GENETIC ANALYSIS OF THE FIRST EIGHT WEEKS BODY MEASUREMENTS OF HUBBARD BROILER BREEDER CHICKENS IN SHIKA, NIGERIA

BY

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DEPARTMENT OF ANIMAL SCIENCE,

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ZARIA, NIGERIA.

APRIL 2010.

DECLARATION

I hereby declare that this thesis "Genetic analysis of the first eight weeks body measurements of Hubbard broiler breeder chickens in Shika, Nigeria" has been performed by me in the Department of Animal Science, Ahmadu Bello University, under the supervision of Prof. G.N. Akpa and Prof. I.A. Adeyinka. The information derived from the literature has been duly acknowledged in the text and the list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

OJO OLUWAKEMI

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Name of student Signature Date

CERTIFICATION

This thesis entitled "**GENETIC ANALYSIS OF THE FIRST EIGHT WEEKS BODY MEASUREMENTS OF HUBBARD BROILER BREEDER CHICKENS IN SHIKA, NIGERIA**" by **OJO OLUWAKEMI** meets the regulations governing the award of the degree of Master of Science in Animal Science of Ahmadu Bello University, Zaria, Nigeria and is approved for its contribution to knowledge and literary presentation.

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Prof. G.N. AKPA

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DEDICATION

This Project is dedicated to the Almighty God whose Grace, help and divine ability has seen me through the end of this work and to my entire family, for their unending prayers, financial and moral support.

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ABSTRACT

This study "Genetic analysis of the first eight weeks body measurements of Hubbard broiler breeder chickens in Shika Nigeria" was undertaken to estimate the genetic parameters of body weights and linear measurements at different ages and to ascertain the extent to which linear body measurements could best predict weight at 8 weeks. Data from 160 Hubbard broiler breeders at the National Animal Production Research Institute (NAPRI) Shika, Zaria was used for the study. Bi-weekly linear body measurements in centimeters were taken using a measuring tape, while body weights measured in grams were taken weekly for 8 weeks using a digital scale. Body conformation traits measured included; back length, chest circumference, chicken height and shank length. The heritability (h^2) estimates for body weight and conformation traits from 2 to 8 weeks were low to moderate. Genetic correlations for body weight ranged from low to high but were positive in most cases except for correlations between 1 and, 5, 6, 7 and 8 weeks body weights. Phenotypic correlations for body weights also ranged from low to high and were positive in all cases (0.007-0.963). Genetic and phenotypic correlations for body weight and conformation traits at 2 weeks were positive in most cases and ranged from low to high while the genetic correlations for body weight and conformation traits at 4 weeks were high and positive in most cases except for correlations between body weight and chicken height which was low and negative, while phenotypic correlations ranged from moderate to high (0.330-0.744). At 6 weeks, the genetic and phenotypic correlations for body weight and conformation traits were all high and positive, while genetic correlations at 8 weeks were positive and ranged from moderate to high, whereas the phenotypic correlations were all high and positive. From this study, chest circumference at 6 weeks could be used for selection as parents of the next generation, while back length at 8 weeks was the best predictor of 8 week body weight.

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CHAPTER ONE

1.0 INTRODUCTION

Broiler chicken is a young tender chicken suitable for roasting or broiling. Broiler breeders on the other hand are birds reared to reproduce commercial broilers. They grow more efficiently due to positive results from broiler genetic selection strategies. (Ewart, 1993).

The primary goal of broiler breeding is to improve profitability of broiler meat production. Until recently most birds were sold whole, but there has been a dramatic increase in the proportion of birds being grown for portioning and further processing (Ewart, 1993). Poultry production and processing technologies have become rapidly accessible and are being implemented on a worldwide basis, which will allow continued expansion and competitiveness in the meat sector (Aho, 2001). Therefore, the success of poultry meat production has been strongly related to improvements in growth and carcass yield, mainly by increasing breast proportion and reducing abdominal fat. Intensive selection of meat-type chickens for growth for more than 50 years has increased growth rate but rapid growth has been accompanied by a number of negative consequences, including an increase in fat deposition. (Zerehdaran *et al.,* 2004)

The Nigerian poultry industry has over the years witnessed the introduction of different broiler strains (Essien and Adeyemi, 1999). The realization of the full growth potentials of these strains is largely expected to depend on the nutritional and climatic variables, subject however to the genotypic traits which in turn set a ceiling on their productive capacity. The implication is that the broiler producer should select stocks which have the genetic potential for fast growth rate and attainment of market weight early enough under the Nigerian climatic conditions. Within the last one decade, there has been an intensified study on the genetic, physiological, nutritional and growth performance of such imported hybrids as Cobb, White Ross, Lohmann Brown, Hypercom Hubbard, Anak, Shaers, and Perdue among others, (Essien and Adeyemi, 1999).

Body weight at market age is considered to be the single most important trait in determining profit from a broiler enterprise (Mishra *et al.,* 1995). Literature reports suggest that body weight is highly heritable and responds well to mass/individual selection (Saxena and Mohapatra, 1981; Mishra, 1986). Continuous selection has helped to reduce the age at marketing during the last four decades. As a result, body weight of 1.5kg in broilers which was possible at 12 weeks of age is now achieved at 5-6 weeks (Mishra *et al.,* 1995).

Apart from body weight, a number of conformation traits are known to be good indicators of body growth and market value in broilers (Ibe, 1989). Such conformation traits include shank length, breast width, keel length, wing span, chicken height, body length, thigh length and head circumference.

The relationships between body weights and conformation traits have been found to have important implications in the production of broilers with desirable body conformation (Ibe and Nwakalor, 1987). In addition Okon *et al.* (1996) reported that the relationships between body weight and conformation traits are direct and positive. As such the knowledge of this relationship would help breeders organize their programme in order to achieve optimum combination of body weight and good conformation for maximum economic returns (Adeniji and Ayorinde, 1990).

Monsi (1992) noted that interrelationships among body measurements can be applied speedily in selection and breeding. Chambers and Fortin (1984) added that the importance of evaluating interrelationships and productivity traits in poultry lies in their usefulness as predictors of characteristics like body weight. Such applications could speed up the assessment of traits through the involvement of simple measurement tools like ruler or tape. Such simple linear measurements that can predict body weight without necessitating bird slaughter will be particularly desirable. However, the knowledge of genetic parameters such as heritability, genetic and phenotypic correlations will be required for further genetic improvement in a broiler breeder enterprise. This study was therefore designed to:

1) Estimate genetic parameters for body weights and body linear measurements at different ages.
2) Ascertain the extent to which linear body measurements could be used to predict body weights.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Broiler breeder

One of the broiler chicken breeding companies is Hubbard, a company of Group Grimaud. With more than 85 years of experience in selecting the best genes for the broiler industry, it provides solutions that focus on the economic performance, health and well-being of breeding stock. Hubbard specializes in state-of-the-art selection programs to improve the performance of pure lines, and offers a range of products that respond to current and future needs of the broiler industry. It has a longstanding experience in breeding, developing and marketing breeding stock for both conventional and alternative markets. Hubbard operates its selection programs in 3 different centers in North America and Europe, along with its own production sites in North America, Europe and Brazil. (Kelly Jane, 2007). She continued that the presence of the company in nearly 100 countries around the world and the support of dedicated teams involved in Production, Technical Service, Sales and Marketing assure the continuous delivery of quality products that are best suited to the different broiler markets throughout the world. The Hubbard ultra –yield breeder package is designed to produce the maximum saleable meat of any broiler breeder available on the market today. This is achieved without compromising the breeder reproductive performance. Its competitive breeder performance allows the ultra-yield broiler to be used at smaller weights thus meeting the needs of the premium whole carcass market by giving a superbly conformed finished product. However, the ultra-yield's genetic potential is maximized at the heavier weights (2.8 – 4.0 kg) where the highest meat yield can be harvested by the processors looking for the maximum value de-boned chicken meat from each carcass. According to her, the ultra-yield is a feather sexable package allowing broiler females to be grown and sexed separately, while allowing the more efficient males to be grown to the heavier weights. (Kelly Jane, 2007).There are several categories, namely:

2.1.2 Hubbard male line

The Hubbard Genetic Male Line Program offers two categories of males that can be combined respectively with the Hubbard Classic, Flex or Yield type females depending on the requirements of their final product.

2.1.3 Hubbard white male

The Hubbard white male has been selected to offer producers the best meat to bone ratio at the lowest live cost. This category is desirable in markets where both cost of production and yield are important. It is characterized by strong growth, feed efficiency, and liveability as well as exceptional meat yield.

2.1.4 Hubbard yellow male

The Hubbard yellow male has been selected to offer competitive breeder performance combined with the efficiencies of conformation. The resultant broiler has fast growth rate and can be used over a wide range of body weights dependant on the product mix needed.

Today, Hubbard offers several parent females able to respond to the different market requirements. Finally, to underline its world leadership in this market, Hubbard has intensified the research and development of its products following the latest trends. The key objective of Hubbard is to bring the "taste with a difference" to more people in the world. (Kelly Jane, 2007).

2.2 Fertility

Fertility is the proportion of eggs that are capable of developing into chicks out of number laid or incubated. Fertility is mainly determined by candling on the 18^{th} day of incubation. It is difficult to differentiate between low fertilization and high degree of early embryonic death. Thus errors are at times made in determining fertility in most hatcheries because fertility and hatchability of fertile eggs are frequently considered together as hatchability of all eggs set. Crittenden *et al.* (1957) separated fertility and hatchability by examining unhatched eggs for evidence of embryonic death. They pointed out that if apparently infertile eggs were not broken out to determine fertility, early embryonic death could be wrongly classified as infertile. As most hatcheries rely on candling to identify 'infertile' eggs, this incorrect classification is probably quite common. Romero-Sanchez *et al.* (2007) reported no difference in fertility of broiler performance at 32 weeks of age.

A major problem encountered with commercial broiler breeder flocks has been the often dramatic decrease in fertility during the latter part of the laying period, particularly after 50 weeks of age (Kirk *et al.,* 1980; Walsh and Brake, 1997). It has been generally considered that this reduction in fertility was caused by a decline in mating activity that was largely attributable to the heavy body weight and poor physical condition of older males (Hocking, 1990). However, other evidence has suggested that Metabolisable Energy deficit was a more likely cause of such male fertility problems (Buckner *et al.,* 1986; Sexton *et al.,* 1989, Cerolini *et al.,* 1995; Bramwell *et al.,* 1996). It has been further shown that the pattern of male feeding during the latter part of the rearing period affected late fertility to a greater extent than feed allocation pattern during the early rearing period (Zhang *et al*., 1999; Peak, 2001; Romero-Sanchez and Brake, 2005).

The late rearing and the early production period (16 to 26 weeks of age), when broiler breeders have typically been photo-stimulated, could be the most critical period in the development of sexual maturity in the breeder male (Lesson and Summers, 1999; Brake, 2002). It has also been demonstrated that the detrimental effects of inappropriate feeding programs on fertility after 45 weeks of age could be reversed by increasing the male feed allocation during the late production period (Romero-Sanchez and Brake, 2005; Romero- Sanchez *et al*., 2007). In a similar manner, Cerolini *et al.* (1995) used a low density diet to show that an increase in male feed allocation from 110 to 130 g/male/day improved fertility. As such increasing the male feed allocation in a consistent manner during the production period would ameliorate the typical late decline in fertility.

2.3 Hatchability

Hatchability refers to the percentage of eggs hatched into viable chicks after 21 or 22 days of incubation (Yassin *et al.,* 2008). Hatchability is either determined on the basis of all eggs set(% hatch) or of fertile eggs set after candling (hatchability). Yassin *et al.* (2008) reported significant differences in hatchability among eggs from different breeder flocks. They also observed that hatchability was significantly related with flock age, egg storage length, strain, feed company, season, year, as well as hatchery. They in addition recorded significant interaction effects between flock age and age at first delivery, egg storage length at hatchery, strain, feed company, and season on hatchability. The effects were also significant. They further reported that variation in hatchability was larger among than within breeder farms. The average estimated difference in hatchability among the hatcheries was 8%. The average estimated

hatchability at 25 week of age was 66%; it increased to 86% between 31 and 36 weeks and decreased to 50% at 65 week of age. On the average, an extra day of storage until day 7 reduced hatchability by 0.2% and from 7 to 14th day by 0.5%. Eggs from older flocks were observed to be less sensitive to prolonged storage, whereas they were more sensitive to season. Hatchability was greater during late summer than during spring. The average estimated differences in hatchability among strains and feed companies of the breeder farms were 8 and 2%, respectively. Based on the relations found, optimization of hatchery results depends not only on good management at the hatchery but also on the hatching egg quality and therefore on the breeder farm management.
Several factors have been reported to influence broiler hatchability, they include: Egg size, period of holding eggs, climatic conditions, (humidity and temperature) and season (Yassin *et al.,* 2008).

2.4 Live body measurements/conformation traits: An over view

A range of techniques is available to gain information about an animal's body mass and body composition. Some of these techniques use simple inexpensive equipments and others require sophisticated, expensive equipment. (Lerner 1937).
The most direct way to determine an animal's mass is to weigh it. However, under some circumstances a scale may not be available. An alternative is to measure a body part and relate the measurement to body weight (Lerner 1937). Shank length is the part that is commonly measured in poultry to relate to body weight. Lerner (1937) reported that a linear relationship exists between bodyweight and shank length. Since body conformations (especially breast width) are different among breeds of chickens, different coefficients and exponents are needed for different breeds of chickens. For livestock, it is more common to estimate weight by measuring parts of the body trunk rather than extremities.

Information about body conformation can be important in several ways, those producing and selling animal products need information about body composition to track their efforts and produce leaner meat animals (Lerner 1937). Nutritionists also need information about body composition to determine how much of the energy that an animal requires is used for growth and other forms of production (Lerner 1937). Some of the body conformation traits usually considered are: shank length, chest circumference, wing span, chicken height, thigh length, back length.

2.4.1 Body weight

Adeyinka *et al.* (2006) obtained body weight of naked necked broiler chickens at day old, 2, 4, 6, and 8 weeks as 37.22 ±0.32g, 210.46± 1.97g, 744.33± 4.31g, 1,351.3± 7.91g and 2,428.1± 14.61g respectively. Okon *et al.* (1996) obtained mean body weights of 265 ± 6.32, 616.88 ±16.52, 1492.13 ± 30.59 and 2550 ± 43.08g at 3, 6, 9 and 12 weeks of age in broilers respectively. They also observed that live body increments at 28 days (4 weeks) were 6.21 and 6.09 times their 7 day (1 week) old values for the Lohman Brown and Anak strains, respectively and added that the chick doubles its weight 3 to 5 times before 6 weeks of age. Hassan and Abdullahi (2006) recorded body weights of mature local cocks and hens in the tropics as 0.9-1.8 kg.

2.4.2 Back length

Okon *et al.* (1996) observed that body length increased with age and recorded a range of 10.23 ± 0.12 to 25.0 ± 0.21cm from 3 to 12 weeks of age in Lohmann Brown broiler chickens and 51.71% increase (over 3-6 weeks), 26.93% (over 6-9weeks) and 26.90% (over 9-12 weeks). Essien and Adeyemi (1999) also reported that body length increased from 16.01± 0.11 to 40.26± 0.47cm in Lohmann brown while in Anak broiler strain a range of 16.10 ±0.12 to 41.08±0.37cm from 1 week to7 weeks of age was obtained. Okpeku *et al* .(2003) obtained body length of 34.16 ± 2.82 and 34.11 ± 2.72cm for males and females respectively in matured local chickens of Edo state.

2.4.3 Chest circumference

Okon *et al.* (1996) reported continuous increase in chest circumference or body girth from 3-12 weeks in broiler chickens. They recorded a range of 15.59±0.08 to 37.08±0.24 from 3-12 weeks of age. For matured local chickens in Edo state, Okpeku *et al.* (2003) recorded a slight difference in chest circumference between male and female local chickens, they obtained 39.02±4.89cm for males and 38.01±4.55cm for females. Essien and Adeyemi (1999) also observed that chest circumference increased with age from 1 to7 weeks in Lohmann brown and Anak broiler strains.

2.4.4 Chicken height

Essien and Adeyemi (1999) reported increased height of Lohmann brown and Anak broiler strains from 8.72±0.11cm to 22.86± 0.23cm and 9.07± 0.09cm to 23.12±0.13cm over a period of 1 to7 weeks, respectively.

2.4.5 Shank length

Okoro and Ogundu (2006) observed that shank length differed between sexes in turkey and they recorded higher shank length for males than females. This was also true for local chickens in Edo state as reported by Okpeku *et al.* (2003) with males recording 9.52±0.32cm and females 8.99±0.64cm. Essien and Adeyemi (1999) reported that shank length increased with age and differed among broiler strains, this agrees with earlier reports by Okon *et al.* (1996).

2.4.6 Thigh length

Essien and Adeyemi (1999) observed that thigh length increased with age and differed between strains of broilers. Okoro and Ogundu (2006) however reported that thigh length differed between sexes in turkeys and males had higher thigh length than females. They also obtained breed differences in thigh length.

2.5 Age effect on body parameters

Essien and Adeyemi (1999) reported increased effect of age on body parameters. They observed that body weight, body length, chicken height, thigh length, wing length, body circumference and head circumference in Lohmann brown and Anak breeds increased with age from 1 to7 weeks. Monsi (1992) also obtained increase in body weight, wing span, tibia length, shank length and full leg length in broiler chickens from one to ten weeks of age. Similarly, Okon *et al.* (1996) observed increases in mean body weight and other body measurements from 3 to 12 weeks of age. Similarly, Adedeji *et al.* (2008) recorded increases in body length, wing length, shank length, and breast girth as age progresses.

2.6 Strain/Breed effect on body parameters

Okon *et al.* (1996) reported that body weights of broiler chickens differed with breed and that Lohman brown broilers had higher body weight than Cobb broilers. Essien and Adeyemi (1999) also reported that body weight also varied with genotype or breed. They observed that Anak broiler chickens exhibited consistent superior body weights over Lohman Brown at 1-7 weeks of age. They also reported strain differences in body parameters of broiler chickens at different ages. Anak broilers were observed to have better performance in body weight, chicken height, body length, shank length, thigh length, wing length, body circumference and head circumference as compared to the Lohmann strain. Similarly, Adedeji *et al.* (2008) reported that body parameters increased with age in pure and crossbred chicken.

2.7 Effect of sex on body parameters

2.7.1 Body weight

Whiting and Pesti (1983) indicated that male broilers were heavier than the females at hatching while Verma *et al.* (1983) gave the average body weight at hatching of 40.31g for male and 36.6g for female broilers. Sharma *et al.* (1983) reported that body weight at hatching was significantly affected by sex of chickens. At growing and finishing stages also, the males were heavier than the females (Keshri *et al.,* 1985). Mark (1985; 1986; 1987) reported various findings on sexual dimorphism in relation to body weight of broilers. He found that the differences between the sexes in body weight when observed post-hatch became significant after 4 days of age and increased thereafter in a more or less linear fashion. In addition, at 14 days of age, males were 7% heavier than the females and consumed more feed and water than the females.

Sola-Ojo *et al.* (2008) did not find any significant sex differences in body weight from 1 to 4 weeks of age in Fulani ecotype chickens. They explained that this may be as a result of close uniformity in arrival weights which ranges from 33 to 38g. In addition, since chicks were not aggressive hence competition for feed and water which could have caused weight differences was minimal. This agrees with similar reports of Okoro and Ogundu (2006). As from 6-20 weeks of age however, body weight in the Fulani ecotype chickens was observed to be higher in males than females. Adedeji *et al.* (2008) on the other hand obtained significant differences by sex at day old, 2, 4, 6, 8 and 12 weeks in pure and cross bred chicken progeny in a derived savannah environment with males recording higher weights than females and this agrees with reports of Okoro and Ogundu (2006) and Monsi (1992) who also obtained significant sex differences in turkey breeds in South Eastern Nigeria where males had higher body weights than females at 2, 4, 6 and 8 weeks of age. Okon *et al.* (1996) also observed that at 12 weeks Cobb broiler males had higher body weights than females. Hassan and Abdullahi (2006) observed that sex had significant effect on body weight of mature local chickens, stating that cocks were heavier than hens.

2.7.2 Body length

Adedeji *et al.* (2008) observed that body length differed with sex as seen in pure and crossbred progeny of chicken in a derived savannah environment with males being higher in lengths than females. Similarly, differences in body lengths were observed by Sola-Ojo *et al.* (2008) between ages 6-20 weeks. They also reported that body length showed no significant difference between male and female of Fulani ecotype chickens between ages 2-6 weeks which agrees with earlier reports by Okpeku *et al.* (2003) on local chickens of Edo state. They also reported that males had longer bodies than females and added that rapid gains in body length were made when the chicks were young and decreased as they grew older.

2.7.3 Chest circumference

Chest circumference was reported to differ with sex by Adedeji *et al.* (2008) stating that males had wider chest circumference than females from day old to 12 weeks of age. However, Sola-Ojo *et al.*

(2008) obtained non significant differences in body girth for the Fulani ecotype chickens at 2 weeks of age. In addition, from 4-20 weeks, males had significantly larger body girth though there was little difference in coefficient of variation.

2.7.4 Wing length

Males were reported to have longer wing lengths in Fulani ecotype chickens than the females for all ages except at 4 weeks and all the co variances were closely related (Sola-Ojo *et al.,* 2008) . This agrees with results obtained by Adedeji *et al.* (2008) in pure and cross bred chicken progeny in a derived savannah environment.

2.7.5 Thigh length

Thigh length (drumstick length) showed no significant differences between male and female Fulani birds at 2, 6 and 20 weeks of age. Though significant differences in thigh length were observed at 4, 8,10,12,14 and 18 weeks of age. Females had higher coefficient of variation than males, (Sola-Ojo *et al.,* 2008). This agrees with earlier reports by Okoro and Ogundu (2006) for turkey at 2, 4, 6, and 8 weeks.

2.7.6 Shank Length and Diameter

Adedeji *et al.* (2008) reported that shank length differed with sex from day old to 12 weeks of age. Similarly, Sola-Ojo *et al.* (2008) recorded higher shank length and diameter in males than females at 2-10 weeks of age.

Okpeku *et al.* (2003) also obtained higher shank length in matured male local chickens (9.52±0.32cm) than females (8.99± 0.64cm) in Edo state.

However these reports contradict those obtained for turkey by Okoro and Ogundu (2006) who obtained non significant sex differences at 2, 4 and 6 weeks but higher shank length in males than in females at 8 weeks.

2.8 Genetic parameter estimates

2.8.1 Phenotypic correlations

Okoro and Ogundu (2006) obtained high and positive phenotypic correlations between body weight and other body parameters namely; thigh length, chest circumference, breast width, keel length and shank length. They suggested that these parameters may be good indicators of body weight. Similarly, Okpeku *et al.* (2003) reported that body weight was positively correlated with body length, chest circumference, fermur and crust but obtained negative and low correlation between body weight and tarsometatarsus (shank length) among local chickens in Edo state of Nigeria. Okon *et al.* (1996) studied the interrelationships of live body measurements in broiler chickens at 3, 6, 9, and 12 weeks of age. They observed that the correlation coefficient at 3 weeks were generally weak and non significant with some traits showing negative relationships. Body weight was observed to be only positively correlated with shank width at 3 weeks of age, whereas body girth at 3 weeks was positively correlated with shank length. From these findings, shank width was the highest estimator of body weight at 3 weeks. Shank width was also positively correlated with body weight at 3, 6, 9 and 12 weeks. At 6 and 9 weeks, body weight was reported to be positively correlated with body girth, body length, keel length, shank length and width. However, at 12 weeks body weight was positively correlated with only three of the parameters namely; body girth, keel length and shank length.

These results suggest that body weight in broiler chickens can be rapidly predicted from these live body measurements at 6, 9 and 12 weeks of age. This agrees with similar observation by Monsi (1992) with Cobb broiler strain.

Okoro and Ogundu (2006) observed that shank length had highly significant and positive correlation with thigh length, thigh circumference, breast width and keel length. Whereas, low but significant correlation was observed between shank length and body weight in turkey breeds of south eastern Nigeria. They also reported that thigh length had high and significant correlations with body weight, thigh circumference, breast width, keel length and shank length. They also obtained highly significant correlations between chest circumference (breast width) with body weight, thigh length, and thigh circumference.

2.8.2 Genetic correlations

Nwosu *et al.* (1985) obtained medium to high genetic correlations between pullet body weight and mature egg weight which agrees with earlier reports by Kinney (1969) who reported positive genetic correlations of 0.52 to 0.68 between body weights taken before sexual maturity and mature weights in chickens. They also observed that body weights taken before sexual maturity had positive genetic correlation of 0.15 with pullet egg weight and mature egg weight.

Siripholvat *et al.* (1995) observed that genetic correlation of body weight computed from sire component in the first generation between 6 to 9 weeks was 0.97. From this value, they stated that it was possible to establish broiler parent stock by using 6 week body weight as selection criteria. Kabir *et al.* (2006) observed that there were positive and high genetic correlations between body weight and shank length at 20-40 weeks of age. They observed that the coefficient of genetic correlations ranged between 0.582 and 0.645.They added that high and positive genetic correlations between body weight and shank length suggest that it was possible to predict body weight of live Rhode Island chickens studied on the basis of their shank length measurement, in situations where sensitive weighing scales are not readily available.

2.8.3 Heritability of Body Weight

Norris and Ngambi (2006) obtained heritability estimates for body weights as 0.36, 0.25, 0.41 and 0.22 for hatch, 4, 10 and 21 weeks respectively in local Venda chickens. Heritability of weight gain from 4 to 6 weeks was observed to be much lower at 32^{o}C than at 22^{o}C (0.13 ± 0.03 vs. 0.24 ± 0.04) (Beaumont *et al.,* 1998). They suggested that selection for increased body weight will thus be less efficient at 32^{o}C than at 22^{o}C. Conversely, heritabilities of the feed conversion ratio were very similar at the two temperatures (0.28 ± 0.04 at 22^{o}C and 0.27 ± 0.04 at 32^{o}C). Selecting for feed conversion ratio would thus be efficient at both temperatures. These results justify, at least under experimental conditions, selecting broiler lines for improved growth performance at 22^{o}C. However, it could be more efficient if broilers are to be reared in hot climates to select for improved feed conversion ratio rather than for increased body weight.

Siripholvat *et al.* (1995) reported that the heritability value of 6 week body weights in five generation periods ranged from medium to high (0.22 to 0.48); the fifth generation had the lowest value (0.22). Adeyinka *et al.* (2004) reported moderate heritability for body weights at various ages, but observed high heritability estimates for body weight at 56 days of age (8weeks) and suggested that selection for body weight at this age will improve body weight in subsequent generations. Chambers (1990) observed that heritability for body weight of broilers tends to increase with age. Oni *et al.* (1991) reported heritability estimates of 0.413 and 0.044, 0.387 and 0.279 respectively for body weights at 16 and 20 weeks in two strains of chicken. Le Bihan-Duval Elisabeth *et al.* (2008) reported that the heritability for growth and body composition traits was moderate to high (estimates ranging from 0.30 to 0.49) in a pure broiler line.

Prado-Gonzalez *et al.* (2003) reported positively low to moderate (0.07 to 0.21) heritabilities for 8 and 16 weeks old chickens and explained that low heritability could mean that dominance, epistatic and environmental effects are more important than genetic additive effects on body weight of Creole chicks. Differences in heritability estimates could be attributed to method of estimation, breed, environmental effects and sampling error due to small data set or sample size (Adeyinka *et al.,* 2006)

2.8.4 Heritability of Body Conformation Traits

Adeyinka *et al.* (2006) obtained low heritability estimates for body conformation traits in naked necked broiler chickens and this agrees with reports by Singh and Julian (2007) who obtained low to moderate heritability for body conformation traits in Van-Cob broiler strain of chickens. However Singh *et al.* (2008) reported high heritability estimates (0.436 and 0.575) respectively for keel length and shank length at 6 weeks of age in a synthetic broiler breeder strain.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study location

This research was conducted at the poultry unit of the National Animal Production Research Institute (NAPRI) Shika, Zaria. Shika lies between latitudes 11 and 12 ^{0}N and longitude 7^0 and 8^{0}E at an altitude of 640m. The area falls within the Northern guinea savannah zone. The average annual precipitation is 1,100mm, which spreads from late April or early May to mid- October, with a peak between June and September (wet season). The wet season is usually followed by "Harmattan", a period of cool, dry weather which lasts from mid-October to February (post rains). The mean maximum temperature varies from 27^{o}C to 35^{o}C depending on the season; and the mean relative humidity during Harmattan and wet season are 21 and 72 % respectively (Oni *et al.,* 2001).

3.2 Base Population

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The base population consisted of 60 Hubbard broiler breeders, 10 cocks and 50 hens of 30 weeks of age. The hens were well established in lay by this age. Initial body weights of both cocks and hens were taken using a digital scale. Pen mating was carried out using a mating ratio of 1 cock to 6 hens and these individuals were placed in pens and numbered. A total of 10 pens were used.

3.3 Hatching Activities

3.3.1 Collection of Fertile Eggs

Cocks were introduced to the hens 1 week prior to egg collection to ensure fertility of eggs. Thereafter eggs were collected on daily basis, marked based on their pen numbers and weighed using a digital scale. Average daily egg weight was recorded per pen and this was repeated for a period of 3 weeks. The eggs collected were stored in the egg holding room at a temperature of 18 degree centigrade.

3.3.2 Egg Setting

Eggs were selected against dirt, cracks and miss-shaped eggs. They were arranged on setting trays according to their pen numbers and fumigated using potassium permanganate ($KMNO_4$) and hydrogen peroxide (H_2O_2) in the fumigation room against hatchery diseases (Salmonella). They were left for 30 minutes before being transferred into the setter at temperature of 37.6-37.8 degree centigrade and relative humidity of 29-30%. Eggs were set weekly for three consecutive weeks on setting trays and placed in a large western type incubator that turns egg automatically four times daily.

3.3.3 Egg Candling

On the 18th day of incubation the eggs were candled using a 200 watt bulb. The number of infertile eggs were counted, recorded and removed, while fertile eggs were transferred to the hatcher.

3.3.4 Hatching Operations

The fertile eggs were placed in the Hatcher for 3 days at a temperature of 37.5-38.7 degree centigrade and relative humidity of 31-32%. Fertile eggs were arranged in hatching trays according to their pen numbers. Upon hatching, chicks were tagged, weighed individually and vaccinated against Marek's disease using Marek's vaccine as well as Newcastle disease using Newcastle disease vaccine (intra-occular) after which they were taken to the brooding pens.

3.4 Brooding/Rearing

Prior to hatching, the brooding pen was washed, disinfected and covered with polythene nylon to provide warmth. Wood shavings were spread on the floor and covered with newspaper. Feeders and drinkers were washed and disinfected prior to arrival of chicks while heat source (electric bulbs, lanterns and charcoal pots) were put in place for the chicks. The chicks were administered vitallyte in water for five days to reduce stress, while Infectious bursal (IBD) vaccine was again given on the 10^{th} and 15^{th} day, Newcastle vaccine on the 21^{st} and Coccidiostat on the 28^{th} days. Throughout the period of the study, the vaccination schedule for broilers was strictly adhered to.

Broiler starter diet was given to the chicks for the first four weeks while broiler finisher was supplied as from the fifth week. Water and feed were provided ad-libitum.

3.5 Data Collection

The weight of individual birds were taken weekly using a digital weighing scale measuring to the nearest one gram, while linear body measurements were taken fortnightly for a period of eight weeks using a measuring tape in centimeters. A total of 160 records were used.

3.5.0 Linear body measurements.

The back length was measured in centimeters from the base of the neck to the tip of the tail.

Tarso-metatarsus (shank) was measured from the lower thigh joint to the base of the three toes.

Chest circumference was measured around the chest region.

Wing length/span was measured from the wing joint to the tip of the out stretched right wing.

The back height was measured from the toes to the back of the chicken. (Figure 1).

All measurements (in centimeters) were carried out using a measuring tape.

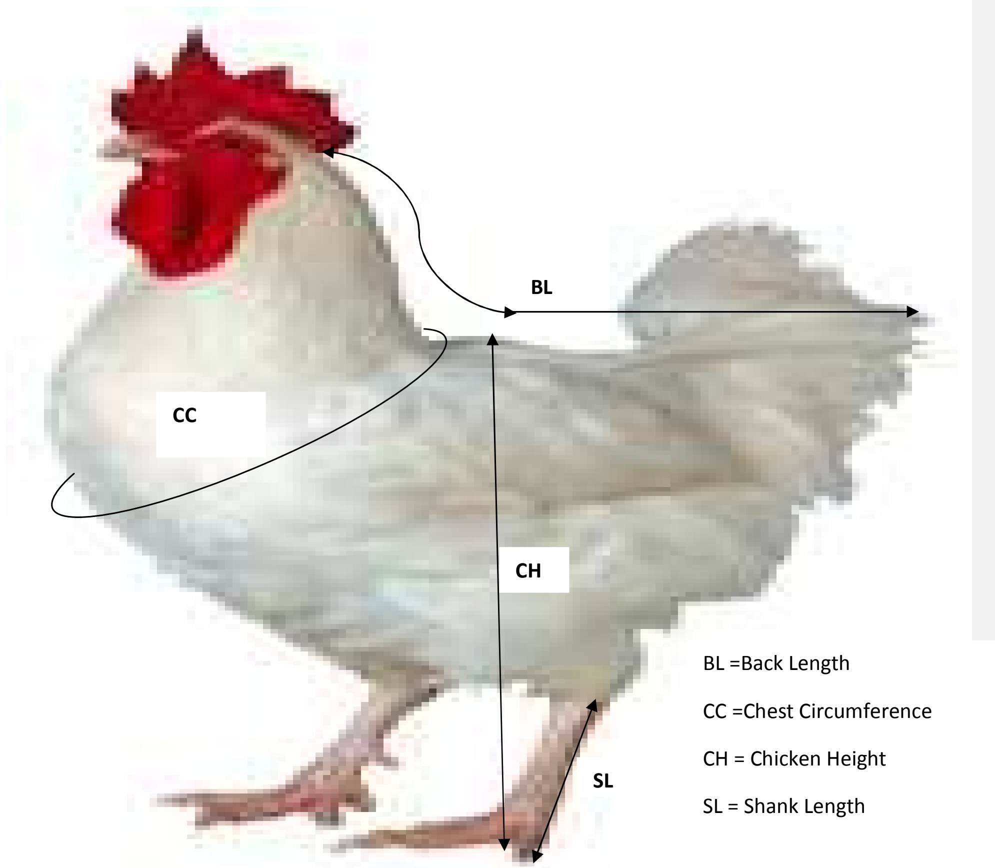

Fig. 1 Shows the hubbard brolier breeder chicken indicating linear body measurements.

3.6 Data Analysis

Data collected were entered into the computer using the excel programme. Analysis of data was carried out according to SAS (2004) procedures. The following traits were computed:

$$\text{Chick Yield} = \frac{\text{Hatch weight}}{\text{Egg weight}} \times 100$$

Means, Standard errors and Coefficient of variations for body weights and average egg weight were also calculated.

3.6.1 Genetic parameter estimates

Genetic parameters were estimated using mixed model least squares and maximum likelihood computer program (Harvey 1990). The sire model was applied whereby the variance component was partitioned into those due to sire or environment. In this design, the statistical model used was:

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

Where Y_{ij} = the record of the j^{th} progeny of the i^{th} sire.

μ = the common mean

S_i = the effect of the i^{th} sire

e_{ij} = the uncontrolled environmental and genetic deviations attributable to the individuals. All error terms were random, normal and independent with expectation equal to zero.

3.6.2 Heritability

Heritabilities of body weight and linear body measurements were estimated using the expression:

$$h^2 = \frac{4\sigma^2_s}{\sigma^2_T}$$

h^2 = heritability estimate

σ^2_s = Variance due to sire

σ^2_T = Total variance

3.6.3 Estimation of correlations

The genetic, environmental and phenotypic correlations between two traits were obtained by a method similar to those used to estimate heritabilities but in addition the analysis of covariance was carried out.

The general formula for estimating correlation was $r = \frac{Cov_{xy}}{\sqrt{\sigma^2_x \sigma^2_y}}$.

A step wise multiple regression analysis was used to determine the interrelationships among conformation traits at different ages. The procedure of Statistical Analysis System (SAS, 2004) was used to determine the trait combinations that best predict 8 weeks body weight. The model was as follows:

$Y= a+b_1X_1+b_2X_2+$---------- $+b_kX_k+e$

Where
Y= dependent variable
a= the regression constant

b_1, b_2 ------ b_k = regression coefficients

X_1, X_2, -------- X_k = independent variables

e =variation of measurements about the regression planes, independently distributed with mean 0. Combinations of variables which gave the highest coefficient of determination (r^2) were regarded as the best models

CHAPTER FOUR

4.0 RESULTS

4.1 Body measurement characterization of Hubbard broiler breeder chickens by age.

Table 4.1 shows the body measurement characterization of Hubbard broiler breeder chicks by age. From the table, there was an increasing trend in measured traits as the birds advanced in age.

Table 4.1: Body measurement of hubbard broiler breeder chickens by age.

Characteristics	Week			
	2	**4**	**6**	**8**
BW (g)	204.4±6.83	460.0±19.84	807.7±41.48	1273.6±61.48
BL (cm)	20.2±0.18	26.4±0.27	34.4±0.39	40.8±0.43
CC (cm)	18.9±0.17	25.9±0.29	35.5 ±0.31	39.9±0.38
CH (cm)	12.2±0.19	19.3±0.24	20.0±0.38	22.7±0.46
WL (cm)	11.2±0.15	14.3 ±0.16	17.8±0.18	20.8±0.13
SL (cm)	4.7±0.05	6.4 ±0.08	7.9±0.10	10.8±0.39

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length. N= 160 in all cases.

4.2 Effect of fixed factors on body weight and conformation traits.

4.2.1 Effect of sire on body weight and conformation traits at different ages.

At 2 weeks of age, there was significant effect ($p < 0.05$) of sire on body weight and shank length as shown in Table 4.2. However, sire had no significant ($p > 0.05$) effect on all other traits.

At 4 weeks of age, sire was observed to have significant ($p < 0.05$) effect on body weight and shank length (Table 4.3), sire had non significant effect on all other parameters.

As shown in Table 4.4, sire effect at 6 weeks was significant ($p < 0.05$) on wing length and chest circumference. All other traits recorded non significant ($p > 0.05$) effects.

Sire effect at 8 weeks was observed to be significant ($p < 0.05$) on body weight, wing length, chicken height and shank length but non -significant ($p > 0.05$) on all other traits as shown in Table 4.5.

Table 4.2: Sire effect on body weight and Conformation traits at 2 weeks of age.

Sire	N	BW (g)	WL(cm)	CC (cm)	CH(cm)	SL(cm)	BL(cm)
1	21	182.6±11.02^{ab}	10.7±0.33^{NS}	18.2±0.25^{NS}	11.8±0.26^{NS}	4.6±0.10^{bc}	20.0±0.33^{NS}
2	1	210.0±19.03^{ab}	9.7±0.07^{NS}	18.8±0.10^{NS}	13.1±0.11^{NS}	5.3±0.04^{a}	20.9±0.11^{NS}
3	26	207.2±10.00^{ab}	10.6±0.16^{NS}	18.9±0.23^{NS}	12.3±0.22^{NS}	4.8±0.12^{bc}	20.6±0.27^{NS}
4	31	206.5±8.33^{ab}	10.8±0.13^{NS}	19.1±0.24^{NS}	12.4±0.24^{NS}	4.8±0.77^{abc}	20.5±0.23^{NS}
5	11	227.2±19.76^{ab}	10.7±0.30^{NS}	19.1±0.33 ^{NS}	12.3±0.44^{NS}	4.7±0.15^{bc}	20.6±0.39^{NS}
6	31	205.4±8.40^{ab}	10.4±0.15^{NS}	18.9±0.21^{NS}	11.7±0.28^{NS}	4.7±0.08^{bc}	20.0±0.23^{NS}
7	6	193.7±15.82^{ab}	10.7±0.26^{NS}	19.0±0.70^{NS}	11.9±0.31^{NS}	4.5±0.21^{c}	19.7±0.60^{NS}
8	3	168.9±17.58^{b}	11.0±0.33^{NS}	18.1±0.33^{NS}	13.1±0.00 ^{NS}	5.1±0.00^{ab}	19.2±0.88^{NS}
9	19	195.2±12.42^{ab}	10.8±0.18^{NS}	18.7±0.33^{NS}	11.5±0.33^{NS}	4.7±0.11^{bc}	20.4±0.32^{NS}
10	11	247.7±13.33^{a}	10.9±0.40^{NS}	19.8±0.56^{NS}	11.8±0.45^{NS}	4.6±0.15^{bc}	20.1±0.48^{NS}

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length

$^{a,\,b,\,c}$ Means in the same column with different super scripts differs significantly ($p< 0.05$) N=number of observations.

Table 4.3: Sire effect on body weight and Conformation traits at 4 weeks of age.

Sire	N	BW (g)	WL (cm)	CC (cm)	CH(cm)	SL(cm)	BL(cm)
1	21	431.1±38.07^{ab}	14.4±0.30 ^{NS}	25.1±0.45^{NS}	18.8±0.35^{NS}	6.3.6±0.10^{ab}	26.0±0.37^{NS}

2	1	606.2±51.64^{a}	15.1±0.09 ^{NS}	27.3±0.17^{NS}	19.9±0.14^{NS}	7.0±0.04^{a}	25.9±0.16^{NS}
3	26	428.5±28.72^{ab}	14.2.6±0.17 ^{NS}	26.2±0.46^{NS}	19.4±0.32^{NS}	6.4±0.11^{ab}	26.6±0.44^{NS}
4	31	466.8±24.2^{ab}	14.7±0.20^{NS}	26.5±0.45^{NS}	19.9±0.36^{NS}	6.5±0.13^{ab}	26.5±0.37^{NS}
5	11	529.2±46.48^{ab}	14.6±0.34^{NS}	26.2±0.44^{NS}	19.7±0.48^{NS}	6.5±0.16^{ab}	26.6±0.39^{NS}
6	31	458.5±25.62^{ab}	14.2.±0.24^{NS}	25.7±0.37^{NS}	19.1±0.33^{NS}	6.4±0.11^{ab}	25.0±0.39^{NS}
7	6	420.0±28.67^{ab}	13.5±0.42^{NS}	25.3±0.26^{NS}	18.1±0.17^{NS}	5.9±0.17^{b}	26.7±0.96^{NS}
8	3	377.5±47.48^{b}	14.1±0.58^{NS}	24.7±0.33 ^{NS}	19.2±0.33^{NS}	6.4±0.33^{ab}	26.2±0.88^{NS}
9	19	368.9±27.90^{b}	13.8±0.27^{NS}	25.3±0.42^{NS}	19.2±0.42^{NS}	5.9±0.15^{b}	26.4±0.44^{NS}
10	11	513.2±51.59^{ab}	14.7±0.49^{NS}	26.1±0.59^{NS}	19.2±0.65^{NS}	6.7±0.2^{ab}	26.1±0.54^{NS}

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length

$^{a, b,}$ Means in the same column with different super scripts differs significantly ($p < 0.05$) N=number of observations.

Table 4.4: Sire effect on body weight and Conformation traits at 6 weeks of age.

Sire	N	BW (g)	WL (cm)	CC (cm)	CH(cm)	SL(cm)	BL(cm)
1	21	751.0±70.47^{NS}	17.8±0.35^{b}	34.5±0.50^{b}	18.9±0.64^{NS}	7.6±0.19^{NS}	34.4±0.71^{NS}
2	1	1059.8±54.20^{NS}	21.1±0.12^{a}	38.2±0.19^{a}	20.6±0.22^{NS}	8.3±0.41 ^{NS}	34.1±0.91^{NS}
3	26	735.3±60.60^{NS}	17.7±0.26^{b}	35.1±0.48^{ab}	18.9±0.55^{NS}	7.7±0.12^{NS}	35.0±0.63^{NS}
4	31	853.8±58.55^{NS}	18.0±0.29^{b}	35.6±0.41^{ab}	19.5±0.46^{NS}	8.0±0.15^{NS}	34.2±0.45^{NS}

5	11	919.8±91.85^{NS}	18.4±0.33^{b}	35.5±0.49^{ab}	20.2±0.61^{NS}	7.9±0.13^{NS}	34.1±0.47^{NS}
6	31	799.2±52.75^{NS}	17.9.±0.27^{b}	35.5±0.46^{ab}	19.3±0.55^{NS}	7.8±0.16^{NS}	34.4±0.52^{NS}
7	6	729.4±59.40^{NS}	17.6±0.43^{b}	35.7±0.50^{ab}	19.9±0.38^{NS}	7.6±0.21^{NS}	36.1±0.37^{NS}
8	3	688.8±56.77^{NS}	17.8±0.33^{b}	34.2.±1.00^{b}	19.2±0.88^{NS}	7.9±0.33^{NS}	32.5±0.88^{NS}
9	19	628.1±59.93^{NS}	17.3±0.34^{b}	34.3±0.49^{b}	18.5±0.62^{NS}	7.6±0.21^{NS}	33.9±0.73^{NS}
10	11	911.3±102.76^{NS}	18.5±0.49^{b}	36.8.±0.87^{ab}	20.3±0.83^{NS}	8.2±0.30^{NS}	35.6±0.78^{NS}

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length

^{a,b} Means in the same column with different super scripts differs significantly ($p< 0.05$) N=number of observations.

Table 4.5: Sire effect on body weight and Conformation traits at 8 weeks of age.

Sire	N	BW (g)	WL (cm)	CC (cm)	CH(cm)	SL(cm)	BL(cm)
1	21	1222.5 ±98.29^{ab}	20.7±0.19^{ab}	39.7±0.52^{NS}	22.5±0.73^{ab}	10.8±0.58^{ab}	40.4±0.71^{NS}
2	1	1736.0±36.15^{a}	21.8±0.08^{a}	41.8±0.22^{NS}	26.0±0.27^{a}	13.9±0.23 ^{a}	41.4±0.25^{NS}
3	26	1113.7 ±88.42^{ab}	20.4±0.18^{b}	39.1±0.53^{NS}	21.2±0.61^{ab}	9.6±0.53^{ab}	40.4±0.69^{NS}
4	31	1267.9±80.82^{ab}	20.9±0.20^{ab}	40.0±0.62^{NS}	22.6±0.73^{ab}	11.1±0.61^{ab}	40.7±0.57^{NS}
5	11	1519.0±188.68^{ab}	20.9±0.32^{ab}	41.0±0.81^{NS}	24.2±1.20^{ab}	11.5±0.97^{ab}	42.3±0.49^{NS}
6	31	1275.0±74.69^{ab}	20.7.±0.15^{ab}	40.5±0.45^{NS}	22.3±0.54^{ab}	10.6±0.44^{ab}	40.9±0.60^{NS}

7	6	1103.2±115.22[b]	20.3±0.39[b]	39.6±0.95[NS]	21.3±1.14[ab]	9.4±0.14[b]	41.1±0.84[NS]
8	3	1084.7±86.33[b]	20.7±0.22[ab]	38.7.±58[NS]	23.3±0.88[ab]	10.5±0.67[ab]	39.4±0.58[NS]
9	19	999.6±89.18[b]	20.3±0.22[b]	38.5±0.68[NS]	20.8±0.74[b]	9.4±0.66[b]	39.1±0.79[NS]
10	11	1415.1±153.57[ab]	20.9±0.27[ab]	40.5±0.90[NS]	22.7±1.00[ab]	11.0±0.80[ab]	42.1±0.85[NS]

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length
[a,b] Means in the same column with different super scripts differs significantly ($p < 0.05$) N=number of observations.

4.3 Effects of hatch and sex on body weight and conformation traits at different ages.

As shown in Table 4.6, there was significant ($p<0.05$) effect of hatch on all the traits measured. Hatch 1 was observed to have the highest weight, longest wing, back, shank and widest chest at 2 weeks of age. Sex effect was only significant ($p<0.05$) on body weight with males possessing higher body weight than females.

Table 4.7 shows the effects of hatch and sex on body weight and conformation traits at 4 weeks of age. There was significant ($p<0.05$) effect of hatch on all other parameters except chicken height and shank length. Hatch 1 had the highest body weight, wing length and chest circumference. Sex effect at 4 weeks was also significant ($p<0.05$) on all the traits measured except body length. Males were observed to have better performance for these traits than their female counterparts.

At 6 weeks of age, hatch effect was significant ($p<0.05$) for all the measured characteristics. Hatch 1 had better performance than the other two hatches as shown in Table 4.8. Similarly, sex effect was observed to be significant ($P<0.05$) for all the measured traits with males showing better performance females.

Effect of hatch and sex at 8 weeks are recorded in Table 4.9. From the Table, hatch had significant ($p<0.05$) effect on wing length, chest circumference, chicken height and shank length whereas, hatch had non significant effect on body weight and length. On the other hand, sex effect was significant ($p<0.05$) on all the measured traits at 8 weeks with males performing far better than the females.

Table 4.6 Effect of hatch and sex on body weight and conformation traits at 2 weeks.

Hatch	N	BW(g)	WL(cm)	CC(cm)	CH(cm)	SL(cm)	BL(cm)
1	34	245.1±7.36[a]	11.1±0.11[a]	20.1±0.20[a]	11.2±0.22[b]	4.6±0.08[b]	20.7±0.18[a]
2	33	225.8±9.03[b]	11.1±0.14[a]	19.3±0.18[b]	12.1±0.23[a]	4.6±0.09[b]	20.8±0.27[a]
3	93	183.0±4.22[c]	10.4±0.10[b]	18.3±0.11[c]	12.2±0.14[a]	4.8±0.47[a]	19.9±0.14[b]
Sex							
Male	29	235.8±10.77[a]	11.0±0.19[NS]	19.5±0.29[NS]	11.8±0.27[NS]	4.6±0.07[NS]	20.5±0.26[NS]
Female	131	198.2±4.10[b]	10.6±0.08[NS]	18.8±0.11[NS]	12.0±0.12[NS]	4.7±0.04[NS]	20.2±0.12[NS]

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length

[a ,b, c] Means in the same column with different super scripts differs significantly ($p < 0.05$) N=number of observations.

Table 4.7 Effect of hatch and sex on body weight and conformation traits at 4 weeks.

Hatch	N	BW(g)	WL(cm)	CC(cm)	CH(cm)	SL(cm)	BL(cm)
1	34	503.6±18.91^{a}	14.9±0.17^{a}	27.7±0.32^{a}	19.7±0.23^{NS}	6.6±0.11^{NS}	26.5±0.23^{ab}
2	33	444.4±27.86^{ab}	13.9±0.21^{b}	25.9±0.30^{b}	19.3±0.30^{NS}	6.4.±0.11^{NS}	27.2±0.40^{a}
3	93	428.2±15.60^{b}	14.2±0.12^{b}	25.2±0.20^{b}	19.1±0.19^{NS}	6.3±0.06^{NS}	26.1±0.21^{b}
Sex							
Male	29	534.9±24.62^{a}	15.1±0.20^{a}	27.0±0.31^{a}	20.0±0.23^{a}	6.6±0.09^{a}	27.2±0.31^{NS}
Female	131	428.2±12.55^{b}	14.1±0.10^{b}	25.6±0.18^{b}	19.1±0.16^{b}	6.4±0.05^{b}	26.2±0.17^{NS}

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length

^{a,b} Means in the same column with different super scripts differs significantly ($p< 0.05$) N=number of observations.

Table 4.7 Effect of hatch and sex on body weight and conformation traits at 6 weeks.

Hatch	N	BW(g)	WL(cm)	CC(cm)	CH(cm)	SL(cm)	BL(cm)
1	34	935.8±48.66[a]	18.6±0.24[a]	36.9±0.37[a]	19.8±0.40[ab]	8.25±0.11[a]	35.6±0.35[a]
2	33	756.9±54.67[b]	17.9±0.27[b]	35.6±0.44[b]	20.5±0.58[a]	7.86.±0.11[b]	35.1±0.56[a]
3	93	741.1±30.78[b]	17.2±0.14[b]	34.5±0.21[c]	18.7±0.26[b]	7.61±0.08[b]	33.9±0.28[b]
Sex							
Male	29	980.5±53.46[a]	18.9±0.21[a]	36.8±0.44[a]	20.5±0.43[a]	8.2±0.12[a]	35.7±0.40[a]
Female	131	742.6±25.60[b]	17.6±0.19[b]	34.9±0.19[b]	19.0±0.24[b]	7.7±0.07[b]	34.2±0.25[b]

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length, N=number of observations. [a, b, c] Means in the same column with different super scripts differs significantly ($p < 0.05$).

Table 4.9 Effect of hatch and sex on body weight and conformation traits at 8 weeks.

Hatch	N	BW(g)	WL(cm)	CC(cm)	CH(cm)	SL(cm)	BL(cm)

1	34	1316.9 ± 76.22^{NS}	20.6 ± 0.13^{ab}	41.5 ± 0.43^{a}	21.8 ± 0.40^{NS}	10.5 ± 0.38^{ab}	41.3 ± 0.43^{NS}
2	33	1216.5 ± 86.18^{NS}	20.3 ± 0.18^{b}	39.1 ± 0.57^{b}	21.3 ± 0.68^{NS}	9.5 ± 0.53^{b}	41.2 ± 0.63^{NS}
3	93	1198.1 ± 46.54^{NS}	20.8 ± 0.10^{a}	39.4 ± 0.27^{b}	22.7 ± 0.37^{NS}	10.8 ± 0.31^{a}	40.3 ± 0.33^{NS}
Sex							
Male	29	1510.0 ± 77.13^{a}	21.0 ± 0.13^{a}	41.5 ± 0.46^{a}	23.4 ± 0.50^{a}	11.6 ± 0.39^{a}	41.5 ± 0.53^{a}
Female	131	1164.5 ± 38.80^{b}	20.6 ± 0.09^{b}	39.4 ± 0.24^{b}	21.9 ± 0.31^{b}	10.2 ± 0.25^{b}	40.5 ± 0.28^{b}

BW=body weight WL=wing length CC=chest circumference CH=chicken height SL=shank length BL=back length

$^{a, b}$ Means in the same column with different super scripts differs significantly ($p< 0.05$) N=number of observations.

4.4 Heritability (h^2) Estimates

4.4.1 Heritability and least squares means with standard errors of egg weight, day old Weight and Chick yield.

Table 4.10 shows the heritability and least square means with standard errors of egg weight, day old weight and chick yield. Very high heritability estimates were obtained for egg weight moderate for day old weight, (0.95 ± 0.11 and 0.35 ± 0.12) respectively, while the heritability of chick yield was low (0.20 ± 0.03).The Least squares means for egg weight, day old weight and chick yield were 64.4 ± 10.05, 44.5 ± 0.47 and 69.0 ± 0.73, respectively. Chick yield had the highest least square means while day old weight had the lowest least square means.

4.4.2 Heritability Estimates of body weight and conformation traits by age

The heritability estimates and standard errors (SE) for body weights and conformation traits are shown in Table 4.11. The heritability estimates were low and ranged between 0.12 ± 0.172 and 0.23 ± 0.213 from ages 2-8 weeks. It was observed that body weight at 2 weeks had the highest heritability estimate (0.23±0.212). Similarly the heritability estimates for the conformation traits were low and ranged between 0.01 ± 0.128 and 0.14 ± 0.81. There was no specific trend in the estimates from 2 to 8 weeks.

Table 4.10: Heritability and least square means with standard errors of egg weight Day old weight and chick yield of Hubbard broiler chickens.

Trait	N	Least Square means ± SE	Heritability ± SE
Egg weight (g)	**160**	**64.4 ± 0.10**	**0.95 ± 0.11**
Day old weight (g)	**160**	**44.5 ± 0.47**	**0.35 ± 0.12**
Chick yield (%)	**160**	**69.0 ± 0.73**	**0.20 ± 0.03**

Table 4.11: Heritability Estimates of body weight and conformation traits of Hubbard broiler breeder by age.

Characteristics	Age (Weeks)			
	2	**4**	**6**	**8**
Body weight (g)	0.23±0.212	0.17±0.190	0.12±0.172	0.19±0.199
Body length (cm)	-	-	-	0.06±0.147
Chest circumference (cm)	0.14±0.179	0.01±0.129	0.14±0.181	0.06±0.148
Chicken height (cm)	0.06±0.150	0.01±0.128	-	0.09±0.160
Wing length (cm)	-	0.07±0.151	-	0.06±0.147
Shank length (cm)	0.10±0.165	0.04±0.139	0.04±0.140	0.06±0.147

N=160 in all cases.

4.5 Genetic and phenotypic correlations among the weight measurements.

Genetic and phenotypic correlations among the measured traits are shown in Table 4.12. Genetic correlation between egg weight and, chick yield, egg weight and 4, 7 and 8 weeks body weights were observed to be low and positive. Whereas, genetic correlations between egg weight and, 5 and 6 weeks body weights were moderate, on the other hand genetic correlations between egg weight and, 3, 2 and 1 weeks body weights as well as day old weight were high and positive.

The genetic correlation between chick yield and day old weight was high and positive whereas, that of chick yield and one week weight was low but positive. Low and negative correlation was observed between chick yield and week 2 body weight, whereas high and negative genetic correlations were observed between chick yield and week 3-8 body weights.

The genetic correlations between Day old weight and week one as well as day old weight and 2 week body weight were high and positive, whereas the genetic correlations between day old weight and week 3 body weight was low and positive. The genetic correlation between day old and 4 week body weights was low and negative. However, Zero correlation was observed between day old and 5 week weights.

The genetic correlations between bodyweight at one week and bodyweight at 2 weeks was high and positive, whereas correlations between and 3 weeks bodyweights as well as 1 and 4 weeks body weights were low and positive. However, genetic correlations between 1 and 5 weeks body weights, 1and 6 weeks body weight as well as 1 and 8 weeks body weight were low and negative, while the genetic correlation between 1 and 7 weeks body weights was high and negative.

The genetic correlations between 2 and, 3, 4, 5, 6, 7 and 8 weeks body weights were high and positive. Similarly, genetic correlations between 3 and, 4, 5, 6, 7 and 8 weeks body weight were high and positive. Genetic correlations between 4 and, 5, 6, 7 and 8 weeks body weights were equally high and positive. High and positive correlations were obtained between 5 and 6, 7 and 8 weeks body weights, likewise the correlations between 6 and 7, 6 and 8 and, 7 and 8 weeks body weights were high and positive.

The phenotypic correlation between egg weight and chick yield was low and positive whereas for day old and egg weights, day old weight and chick yield, they were high and positive. Low and positive correlations were obtained for Egg and week 1 weights, week 1 and day old weights. Similarly, low and positive correlations were obtained for week 2 and egg weights, week 2 and chick yield, week 2 and day old weights while that of weeks 2 and 1 were high and positive. Phenotypic correlations between week 3 and egg weight, week 3 and chick yield, week 3 and day old weights were low and positive. However, high and positive correlations were observed for weeks 3 and 1 weights, weeks 3 and 2 weights. Correlations of week 4 and Egg weights, week 4 and chick yield, week 4 and day old weights were all low and positive. Whereas that of weeks 4 and 1 was positive and moderate. Those of weeks 4 and 2, weeks 4 and 3 however were high and positive. Low and positive correlations were observed for week 5 and egg weights, week 5 weight and chick yield, week 5 and day old weights, while the correlation between weeks 5 and 1 was moderate and positive whereas those of weeks 5 and 2, weeks 5 and 3, weeks 5 and 4 were all high and positive. Correlations between week 6 and egg weights, week 6 weight and chick yield, week 6 and day old weights, weeks 6 and1 weights were low and positive, while those of weeks 6 and 2, 6 and 3, 6 and 4, and 6 and 5 weights were high and positive. The phenotypic correlations between week 7 and egg weights, week 7 weight and chick yield, week 7 and day old weights as well as weeks 7 and 1 weights were low and positive. Whereas those of weeks 7 and 2, 7 and 3 weeks, 7 and 4, 7 and 5 and 7 and 6 were high and positive. Low and positive correlations were obtained for egg and week 8 body weights, chick yield and 8 weeks body weight, day old and 8 weeks bodyweights, 8 and 1 week body weight.

However, high and positive phenotypic correlations were obtained for 8 and 2, 8 and 3, 8 and 4, 8 and 5, 8 and 6 and, 8 and 7 weeks body weights.

Table 4.12: Genetic and Phenotypic Correlations of various traits of Hubbard Broiler Breeders.

				Weekly body weight							
Traits	**Egg wt**	**CYLD**	**Day old weight**	**Wk1**	**Wk2**	**Wk3**	**Wk4**	**Wk5**	**Wk6**	**Wk7**	**Wk8**
Eggwt(g)	-	0.360	0.918	1.257	0.898	0.696	0.377	0.427	0.487	0.230	0.140
Cyld (%)	0.070	-	0.703	0.328	-0.189	-0.698	-0.838	-0.821	-1.110	-1.038	-0.675
Day oldwt(g)	0.523	0.884	-	1.107	0.621	0.254	-0.047	0.000	-0.071	-0.242	-0.164
Wk1	0.217	0.363	0.405	-	0.691	0.024	0.187	-0.063	-0.061	-0.522	-0.313
Wk2	0.130	0.232	0.254	0.846	-	0.841	0.670	0.785	0.774	0.633	0.646
Wk3	0.075	0.122	0.138	0.583	0.831	-	0.898	0.889	1.007	0.997	1.061
Wk4	0.050	0.058	0.073	0.484	0.760	0.937	-	1.075	1.234	1.249	1.125
Wk5	0.047	0.063	0.076	0.427	0.708	0.903	0.953	-	1.111	1.040	1.034
Wk6	0.059	0.070	0.086	0.370	0.633	0.811	0.856	0.914	-	1.134	1.086
Wk7	0.007	0.032	0.033	0.314	0.601	0.825	0.886	0.954	0.911	-	1.270
Wk8	0.036	0.021	0.036	0.313	0.593	0.803	0.872	0.923	0.880	0.963	-

CYLD= chick yield (%)

4.6 Environmental correlations of various weight measurements of Hubbard broiler breeders.

The estimated environmental correlations amongst egg weight, chick yield, and body weights are presented in Table 4.13. The correlations between egg weight and chick yield was low and positive, whereas those of day old and egg weights, day old and chick yield were high and negative. Environmental correlation between week one and egg weight was high and positive, whereas that of chick yield and week one weight was low and positive while that of week one and day old weights was moderate. Moderate correlation was also obtained for egg and 2 week body weights, while low and positive correlations were obtained for chick yield and 2 week bodyweight, day old and 2 week body weights. However, high and positive correlation was obtained for 1 and 2 weeks body weights. Low and positive correlations was obtained for egg weight and 3 week body weight, chick yield and 3 week body weight. Negative and low correlation was however obtained for day old and 3 week body weight, whereas high and positive correlation were recorded for 1 and 3 weeks body weights, 2 and 3 weeks body weights.

Environmental correlations obtained for egg weight and 4 week body weight, chick yield and 4 week body weight were low and positive, whereas day old and 4 week body weights had low and negative, while 4 and 1, 4 and 2 and 4 and 3 weeks body weights had high and positive values. Low and positive environmental correlations were obtained for egg and 5 week body weights, chick yield and 5 week body weight. The correlation between day old and 5 week body weights was low and negative whereas, high and positive correlation were obtained for 1 and 5, 2 and 6, 3 and 5, 4 and 5 weeks body weights. Environmental correlations for 6 week body and egg weights, 6 week body weight and chick yield were low and positive. Low and negative correlation was however obtained for day old and 6 week body weights, while that of 6 week and 1 week body weights was moderate and positive, whereas that of 6 and 2, 6 and 3, 6 and 4, 6 and 5 weeks body weights were all high and positive.

Low and positive environmental correlations were obtained for egg and 7 week body weights, chick yield and 7 week body weight, while the correlation of day old and 7 week body weights was low and negative. Moderate correlation was obtained for 7 and 1 weeks body weights, while those of 7 and 2, 3, 4, 5 and 6 weeks body weights, were high and positive.

The environmental correlations obtained for egg and 8 week bodyweight, chick yield and 8 week body weight were low but positive. Negative and low correlation was recorded for day old and 8 week body weights. Moderate and positive correlation was however obtained for 1 and 8 weeks body weights whereas high and positive correlations were obtained for 8 and 2, 3, 4, 5, 6 and 7 weeks body weights.

Table 4.13. Environmental correlations of various weight measurements.

Traits	Eggwt (g)	Cyld (%)	Day old weight(g)	Wk1	Wk2	Wk3	Wk4	Wk5	Wk6	Wk7
Eggwt	-									
Cyld	0.207									
Day old weight	-1.612	-0.953								
Wk1	0.653	0.377	0.413							
Wk2	0.479	0.372	0.172	0.892						
Wk3	0.250	0.309	-0.070	0.703	0.840					
Wk4	0.165	0.305	-0.184	0.651	0.785	0.946				
Wk5	0.169	0.280	-0.144	0.538	0.697	0.906	0.933			
Wk6	0.171	0.338	-0.214	0.462	0.613	0.785	0.796	0.886		
Wk7	0.074	0.226	-0.205	0.457	0.612	0.809	0.848	0.949	0.889	
Wk8	0.055	0.227	-0.231	0.479	0.580	0.762	0.818	0.904	0.849	0.955

CYLD =Chick yield (%)

4.7 Genetic and phenotypic correlations of body weight and conformation traits at various ages.

4.7.1 Genetic and phenotypic correlations of body weight and conformation traits at 2 weeks.

Table 4.14 shows the genetic and phenotypic correlations of body conformation traits at 2 weeks of age. Genetic correlations ranged from -0.182 to 0.974 with correlations between body weight and back length, shank length and chicken height being high and positive while the correlations between shank length and chest circumference and, chicken height and chest circumference were low and negative. However correlation between body weight and chicken height was low but positive. The phenotypic correlations for the conformation traits at 2 weeks were positive and ranged from low to high. The correlation between chicken height and shank length was high and positive (0.683) as well as the correlation between bodyweight and chest circumference (0.624) while the correlations between chest circumference and, shank length, chicken height, and back length, back and shank lengths and back length and chicken height were low but positive.

Table 4.14: Genetic (above diagonal) and phenotypic (below diagonal) correlations of body weight and conformation traits at 2 weeks of age.

	WT	WL	SL	CH	CC	BL
WT	*	-	-	0.435	-	0.815
WL	0.311	*	-	-	-	-
SL	0.215	-	*	0.974	-0.182	-
CH	0.412	-	0.683	*	-0.204	-
CC	0.624	-	0.067	0.218	*	-
BL	0.273	-	0.161	0.153	0.393	*

WT = weight, SL = shank length, CH = chicken height, CC = chest circumference,

BL = back length WL = wing length.

4.7.2 Genetic and phenotypic correlations of body weight and conformation traits at 4 weeks of age.

Table 4.15 shows the genetic and phenotypic correlations of body weight and conformation traits at 4 weeks of age. Very high and positive genetic correlations were observed for most of the conformation traits at 4 weeks of age and ranged from 0.681 to 1.751, except the correlation between body weight and chest circumference which was low and negative (-0.276). Phenotypic correlations between body weight and linear body measurements were high and positive in most cases except the correlation between body weight and back length. Similarly, phenotypic correlations amongst the conformation traits were positive and ranged from 0.330 to 0.744. The correlation between back length and chest circumference was observed to be low while the correlations between back and, wing, shank length, and chicken height were moderate. Phenotypic correlations between wing and shank lengths, chicken height and wing length, chicken height and shank length, chest circumference and, wing length, shank length, and chicken height were high and positive.

Table 4.15: Genetic (above diagonal) and phenotypic (below diagonal) correlations of body weight and conformation traits at 4 weeks of age.

	WT	WL	SL	CH	CC	BL
WT	*	0.950	0.681	-0.276	0.389	-
WL	0.702	*	1.437	-	1.751	-
SL	0.683	0.630	*	-	1.126	-
CH	0.646	0.516	0.744	*	-	-
CC	0.647	0.529	0.586	0.501	*	-
BL	0.441	0.404	0.421	0.489	0.333	*

WT =weight, WL= wing length, SL = Shank length, CH=chicken height,

CC =chest circumference, BL =back length.

4.7.3 Genetic and phenotypic correlations of body weight and conformation traits at 6 weeks of age.

As presented in Table 4.16, genetic correlations were observed to be high and positive (0.744 - 1.738) while some others were inestimable. The phenotypic correlations amongst the conformation traits were also observed to be high and positive in general (0.568 -0.851) except the correlations between body weight and chest circumference which was low but positive (0.379).

Table 4.16: Genetic (above diagonal) and phenotypic (below diagonal) correlations of

body weight and conformation traits at 6 weeks of age.

	WT	WL	SL	CH	CC	BL
WT	*	1.504	1.738	-	1.184	-

WL	0.568	*	-	-	-	-
SL	0.600	-	*	-	0.744	-
CH	-	-	0.851	*	-	-
CC	0.379	-	0.819	0.748	*	-
BL	-	-	0.642	0.626	0.656	*

WT = weight, WL= wing length, SL=shank length, CH= chicken height,

CC= chest circumference, BL= back length.

4.7.4 Genetic and phenotypic correlations of body weight and conformation traits at 8 weeks of age.

Table 4.17 shows the genetic and phenotypic correlations of body conformation traits at 8 weeks of age. Genetic correlations were all positive and ranged from moderate to high. The correlation between shank and back lengths was moderate, while the other correlations were high. Phenotypic correlations amongst the various conformation traits were also high and positive except the correlations between body weight and chicken height and body weight and chest circumference which were low but positive.

Table 4.17: Genetic (above diagonal) and Phenotypic (below diagonal) Correlations of Body Conformation Traits at 8 weeks of Age.

	WT	SL	CH	CC	BL	WL
WT	*	1.223	1.176	1.127	1.661	-
SL	0.737	*	0.964	0.877	0.485	1.00
CH	0.378	0.935	*	0.893	0.795	0.963
CC	0.342	0.815	0.813	*	1.649	0.878
BL	1.966	0.681	0.717	0.729	*	0.489
WL	-	1.00	0.935	0.815	0.681	*

SL = shank length, CH = chicken height, CC = chest circumference, BL = back length,

WT= weight, WL = wing length.

4.8 Environmental correlations amongst body weight and conformation traits at various ages.

4.8.1 Environmental correlations amongst body weight and conformation traits at 2 weeks of age.

The environmental correlations at 2 weeks were low but positive in most cases as shown in Table 4.18, except those of chicken height and shank length (0.660) as well as body weight and chest circumference, which were high and positive.

Table 4.18: Environmental correlations of body weight and conformation traits at 2 weeks of age.

	WT	SL	CH	CC	BL	WL
WT	-					
SL	-	-	-			
CH	0.412	0.660	-			
CC	0.529	0.101	0.263	-		
BL	0.220	-	-	0.148	-	
WL	-	-	-	-	-	-

WT = weight, SL = shank length, CH = chicken height, CC = chest circumference,

BL = back length, WL = wing length.

4.8.2 Environmental correlations amongst body conformation traits at 4 weeks of age.

As presented in Table 4.19, at 4 weeks of age, environmental correlations were high and positive in most cases and ranged from 0.409 to 0.723, except for correlations between chest circumference and chicken height and chest circumference and wing length which were moderate and positive.

Table 4.19: Environmental correlations of body weight and conformation traits at 4 weeks of age.

	WT	WL	SL	CH	CC	BL
WT	-					
WL	0.669	-				
SL	0.702	0.590	-			
CH	0.723	0.446	0.720	-	S	
CC	0.686	0.500	0.577	0.409	-	
BL	-	-	-	-	-	-

WL = wing length, SL = shank length, CH = chicken height, CC = chest circumference

WT = weight, BL = back length.

4.8.3 Environmental correlations amongst body weight and conformation traits at 6 weeks of age.

As presented in Table 4.20, at 6 weeks of age, environmental correlations were high and positive in most cases and ranged from 0.426 to 0.705, except for the correlation between body weight and wing length which was moderate and positive.

Table 4.20: Environmental correlations of body weight and conformation traits at 6 weeks of age.

	WT	WL	SL	CH	CC	BL
WT	-					
WL	0.426	-				
SL	0.507	0.705	-			
CH	-	-	-	-		
CC	0.646	0.697	-	-	-	
BL	-	-	-	-	-	-

WT =weight, WL = wing length, SL = shank length, CH = chicken height, CC = chest circumference, BL = back length.

4.8.4 Environmental correlations amongst body weight and conformation traits at 8 weeks of age.

Table 4.21 shows the environmental correlations amongst body conformation traits at 8 weeks of age. The environmental correlations were observed to be very high and positive in all cases and ranged from 0.673 to 1.00.

Table 4.21: Environmental correlations of body weight and conformation traits at 8 weeks of age

	WT	WL	SL	CH	CC	BL
WT	-					
WL	-	-				
SL	0.845	1.000	-			
CH	0.864	0.935	0.935	-		
CC	0.876	0.811	0.811	0.808	-	
BL	0.673	0.693	0.693	0.712	0.673	-

WT= weight, WL = wing length, SL = shank length, CH = chicken height,

CC = chest circumference, BL = back length.

4.9 Prediction equations for 8 week body weight of Hubbard broiler breeders by age using body linear measurements.

From Table 4.22, at 2 weeks of age, Chest circumference and Shank length were observed to be highly significant ($p<0.01$) while others were non significant ($p>0.05$) though these characteristics were poor estimators of 8 week body weight. Similarly at 4 weeks, all other measured characteristics were non significant ($p>0.05$) except chest circumference and shank length which were highly significant though moderate estimators of 8 week body weight.

Similarly, at 6 weeks, chest circumference and chicken height were highly significant ($p< 0.01$) but moderate estimators ($R^2 = 0.473$ and 0.506 respectively) of 8 week body weight. Whereas at 8 weeks, chest circumference, chicken height and back length were all highly significant ($P< 0.01$) and very good estimators ($R^2 = 0.781$, 0.845 and 0.849 respectively) of body weight compared to all other measured traits though back length was observed to be the best predictor ($R^2 =0.849$) of body weight at 8 weeks.

Table 4.22: Prediction equations for 8 weeks body weight of Hubbard broiler breeders by age using body linear measurements.

Age (weeks)	Predictor	Prediction Equation	r^2	Sig. of 'r^2' (p<0.0001)
2	CC	Y= -236+132CC	0.146	***
	SL	Y= -1208+217SL+127CC	0.183	***
4	SL	Y = -1995+503SL	0.410	***
	CC	Y= -2043+392SL+52CC	0.440	***
6	CC	Y = -1039+133CC	0.470	***
	CH	Y= -1579+46CH+93CC	0.510	***

8	CC	Y= -1638+143CC	0.780	***
	CH	Y= - 2407+57CH+86CC	0.845	***
	BL	Y= -2468 +14BL+79CC+52CH	0.849	***

CC=chest circumference, SL=shank length, CH=chicken height, BL=back length.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Body measurements of Hubbard Broiler Breeder chickens by age.

The increasing trend obtained in this study for body weights and linear body measurements as the birds advanced in age is supportive of previous reports of Pingel *et al*.(1990), Essien and Adeyemi (1999), Adedeji (2004) and Adedeji (2008). This suggests that age is a major determinant of growth and physiological development.

5.2 Sire effect on body weight and conformation traits at different ages.

The significant effect of sire on body weights and some linear measurements at 2, 4, 6 and 8 weeks in Hubbard broiler breeder agrees with the findings of Hossain and Ahmed (1993) in their work on indigenous Rhode island Red and Barred Plymouth Rock chickens. Similarly, Adedeji *et al.* (2008) obtained significant effect of sire on body weight and linear body measurements in pure and crossbred chicken progeny in a derived savannah environment. This implies considerable genetic contribution of sire to these traits. Although, the sire does not lay eggs, it contributes genetically to the growth and performance of the chick. Therefore appropriate selection programme that will ensure the use of proven sires in the poultry combined with good mating system would yield good results.

5.3 Effect of Hatch and Sex on body weight s and conformations at different ages.

Significant effect of hatch on body weights and body measurements at 2, 4 and 6 weeks suggests that environmental factors such as humidity and temperature at setting and hatching may have contributed to these results. Yassin *et al.* (2008) reported that variations in temperature, humidity, storage length of eggs, season and year contributed greatly to the hatchability of eggs. High atmospheric temperature was observed to be the most limiting factor to hatchability; and poor hatches resulted in weaker birds at subsequent ages.

The non-significant effect of hatch on body weight and body length at 8 weeks implies that irrespective of hatch, the performances of these traits at 8 weeks were similar. There was significant effect of sex at 2, 4, 6 and 8 weeks on body weight in this study and males were superior in body weight than their female counterparts. This result is in agreement with findings of Monsi (1992), Okoro and Ogundu (2006) as well as Adedeji *et al.* (2008), who reported the presence of sexual dimorphism in favour of male birds. This may have resulted from differences in hormonal profile, aggressiveness and dominance of male when feeding especially when both sexes are reared together.

The non significant effect of sex on body length at 4 weeks is in agreement with results of Okpeku *et al.* (2008) and Sola-Ojo *et al.* (2008), who obtained non significant differences between males and females of local chickens of Edo state and Fulani ecotype chickens respectively between ages 2-6 weeks. However, this contradicts reports of Adedeji *et al.* (2008) who observed that body length differed with sex in pure and crossbred progeny of chicken in a derived savannah environment. This contradiction may be due to strain and environmental differences.

The significant effects of sire, sex, and hatch on body weight and conformation traits imply that they could be included in the model designed for genetic evaluation of broiler breeders.

5.4 Heritability estimates for body measurements, Egg weight, Day old weight and Chick yield.

The low heritability estimate obtained for body weight from 2 to 8 weeks of age agrees with reports of Siripholvat (1995) and Beaumont *et al* .(1998), but contradicts results of Adeyinka *et al.* (2004) and Le Bihan-Duval Elisabeth *et al.* (2008), who obtained moderate to high heritability estimates for body weight at different ages. These low estimates of heritability could be attributed to the small data size used in this study. The none specific trend observed for the heritability estimates of body weight from 2 to 8 weeks in this study contradicts reports of Chambers (1990) who obtained an increasing trend in heritability of body weights with age.
Low heritability estimates obtained in this study for the conformation traits from 2 to 8 weeks of age is in agreement with Adeyinka *et al*. (2006) who obtained a similar result for naked necked broiler chickens while Singh and Julian (2007) reported low to moderate heritability for conformation traits in Van-cob broiler chickens. On the other hand, the present result contradicts the report of Deeb and Lamont (2002) who obtained moderate to high heritability for growth and body composition traits. Similarly, Singh *et al.* (2008) obtained high heritability estimates for keel length at 6 weeks in a synthetic broiler breeder strain. The low estimate of heritability however is a reflection that there are more non-additive genetic variance (dominance, epistatic and environmental effects) than additive genetic variance or may have resulted from the small data size used in this study; as such, selection based on pedigree, family or collateral relatives would be most advisable.

The high heritability estimate obtained for egg weight contradicts results of Brah *et al.* (1995) who reported low to moderate heritability for egg weight in white leghorn chickens. The low heritability estimate obtained in this study for day old weight agrees with reports of Sati *et al.* (1999) and Adeyinka *et al*. (2006), who obtained low heritability estimates for day old weight

5.5 Genetic and phenotypic correlations

The low but positive genetic correlations obtained between egg weight and, chick yield, 4, 7 and 8 weeks bodyweights suggest that there are indications that the larger the egg size or weight the higher the body weight and chick yield. Verma *et al.* (1983) also obtained low but positive genetic correlations between initial egg weight and 8 week body weight in White leghorn chickens. Pinchasov (1991) observed that the initially high correlation between egg weight and hatch weight declined with age. North (1986) indicated that the weight of the chick represents approximately 70% of the egg weight. High and positive genetic correlations reported between chick yield and day old weight imply that direct relationship exists between these traits. Therefore an increase in day old weight will result in increase in chick yield. As such, any improvement in one of the traits will lead to improvement in the others. The high but negative genetic correlations observed between chick yield and body weights of 3 to 8 weeks suggests that an inverse relationship exists between body weight at these ages and chick yield. As such selection for improvement in one of these traits would have an adverse effect on the others hence one has to be careful when including them in the selection index for a broiler breeder enterprise.

High and positive genetic correlation between day old weight and 2 week body weight suggests that any improvement in one trait would result in a corresponding improvement in the others as such positive genetic progress can be achieved during selection for these traits. However the low but positive correlation obtained between day old weight and 3 week body weight indicates a weak relationship as such many generations of selection would have to be carried out to achieve genetic progress.

5.6 Environmental correlations between egg weight, chick yield and body weights of Hubbard broiler breeder.

Positive environmental correlations were obtained for most of the measured traits of Hubbard broiler breeders except for those of egg weight and day old weight, Day old weight and chick yield, Day old weight and 3 to 8 weeks body weights. This implies that environmental factors (climate, nutrition and management) had great influence on the expression of these traits.

5.7 Genetic and Phenotypic Correlations of body measurements at Different Ages.

The high and positive genetic correlations obtained at 2 weeks between body weight and back length, shank length and chicken height, imply that an increase in back length would result in a corresponding increase in body weight. Similarly, an improvement in chicken height can be achieved through selection for increased shank length. Whereas, low and negative genetic correlations obtained between shank length and chest circumference, chicken height and chest circumference suggest that selection for any one of these traits may have a negative consequence on the value of the other traits, hence it is not advisable to include these traits together in the selection index of a broiler breeder enterprise.
The very high and positive genetic correlations observed amongst most of the body measurements at 4 weeks suggest that improvement in any one of these traits would result in corresponding improvements in the other traits. As such, great genetic progress can be achieved upon selection. The moderate to high and positive range of phenotypic correlations for the body measurements at this age are in agreement with findings of Okon *et al.* (1996) indicating that a favourable relationship exists among these traits hence, these traits could be collectively included in the selection index to achieve positive genetic progress.

The high and positive genetic and phenotypic correlation obtained at 6 weeks between shank length and chest circumference implies that improvement in shank length would result in a corresponding improvement in chest circumference, as such selection for increased shank length alone would have a positive effect on chest circumference, this result concurs with the findings of Okoro and Ogundu (2006) as well as that of Singh (2008).

Similarly, high and positive genetic and phenotypic correlations for body weight and conformation traits obtained at 8 weeks in this study are in agreement with results of Okon *et al.* (1996) and Singh (2008). This suggests that upon selection of anyone of these traits, significant genetic progress would be achieved in the broiler breeder enterprise on the other traits.

5.8 Environmental correlations for body weight and conformation traits at different ages. The environmental correlations obtained at 2,4,6 and 8 weeks which ranged from low to high but positive implies that environmental factors especially nutrition and management contributed positively to the performance of these traits at various ages.

5.9 Prediction equations for 8 weeks body weight of Hubbard broiler breeders by age using body linear measurement.

The low but highly significant coefficients of determination obtained for chest circumference and shank length at 2 weeks imply that these traits are poor estimators of body weight at 8 weeks. At 4 weeks, moderate but highly significant coefficient of determination obtained for chest circumference suggests that this character is a moderate estimator of body weight at 8 weeks. Similarly, at 6 weeks, chest circumference and chicken height though highly significant revealed that they are moderate estimators of body weight at 8 weeks.

At 8 weeks, chest circumference, chicken height and back length had highly significant coefficient of determination, though 8 week body weight was best predicted using back length at 8 weeks. The highly significant coefficient of determination values with respect to each of the predictors at 2, 4, 6 and 8 weeks are indicators of the reliability of these linear measurements as predictors of body weight at 8 weeks. In addition, the r^2 values show the contribution of each parameter to the body weight development.

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

This study was undertaken to estimate the genetic parameters for body weights and body linear measurements at different ages and to ascertain the extent to which linear body measurements could best predict body weight at 8 weeks in Hubbard broiler breeders. Data from 160 Hubbard broiler breeders at the National Animal Production Research Institute (NAPRI) Shika, Zaria were used for the study. The data analyzed consisted of 160 body weight records from 0-8weeks as well as conformation traits (Back length, Chest circumference, Chicken height and Shank length) at 2,4,6 and 8 weeks. Body weight records were measured in grams while conformation traits were measured in centimeters. The results indicated that Sire significantly ($P<0.05$) affected body weights at 2, 4, and 8 weeks but was non significant ($P> 0.05$) at 6 weeks. Hatch effect was significant ($P<0.05$) on body weight at 2, 4, 6 and 8 weeks. Similarly, Sex effect was significant ($P< 0.05$) on body weight at 2, 4 and 6 weeks except at 8 weeks. The heritability (h^2) estimates for body weight and conformation traits from 2 to 8 weeks were low, and ranged from 0.12 ± 0.172-0.23 ± 0.213 and 0.01± 0.128-0.14 ± 0.81 respectively. However, high heritability estimates were reported for egg weight (0.95 ± 0.11), while that of chick yield and day old weight were low (0.2 ± 0.23 and 0.35 ± 0.12) respectively. Genetic correlations for body weight at different ages ranged from low to high but were positive in most cases except for correlations between 1 and, 5, 6, 7 and 8 weeks weights. Phenotypic correlations for body weights at different ages also ranged from low to high and were positive in all cases (0.007-0.963). Genetic and phenotypic correlations for body weight and conformation traits at 2 weeks were positive in most cases and ranged from low to high except for genetic correlations between chest circumference and shank length as well as chest circumference and chicken height which were negative. Genetic correlations for body conformation traits at 4 weeks were high and positive in most cases and ranged from 0.681 to 1.751, except for correlations between body weight and chicken height which was low and negative, while phenotypic correlations ranged from moderate to high (0.330 to 0.744). At 6 weeks, the genetic and phenotypic correlations for body weight and conformation traits were all high and positive, while those of 8 weeks were positive and ranged from moderate to high for the genetic correlations whereas the phenotypic correlations were all high and positive ranging from 0.681 to 1.00. Environmental correlations between egg weight, chick yield and body weights were positive in most cases ranging from low to high except for those of egg weight and day old weight, day old weight and chick yield, day old weight and 3 to 8 weeks. Environmental correlations for body conformation traits at 2 weeks were low except for shank length and chicken height, while moderate to high and positive correlations were obtained at 4 and 8 weeks. From this study, chicken height at 6 weeks was the best conformation trait that could be used for selection purposes, while back length at 8 weeks was the best predictor of 8 week body weight.

6.2 Conclusions

From the results obtained in this study, significant effect of Sire, Sex and Hatch on body weight and some linear body measurements imply that they could be included in the model designed for genetic evaluation of the broiler breeders especially for selection purposes.

Low heritability estimates obtained for body weights and conformation traits can be attributed to high environmental effects and it implies that selection based on individual performance alone may not be advisable.

Low to high and positive genetic and phenotypic correlations for body weight and conformation traits are indications of linkage effects.

The highly significant coefficient of determination values with respect to each of the predictors at 2, 4, 6, and 8 weeks are indications of the reliability of these linear measurements as predictors of 8 week body weight, though from this study, back length at 8 weeks was observed to be the best predictor of 8 week body weight.

6.3 Recommendation

Further research should be carried out in terms of selection for the improvement of body weight and conformation traits, taking environmental factors into consideration.

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APPENDICES

Appendix A: VACCINATION SCHEDULE /MEDICATION

Age of bird	Vaccination/Medication
Day 1	Newcastle and Mareks vaccine
Day 1-5	Neoterramycin and Vitalye
Day 10	Gumboro /Infectious bursal disease vaccine (IBDV) 1st dose
Day 24	Gumboro /IBDV 2nd dose
Week 3	Coccidiostat (for 5 days)
Week 4	New castle disease vaccine 1st dose
Week 7	Komarov 1st dose and Fowl pox
Week 8	Coccidiostat (for 5 days)
Week 8	Dewormer (for 1 day)

Appendix B: COMPOSITION OF BROILER STARTER RATION

Feed Ingredients	
Maize	38.05
Groundnut cake	20.00
Maize Offal	28.00
Wheat bran	10.00
Limestone	1.00
Salt	0.30
Bonemeal	2.00
Methionine	0.20

Calculated Analysis	
Me (Kcal/kg)	2884
Cp (%)	20.00
Cf (%)	4.10
EE (%)	3.17
Methionine	0.20
Cystein	0.20
Lysine	1.04
Calcium	1.06

Me = metabolisable energy, Cp =crude protein, Cf = crude fiber, EE= ether extract

Appendix C: COMPOSITION OF BROILER FINISHER RATION

Feed Ingredients	
Maize	61.7
Ground nut cake	15.0
Soya bean meal	20.0
Bone meal	1.8
Lime stone	0.5
Premix	0.3
Methionine	0.2
Lysine	0.2

Calculated Analysis	
Me (Kcal/kg)	2650
CP (%)	16.0
CF (%)	5.70
EE (%)	4.30
Methionine	0.20

Cystein	0.20
Lysine	0.52
Calcium	1.00
Phosphorus	0.30

Me = metabolisable energy, Cp =crude protein, Cf = crude fiber, EE= ether extract