |
| X 4thweek keel length | -0.0055 ± 0.058 | -0.0292 ± 0.058 | -0.0267 ± 0.061 | -0.1254 ± 0.057 |
| X 8 th week keel length | 0.1778 ± 0.061 | 0.042 ± 0.062 | -0.1853 ± 0.064 | -0.0339 ± 0.062 |
| X 12 th week keel length | -0.11802 ± 0.066 | 0.0903 ± 0.066 | 0.039 ± 0.069 | 0.1322 ± 0.066 |
| X 16 th week keel length | -0.0733 ± 0.069 | -0.242 ± 0.069 | 0.0793 ± 0.069 | 0.0807 ± 0.069 |
| X 20thweek keel length | 0.0599 ± 0.071 | 0.0466 ± 0.072 | 0.0526 ± 0.072 | 0.0526 ± 0.072 |
| 4th week Body wt. | | | | |
| X 4 th week shank length. | 0.101 ± 0.057 | 0.877** ± 0.028 | $0.910^{**} \pm 0.024$ | 0.938 ** ± 0.020 |
| X 8 th week shank length. | 0.185 ** ± 0.061 | 0.099 ± 0.062 | 0.205 ^{**} ± 0.061 | $0.308^{*+} \pm 0.059$ |
| X 12thweek shank length | 0.074 ± 0.066 | 0.001 ± 0.065 | 0.045 ± 0.064 | $0.152^{**}\pm0.064$ |
| X 16 th week shank length | 0.103 ± 0.069 | -0.121 ± 0.069 | 0.258 ± 0.069 | $0.261^{*+} \pm 0.066$ |
| X 20thweek shank length | 0.096 ± 0.072 | 0.032 ± 0.070 | 0.058 ± 0.071 | $0.370^{**} \pm 0.070$ |
| X 4thweek keel length. | 0.024 ± 0.058 | $0.800* \pm 0.035$ | $0.822^{**} \pm 0.033$ | $0.760^{++} 0.038$ |
| X 8 th week keel length. | $0.250^{**} \pm 0.060$ | -0.049 ± 0.062 | $0.224^{**} \pm 0.061$ | 0.305 ⁺ ± 0.059 |
| X 12 th week keel length. | 0.237 ** ± 0.066 | 0.064 ± 0.065 | 0.001 ± 0.064 | $0.118^{**}\pm 0.064$ |
| X 16 th week keel length. | 0.088 ± 0.069 | 0.001 ± 0.068 | -0.227 ± 0.069 | $0.902^{*+} \pm 0.067$ |
| X 20thweek keel length | -0.227 ± 0.072 | -0.125 ± 0.072 | 0.143 ± 0.071 | 0.225 ** ± 0.068 |

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|--------------------------------------|---------------------|------------------------|--|----------------------|
| o week body wi. | | | | |
| X 4thweek shank length. | 0.051 + 0.061 | 0.000 - #0.000 | , the state of the | |
| X Sthweek shant land | | 60.0 + 60.03 | 090.0 = 901.0 | $0.245^{**} + 0.059$ |
| V 10th 1 Cilgin. | 0.188 ± 0.061 | 0.075 ± 0.062 | 0.196**+ 0.061 | 0.396**+ 0.057 |
| A 12"Week shank length | -0.073 ± 0.066 | 0.054* + 0.066 | 7 0 032 + 0 065 | 100:0 - #770 O |
| X 16 th week shank length | 0.071 + 0.068 | 0.017 + 0.060 | 0108 - 0060 | 0.0244 ± 0.060 |
| X 20thweek shank length | 0000- | 0.017 ± 0.069 | 0.108 ± 0.069 | 0.203***± 0.067 |
| V Athmool-111 | 170.0 1000.0- | 0.108 ± 0.070 | -0.001 ± 0.072 | $0.185^* + 0.071$ |
| A + week keel length. | $0.134^*\pm0.061$ | $0.142^{*} \pm 0.061$ | 0.158** + 0.060 | 0.107 + 0.061 |
| A Suweek keel length. | $0.128^*\pm0.061$ | 0.025 + 0.062 | 0 117 + 0 062 | 10000 T##COCO |
| X 12 th week keel length. | 0.016 + 0.066 | 0 140 + 0 066 | 7000 - #6000 | 670.0 + 762.0 |
| X 16thweek keel length | 0000 - 9000 | 00000 - 01100 | 0.003 ± 0.004 | 0.132" ± 0.062 |
| VOOth 1 1 1 1 1 | 800.0 + 0+0.0 | 0.054 ± 0.068 | 0.018 ± 0.069 | 0.040 + 0.069 |
| A 20 wweek keel length. | $0.031^* \pm 0.071$ | 0.132 ± 0.071 | -0.085 ± 0.072 | |
| 8th week Body wt. | | | | 1 |
| X 4 th week shank length. | 0.140*+0.062 | 0.127* + 0.062 | 0900 +**8900 | 0.306**+0.057 |
| X 8 th week shank length. | 0 885** + 0 029 | 0 040** + 0 010 | 0.500 - 0.000 | 1000 - #000 |
| X 10thmest should lost | | 610.0 - 616.0 | 0.004 + 0.031 | 0.920"+ 0.024 |
| X 12 wcc signik lengin | -0.070± 0.066 | $0.122^{**} \pm 0.065$ | 0.040** ± 0.064 | 0.327**+ 0.059 |
| X 10 week shank length | 0.094 ± 0.069 | -0.060 ± 0.069 | 0.072+ 0.069 | $0.187^* + 0.069$ |
| X 20thweek shank length | $0.141^* \pm 0.071$ | 0.006 ± 0.072 | -0.145 + 0.071 | 690 0 + # 968 0 |
| X 4thweek keel length. | 0.023 ± 0.062 | 0.036 + 0.062 | 0.237 ^{**} + 0.061 | 0900 = 0000 |
| X 8thweek keel length. | $0.723^* + 0.043$ | 0.787** + 0.039 | 0.752**+ 0.041 | 0.784**+ 0.038 |
| X 12 th week keel length. | - 0.020 + 0.066 | 0.044 + 0.065 | 0.041 ± 0.064 | 0000 - #000 |
| X 16 th week keel length | 0900 + 0800 | 0 101 - 0 060 | +00.0 - +00.0 | 0.27.3 ± 0.002 |
| V 20thres 1-2-11 | 800.0 T 080.0 | 600.0 = 101.0 | 0.081 ± 0.068 | 0.009 ± 0.069 |
| A 20 "week keel length. | 0.058 ± 0.072 | -0.022 ± 0.072 | 0.007 ± 0.071 | 0.319**+ 0.067 |

| 10th week Body wt. | | | | |
|--------------------------------------|------------------------|------------------------|------------------------|-----------------------|
| X 4thweek shank length. | 0.057 ± 0.064 | 0.003 + 0.064 | 0.079 + 0.004 | -0.010 + 0.064 |
| X 8 th week shank length. | 0.057 ± 0.063 | 0.060 ± 0.063 | | 0.010 + 0.064 |
| X 12 th week shank length | -0.021 ± 0.066 | 0.068 ± 0.066 | 0.093 ± 0.065 | 0.206*+0.065 |
| X 16 th week shank length | 0.022 ± 0.069 | -0.057 ± 0.069 | -0.023 ± 0.069 | 0.100 + 0.069 |
| X 20 th week shank length | -0.013 ± 0.072 | 0.015 ± 0.072 | 0.025 ± 0.072 | -0.016 + 0.072 |
| X 4thweek keel length. | 0.022 ± 0.064 | 0.014 ± 0.064 | 0.064 ± 0.063 | 0.032 + 0.064 |
| X 8thweek keel length. | 0.099 ± 0.064 | 0.043 ± 0.064 | 0.096 ± 0.064 | 0.010 + 0.064 |
| X 12 th week keel length. | 0.108 ± 0.066 | -0.015 ± 0.066 | $0.110^* \pm 0.065$ | |
| X 16 th week keel length. | 0.100 ± 0.069 | 0.052 ± 0.068 | 0.039 + 0.069 | |
| X 20thweek keel length. | 0.038 ± 0.072 | 0.186 ± 0.071 | -0.120 ± 0.072 | |
| 12 th week Body wt. | | | | |
| X 4thweek shank length. | 0.119 ± 0.065 | 0.143* ± 0.065 | 0.262** + 0.064 | 0.319**+ 0.063 |
| X 8 th week shank length. | 0.073 ± 0.066 | $0.168* \pm 0.065$ | $0.329** \pm 0.063$ | 0.406**+ 0.060 |
| X 12thweek shank length | 0.025 ± 0.047 | 0.011 ± 0.065 | 0.028 ± 0.036 | 0.487**+ 0.025 |
| X 16thweek shank length | 0.006 ± 0.069 | $0.142^{**} \pm 0.068$ | -0.046 ± 0.069 | $0.426^{**+} 0.063$ |
| X 20thweek shank length | 0.096 ± 0.071 | 0.085 ± 0.072 | -0.002 ± 0.072 | $0.267** \pm 0.067$ |
| X 4 th week keel length. | -0.088 ± 0.066 | $0.142^* \pm 0.065$ | $0.171* \pm 0.065$ | $0.238^{**}\pm0.064$ |
| X 8 th week keel length. | $0.135* \pm 0.066$ | $0.131* \pm 0.066$ | $0.254^{**} \pm 0.064$ | 0.395**+ 0.061 |
| X 12thweek keel length. | $0.081^{**} \pm 0.048$ | 0.204** ± 0.027 | $0.068** \pm 0.034$ | $0.219^{**}\pm 0.046$ |
| X 16 th week keel length. | 0.014 ± 0.067 | 0.119 ± 0.069 | 0.115 ± 0.068 | $0.137**_{\pm} 0.067$ |
| X 20thweek keel length. | $0.163* \pm 0.071$ | -0.061 ± 0.072 | 0.050 ± 0.071 | 0.298**+ 0.058 |

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| X 4thweek shank length. | 0.090 ± 0.071 | 0.019 ± 0.071 | 0.069 ± 0.071 | 0.034 + 0.071 | |
| X 8 th week shank length. | -0.007 ± 0.071 | 0.008 ± 0.071 | 0.041 ± 0.072 | | |
| X 12 th week shank length | 0.033 ± 0.071 | -0.063 ± 0.071 | 0.052 ± 0.071 | | |
| X 16 th week shank length | 0.031 ± 0.071 | 0.025 ± 0.071 | 0.046 ± 0.070 | | |
| X 20thweek shank length | 0.007 ± 0.072 | -0.005 ± 0.072 | -0.070 ± 0.072 | | |
| X 4thweek keel length. | -0.026 ± 0.071 | 0.009 ± 0.071 | 0.062 ± 0.071 | 0.005 ± 0.071 | |
| X 8 th week keel length. | 0.051 ± 0.071 | 0.029 ± 0.071 | -0.064 ± 0.071 | 0.052 ± 0.071 | |
| X 12 th week keel length. | 0.011 ± 0.070 | 0.012 ± 0.071 | 0.022 ± 0.071 | 0.065 ± 0.071 | |
| X 16 th week keel length. | -0.024 ± 0.071 | 0.022 ± 0.071 | 0.019 ± 0.071 | -0.009 ± 0.071 | |
| X 20thweek keel length. | 0.002 ± 0.071 | 0.031 ± 0.071 | 0.038 ± 0.072 | 0.062 ± 0.072 | |
| 20th week Body wt. | | | | | |
| X 4thweek shank length. | 0.060 ± 0.072 | 0.220**+ 0.070 | 0.134 ± 0.071 | 0.335**± 0.068 | |
| X 8 th week shank length. | 0.084 ± 0.071 | 0.001 ± 0.072 | $0.227^{**}\pm0.069$ | 0.339**± 0.067 | |
| X 12thweek shank length | 0.044 ± 0.072 | -0.075 ± 0.072 | $0.145* \pm 0.071$ | 0.250**± 0.059 | |
| X 16thweek shank length | 0.093 ± 0.070 | $0.182^{**} \pm 0.067$ | 0.048 ± 0.070 | $0.631^{**} \pm 0.056$ | |
| X 20thweek shank length | 0.049 ± 0.072 | $0.094* \pm 0.049$ | 0.071 ± 0.069 | 0.306**+ 0.058 | |
| X 4thweek keel length. | 0.005 ± 0.072 | -0.094 ± 0.071 | 0.107 ± 0.071 | 0.206**+ 0.070 | |
| X 8thweek keel length. | -0.026 ± 0.072 | 0.017 ± 0.072 | $0.242^{**}\pm 0.069$ | 0.365**+ 0.067 | |
| X 12thweek keel length. | 0.067 ± 0.072 | -0.092 ± 0.072 | 0.050 ± 0.070 | $0.467^{**} \pm 0.065$ | |
| X 16thweek keel length. | 0.083 ± 0.071 | 0.197** ± 0.066 | $0.234^{**}\pm 0.067$ | 0.079**± 0.063 | |
| X 20thweek keel length. | 0.031 ± 0.058 | 0.037 ± 0.043 | 0.098 ± 0.066 | $0.346^{**} \pm 0.023$ | |

. GP= Gramapriya, VR=Vanaraja, *Significant at P<0.05, **Significant at P<0.01

Inter-relationship between conformation traits.

Shank length x keel length

The phenotypic correlation coefficients between shank length x keel length at various ages in different genetic groups have been depicted in Table -30.

Table -30 revealed that out of total 100 estimates of rp 87 were positive of which 41 were statistically significant (P<0.05 or 0.01). All the 13 negatively correlated estimates were observed to be non-significant. Among 41 significant estimates of rp, 9 belonged to 4th week shank length x keel length at different ages. The corresponding values for 8 week shank length x keel length at different ages, 12 week shank length x keel length at various ages, 16 week shank length x keel length at various ages and 20 week shank length x keel length at different ages were observed to be 8, 12, 6 and 6. Besides, out of 25 estimates of rp in each genetic group, the positive and significant estimates of r_p in $VR \ \mathcal{A} \ x \ VR \ \mathcal{P}$ genetic group were 20 in number whereas, the corresponding number in GP 33 x GP 99, VR 33 x GP 99 and GP 33 x VR 99 genetic groups were obtained as 9, 5 and 7.

Mahapatra et al. (1983) in desi chicken, Mishra et al. (1984) in Red Cronish, Venkatesh et al. (1985) in RC 33 x WR 99 and Khurana et al. (2006) have reported positive and significant phenotypic correlations of high magnitude between shank length x keel length at different ages which are similar to the findings of the present

study. High, positive and significant phenotypic correlations between shank length x keel length at different ages might suggest that selection in shank length would also lead to improvement in keel length at various ages and vice-versa.

Table-30: Phenotypic correlations along with their standard errors among conformation traits at different ages in various genetic groups of poultry.

| Traits | GP ♂♂ | VR∂∂ | GP ♂♂ | VR♂♂ |
|-------------------------------------|------------------|------------------|------------------|------------------|
| | x | x | x | x |
| | VR QQ | GP ♀♀ | G₽♀♀ | VRΩΩ |
| 4 th week shank length | | | | |
| X 4 th week keel length | 0.442** | 0.671** <u>+</u> | 0.748** <u>+</u> | 0.683** |
| | <u>+</u> 0.052 | 0.043 | 0.038 | <u>+</u> 0.042 |
| X 8thweek keel length | 0.178** <u>+</u> | -0.083 <u>+</u> | 0.218** <u>+</u> | 0.329** <u>+</u> |
| | 0.061 | 0.062 | 0.061 | 0.059 |
| X 12 th week keel length | 0.057 <u>+</u> | 0.076 <u>+</u> | 0.032 <u>+</u> | 0.134 <u>+</u> |
| | 0.066 | 0.066 | 0.064 | 0.064 |
| X 16 th week keel length | 0.050 <u>+</u> | 0.006 <u>+</u> | -0.022 <u>+</u> | 0.099 <u>+</u> |
| | 0.069 | 0.069 | 0.069 | 0.067 |
| X 20 th week keel length | -0.087 <u>+</u> | -0.135 <u>+</u> | 0.080 <u>+</u> | 0.165** <u>+</u> |
| | 0.072 | 0.072 | 0.071 | 0.068 |
| 8 th week shank length | | | | |
| X 4 th week keel length | 0.043 | -0.003 <u>+</u> | 0.263** <u>+</u> | 0.197** <u>+</u> |
| | <u>+</u> 0.062 | 0.062 | 0.062 | 0.061 |
| X 8 th week keel length | 0.767** | 0.770** <u>+</u> | 0.674** <u>+</u> | 0.808** <u>+</u> |
| | <u>+</u> 0.039 | 0.039 | 0.046 | 0.037 |
| X 12 th week keel length | -0.015 | 0.033 <u>+</u> | 0.031 <u>+</u> | 0.217** <u>+</u> |
| | <u>+</u> 0.066 | 0.065 | 0.065 | 0.063 |
| X 16 th week keel length | 0.149 | 0.119 <u>+</u> | 0.035 <u>+</u> | 0.019 |
| | <u>+</u> 0.069 | 0.069 | 0.068 | <u>+</u> 0.069 |
| X 20 th week keel length | 0.103 <u>+</u> | 0.025 <u>+</u> | 0.017 <u>+</u> | 0.289** <u>+</u> |
| | 0.071 | 0.072 | 0.072 | 0.067 |
| 12 th week shank length | | | | |
| X 4 th week keel length | -0.127 | 0.129 <u>+</u> | 0.138* ± | 0.210** <u>+</u> |
| | <u>+</u> 0.066 | 0.066 | 0.066 | 0.065 |

| X 8 th week keel length | 0.170** <u>+</u> | 0.138* <u>+</u> | 0.199** <u>+</u> | 0.373** <u>+</u> |
|-------------------------------------|--------------------------|-------------------------|-------------------------|---------------------------|
| | 0.065 | 0.065 | 0.065 | 0.061 |
| X 12 th week keel length | 0.028** <u>+</u> | 0.185** <u>+</u> | 0.046 <u>+</u> | 0.203** <u>+</u> |
| | 0.056 | 0.035 | 0.031 | 0.049 |
| X 16 th week keel length | 0.050 <u>+</u> | 0.101 <u>+</u> | 0.106 <u>+</u> | 0.127** <u>+</u> |
| | 0.068 | 0.069 | 0.069 | 0.037 |
| X 20 th week keel length | 0.154* | -0.045 <u>+</u> | 0.03 <u>+</u> | 0.296** <u>+</u> |
| | ± 0.071 | 0.072 | 0.072 | 0.060 |
| 16 th week shank length | | | | |
| X 4 th week keel length | 0.058 | 0.055 <u>+</u> | 0.085 <u>+</u> | 0.214** <u>+</u> |
| | <u>+</u> 0.069 | 0.069 | 0.069 | 0.068 |
| X 8 th week keel length | 0.011 | -0.078 <u>+</u> | 0.161* <u>+</u> | 0.108 |
| | <u>+</u> 0.069 | 0.069 | 0.068 | <u>+</u> 0.069 |
| X 12 th week keel length | 0.080 | 0.155* <u>+</u> | -0.009 <u>+</u> | 0.309** <u>+</u> |
| | ± 0.069 | 0.068 | 0.069 | 0.066 |
| X 16 th week keel length | 0.073 <u>+</u> | 0.079 <u>+</u> | 0.090 <u>+</u> | 0.149** <u>+</u> |
| | 0.054 | 0.054 | 0.060 | 0.049 |
| X 20thweek keel length | -0.094 <u>+</u> 0.071 | 0.079 <u>+</u> 0.069 | 0.046 <u>+</u> 0.071 | 0.197** <u>+</u> 0.057 |
| 20thweek shank length | | | | |
| X 4 th week keel length | 0.068 | -0.089 <u>+</u> | 0.203** <u>+</u> | 0.090 |
| | <u>+</u> 0.072 | 0.072 | 0.070 | ± 0.071 |
| X 8 th week keel length | 0.145* | 0.058 <u>+</u> | 0.046 <u>+</u> | 0.232** <u>+</u> |
| | <u>+</u> 0.071 | 0.072 | 0.072 | 0.069 |
| X 12 th week keel length | -0.038 <u>+</u> 0.072 | 0.081 ± 0.071 | 0.026 <u>+</u> 0.072 | 0.232** <u>+</u> 0.068 |
| X 16 th week keel length | 0.050 <u>+</u> | 0.059 <u>+</u> | 0.175* <u>+</u> | 0.045 <u>+</u> |
| | 0.069 | 0.069 | 0.071 | 0.070 |
| X 20 th week keel length | 0.060 <u>+</u> | 0.045 <u>+</u> | 0.006 <u>+</u> | 0.213** <u>+</u> |
| | 0.072 | 0.056 | 0.059 | 0.061 |

^{*}Significant at P<0.05
**Significant at P<0.01

CHAPTER -5 SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present investigation was conducted on four genetic groups of poultry involving Vanaraja, Gramapriya and their crosses maintained at I.L.F.C. farm of B. V. College, Patna. The four genetic groups from the two breeds were formed on random mating for a large number of generations in the following manner for present investigation:

- 1. Vanaraja 🖧 x Vanaraja 👭
- 2. Gramapriya 🔗 x Gramapriya 👭
- 3. Vanaraja 👌 x Gramapriya 👭
- 4. Gramapriya 👌 x Vanaraja 👭

The number of progenies in each group at 4th week of age was 299 which decreased with the advancement of age. The traits measured in the present investigation were:

A. Body weight traits.

- 1. Day old body weight (g)
- 2. 4 week body weight (g)
- 3. 6 week body weight (g)
- 4. 8 week body weight (g)
- 5. 10 week body weight (g)
- 6. 12 week body weight (g)
- 7. 14 week body weight (g)
- 8. 16 week body weight (g)
- 9. 18 week body weight (g)
- 10. 20 week body weight (g)

B. Conformation traits:

- 1. 4 week shank length
- 2. 8 week shank length
- 3. 12 week shank length
- 4. 16 week shank length
- 5. 20 week shank length

Keel length:-

- 1. 4 week keel length
- 2. 8 week keel length
- 3. 12 week keel length
- 4. 16 week keel length
- 5. 20 week keel length

C. Feed efficiency:

- 1. at 1 week
- 2. at 2 week
- 3. at 3 week
- 4. at 4 week
- 5. at 5 week
- 6. at 6 week
- 7. at 7 week
- 8. at 8 week

The experiment was planned with the following objectives:

- 1. To estimate the mean, standard error and coefficient of variation percentage of various body weight and conformation traits in different genetic groups.
- 2. To study the effect of sex on various body weight and conformation traits in different genetic groups.
- 3. To study the effect of different genetic groups on various body weight and conformation traits.
- 4. To estimate the percentage of heterosis for various body weight and conformation traits.
- 5. To estimate the coefficient of phenotypic correlations among various body weight and conformation traits.

The average body weights (sexes pooled) at zero day, 4th week, 6th week, 8th week, 10th week 12th week, 14th week, 16th week, 18th week and 20th week in VR 33 x VR 99 genetic group were obtained as 37.45 (g), 300.93 (g), 467.33 (g), 639.86 (g), 860.17 (g), 1313.27 (g), 1493.86 (g), 1807.58 (g), 2106.69 (g) and 2437.46 (g) respectively. The corresponding weights in GP ♂♂ x GP ♀♀ genetic group were noted as 36.07 (g), 278.34 (g) 417.31 (g), 520.62 (g) 627.46 (g), 880.12 (g), 913.04 (g), 1153.22 (g), 1347.90 (g) and 1688.59 (g) whereas, the corresponding weights in VR 33 x GP 99 genetic group were obtained to be 36.78 (g), 271.70 (g), 399.14 (g), 488.28 (g), 595.59 (g), 823.82 (g), 919.06 (g), 1114.05 (g), 1239.39 (g) and 1551.65 (g), and in GP ♂♂ x VR ♀♀ the corresponding weights were 37.19 (g), 291.54 (g), 446.92 (g), 512.72 (g), 662.98 (g), 1030.17 (g), 1392.01 (g), 1605.32 (g), 1755.33 (g) and 2056.26 (g).

The highest body weights were observed to be in VR 33 x VR 99 followed by GP 33 x VR 99, GP 33 x GP 99 and VR 33 x GP 99 genetic groups.

The 4th, 8th, 12th, 16th, and 20th, week shank lengths in VR $33 \times VR$ 99 genetic group were observed to be 7.11 (cm), 8.72 (cm), 9.11 (cm), 9.58 (cm) and 10.14 (cm) respectively. The corresponding lengths in GP $33 \times GP$ 99 were obtained as 7.04 (cm), 8.70 (cm), 9.03 (cm), 9.37 (cm) and 9.48 (cm), whereas the corresponding lengths in VR $33 \times GP$ 99 genetic group were found to be 6.73 (cm), 8.25 (cm), 8.39 (cm), 8.49 (cm), and 8.61 (cm) and in GP $33 \times VR$ 99 genetic group the corresponding shank lengths were noted as 7.09 (cm), 8.53 (cm), 8.73 (cm), 9.08 (cm) and 9.28 (cm).

The lengthiest shanks were obtained in VR $33 \times VR$ $99 \times 33 \times GP$ genetic group, whereas the shortest shanks were found in VR $33 \times GP$ $99 \times GP$ group. The genetic groups GP $33 \times GP$ $99 \times GP$ and GP $33 \times VR$ $99 \times GP$ ranked second and third respectively.

The average keel lengths at 4th week of age in VR 33 x VR 99 genetic group were observed to be 5.12 (cm), 6.44 (cm), 6.56 (cm),6.67 (cm) and 7.24 (cm) at 4th, 8th, 12th, 16th, and 20th week of age respectively. The corresponding lengths in GP 33 x GP 99 were noted as 4.74 (cm), 6.04 (cm), 6.18 (cm), 6.35 (cm) and 6.40 (cm). The corresponding lengths in VR 33 x GP 99 genetic group were found to be 4.69 (cm), 5.91 (cm), 6.07 (cm), 6.33 (cm) and 6.38 (cm) and in GP 33 x VR 99 genetic group,

these corresponding values were noted as 5.10 (cm), 5.99 (cm), 6.42 (cm), 6.50 (cm) and 7.16 (cm).

The trend of increment in keel lengths in all the four genetic groups were similar to that of shank length. The lengthiest and shortest keel lengths were observed to be in VR $\partial \partial x$ VR QQ and VR $\partial \partial x$ GP QQ genetic groups,

Sex had highly significant (P<0.01) effect on body weight, shank length and keel length in all the four genetic groups. Males had significantly (P<0.01) heavier body weights and lengthier shank and keel than their female counterparts in all the four genetic groups.

Genetic group played significant (P<0.01) role on body weight and conformation traits. The heaviest body weights (g) and lengthiest shank and keel lengths (cm) were observed to be in VR $33 \times VR$ $99 \times CR$ genetic group followed by GP $33 \times VR$ $99 \times CR$ $99 \times CR$ and VR $33 \times CR$ $99 \times CR$ genetic groups.

The trend and direction of heterosis % for body weight and conformation traits were not consistent. In GP $\partial \partial x$ VR $\varphi \varphi$ genetic group the heterosis % for body weight were positive at zero day, 4th week, 6th week, 14th week, 16th week and 18th week ranging from 0.658% at 4th week to 15.668% at 14th week. The positive heterosis % in VR $\partial \partial x$ x GP $\varphi \varphi$ genetic group for body weight was found to be at zero day only.

The heterosis % for shank length was positive at zero day in GP $33 \times VR$ 99 genetic group, whereas for keel length the positive values were obtained at 4^{th} , 12^{th} and 20^{th} week of age in this group.

The highest and lowest feed efficiency % were obtained to be in VR $33 \times VR$ $99 \times VR$ and GP $33 \times VR$ $99 \times VR$ genetic groups respectively.

The estimates of r_p among body weight and conformation traits from 4th week of age onwards, in general, were positive and many of them were significant (P<0.01) and of high magnitude with low standard errors suggesting high precision of estimates. Positive and significant correlation coefficients of high magnitude between the two traits might suggest that there would be simultaneous improvement through correlated response on the primary trait if selection is practised for secondary trait.

On the basis of the present of findings it may be concluded that for economic body weight and conformation traits Vanaraja $\partial \partial x$ Vanaraja $\partial \varphi$ genetic groups should be preferred followed by the crossbred GP $\partial \partial x$ VR $\varphi \varphi$ and suitable selection procedures may be adopted for their genetic improvement for these traits.

CHAPTER -6

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