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I am submitting herewith a dissertation written by Harold Albert Herzog, Jr., entitled "Studies of the Behavior of Gamecocks." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

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STUDIES OF THE BEHAVIOR
OF GAMECOCKS

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Harold Albert Herzog, Jr.

March 1979

1379300

ACKNOWLEDGMENTS

The research reported herein would not have been possible but for the assistance of numerous individuals. John Ball, John Chandler, R. H. Rogers, Ralph Spurling, and the late Fabe Webb provided access to gamecocks and patiently answered my sometimes stupid questions about cockfighting. Observations at cockpits were made with the generous permission of cockers and pit operators in North Carolina and Tennessee who for obvious reasons prefer to remain anonymous. Clifton Bryant of Virginia Polytechnical Institute and the late William Capel of Clemson University were kind enough to allow me access to their unpublished data from the American Cockers Survey.

Rob Amberg, Gordon Burghardt, Mac Davis, Paul Gurewitz, Walter Stroud, and Bob Vance aided in the collection of data at cockfights, and Shrikant Awasti and Elizabeth Gordon assisted with the laboratory experiments. Ann Lacava was instrumental in putting the dissertation in final form.

Gordon Burghardt has been my friend and teacher for seven years. During that time he has provided encouragement, prodding, financial support, and a model of intellectual excellence. I thank him.

My wife Mary Jean has put up with a great deal during my years in graduate school. She has endured alligators in the bathroom and game roosters in the basement. She has paddled me around swaps in the middle of the night and patiently waited up for me to return from cockfights in the wee hours of the morning. She also typed this dissertation and continues to provide love and companionship. What more can I say?

This research was supported by grants from Sigma Xi, the University of Tennessee psychology department, and Mars Hill College.

ABSTRACT

Scientific and popular accounts of cockfighting are reviewed, and cultural and psychological aspects of the sport are examined. Information is presented on breeding and husbandry of gamecocks, fight preparation, rules and types of fights, gambling practices, and legal aspects of cockfighting. The scientific literature on the agonistic behavior of chickens is briefly reviewed with emphasis on the behavior of gamecocks, descriptive studies of fighting in chickens and the factors which determine fight outcome.

In Chapter III data recorded at actual cockfights are presented. This includes information on fighting behaviors, fight length, number of "pittings" (rounds) per fight, pitting length, the effect of weight on outcome, and survivorship. Of particular interest are observations of immobility responses similar to manually induced tonic immobility (TI) or "animal hypnosis." This response occurred in 33 of 86 fights and in 227 of 1,528 pittings. The response was relatively more frequent in longer fights suggesting that fatigue and exhaustion may facilitate the response. It was also found that mobile animals are attacked with greater frequency than immobile animals suggesting a possible function for the behavior. A possible evolutionary relationship between fatigue, TI and submissive postures is discussed.

In the second part of the dissertation are presented the results of three experiments designed to examine strain difference between gamecock chicks and chicks of two commercial strains, White Leghorns (WL) and Rhode Island Reds (RIR), in regard to TI and open field behavior. Previous research has shown that WLs show greater TI duration than RIRs and are more

"emotional" in terms of open field behaviors. It was hypothesized that the GCs would show greater TI than the other strains because of greater selection pressure for the response both during cockfights and in predator-prey encounters. In Chapter IV the literature pertaining to several aspects of TI is reviewed: theoretical issues, methodological difficulties and problems associated with operationally defining the response, and genetic influences.

Experiment 1 was designed to assess strain differences in duration and susceptibility to TI. The subjects were two-week old WLs, RIRs, and GCs which were housed and tested in single strain groups using a 25 min ceiling TI duration. The results did not support the hypothesis that the GCs would show greater TI duration and susceptibility. Although there was a significant difference between the WLs and RIRs and between the GCs and the RIRs in regard to duration, there was not a significant difference between the WLs and GCs. A significant difference was found between the strains in the number of subjects becoming immobile on the first induction trial with 53% of the RIRs, 83% of the WLs, and 87% of the GCs showing the response on the first trial.

Experiment 2 was a replication of Experiment 1 using a longer ceiling duration (120 min) and with the subjects housed in mixed strain groups. As in the first experiment there was a significant difference between the RIRs and WLs in TI duration. In this experiment, however, the GCs shifted and were significantly different from the WLs but not the RIRs. Data on susceptibility to induction procedures were consistent with Experiment 1 with 30% of the RIRs, 76% of the WLs, and 70% of the GCs becoming immobile on the first trial.

Experiment 3 examined strain differences between the three strains in open field behavior using five and six day old chicks. Five dimensions

of open field behavior were recorded: latency to move from the center square, ambulation, latency to peep, number of peeps during the trial, and number of defecations. On all of the dimensions there were significant differences between the WLs and RIRs. The game chicks were found to differ from the RIRs in ambulation and number of defecations, and they differed from the WLs in latency to peep and number of peeps.

PREFACE

This dissertation describes laboratory experiments and field observations of animals whose behavior has rarely been systematically investigated: gamecocks. Although many investigators have studied the behavior of domestic chickens, commercial strains have always been used as subjects. Gamecocks have been selectively bred for thousands of years for aggressiveness and fighting ability rather than for food production, and they bear a close physical resemblance to the ancestral red jungle fowl (Gallus gallus). Game roosters are strikingly beautiful animals.

There are two distinct parts to this study. In the first are presented the results of observations which I made at organized cockfights in North Carolina and Tennessee. Information was gathered on a number of aspects of cockfights in addition to the behavioral observations on the interactions of the roosters. The focus of this part of the dissertation, however, is on the incidence and possible function of immobility responses in agonistic encounters between roosters in cockfights.

The discovery of immobility responses in adult gamecocks in a "natural" situation led to the experiments described in the second part of the dissertation. These experiments attempted to investigate strain differences between gamecock chicks and chicks of two commercial strains of fowl, White Leghorns (WL) and Rhode Island Reds (RIR) with regard to susceptibility and duration of tonic immobility and in open field behavior.

As with any scientific research the present work answers some questions while at the same time generating new ones. It is hoped that it will be of use to others interested in the function, evolution, causation, and development of behavior.

A NOTE ON TERMINOLOGY

When animals are restrained and/or inverted they often remain in a state of relatively prolonged immobility. There is a lack of agreement among researchers as to the function, causation, and even the labels that should be given to this state. The most common term for immobility as induced by restraint is "tonic immobility" (TI), and I have chosen to follow this convention in the present work for two reasons. First, it is a relatively neutral term in that it does not imply a function or mechanism for the phenomenon as do some of the other frequently encountered terms such as animal hypnosis or death feigning. Secondly, the use of the most accepted terminology may make it easier for the experiments reported in this dissertation to be interpreted in light of other research in this field.

Here, TI will be taken as the state of motionlessness in animals which follows manual restraint. By definition then, TI can only be said to have occurred if restraint was used in the induction procedure. Because of this specification the term TI will be confined to laboratory studies.

Motionlessness observed outside the confines of the laboratory may or may not be the same phenomenon as TI. In this study immobility behaviors are reported to be an important component of agonistic encounters between gamecocks in which there is no restraint. I will call these instances "immobility responses" to distinguish them from the immobility produced by restraint (TI). It may be argued that this distinction is trivial and creates additional terminological confusion. I feel, however, that it will avoid the premature categorization of responses

that has occurred in the past. This issue is treated in greater detail in Chapter IV.

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PART I
THE BEHAVIOR OF ROOSTERS
DURING COCKFIGHTS

CHAPTER I

COCKFIGHTING

I. Research and Writing on Cockfighting

Scientific Accounts

Scientific accounts of social and cultural aspects of cockfighting are sparse, and empirical research on the behavior of gamecocks during fights is virtually non-existent. Parsons (1969) realized the potential of cockfighting as a subject worthy of sociological interest. His paper, however, is an outline of research topics together with an extensive and partially annotated bibliography rather than a comprehensive treatment of the subject. McCaghy and Neal (1974) described several aspects of cockfighting but focused on the justifications used by cockfighters (cockers) in morally defending their participation in a sport largely condemned by the larger society. Geertz (1972) described cockfighting as it occurs in Bali and made a lengthy interpretation of its symbolic importance in Balinese culture.

The most extensive research on the sociology and psychology of cockfighting in the United States is the unpublished study of Clifton D. Bryant and the late William C. Capel. Bryant and Capel developed the American Cocker's Survey (ACS) which was designed to measure demographic and psychological characteristics of active participants in cockfighting. One thousand copies of the ACS were distributed through the auspices of Grit and Steel, a magazine for cockers, to randomly selected subscribers. Respondents were guaranteed anonymity, and over 60% of the surveys were returned, a high response rate for this type of study. The results of the

Bryant and Capel study are presented in a later section.

Historic and Popular Accounts of Cockfighting

Popular accounts of cockfighting are numerous. Scott (1957) listed over 70 books pertaining to cockfighting in his bibliography, and Parsons (1969) listed 32 periodicals in the United States alone that were devoted to cocking. Finsterbusch's book, Cockfighting All Over the World (1929) concentrated on the origins of the various strains of game-fowl but included some interesting information on the cross-cultural aspects of the sport. Fitz-Bernard (1921), writing from the British tradition, included a lengthy section on cockfighting. This book also covered other unusual "blood sports" such as dog, camel, and man fights. Scott (1957) concentrated on the history of cockfighting, and is of special interest because of the coverage of the laws banning the sport and the moral issues involved with cockfighting. Scott made the case that the original laws against cockfighting in Great Britian, which were enacted in 1654 and 1835, were legislated not because of sentiment against the cruelty of the sport but to discourage the rowdy behavior of the spectators.

Perhaps the most comprehensive modern account of cockfighting in America is to be found in Rupert's The Art of Cockfighting: A Handbook for Beginners and Old Timers (1949). The book includes information on the history of cockfighting, gamecock breeding and husbandry, preparation for fighting, tips on conditioning and disease control, and a glossary of terms. The book also includes three sets of rules for conducting fights. Pridgen's book, Courage: The Story of Modern Cockfighting (1938) is a popular account of cockfighting and is oriented more towards the non-cocker than the aficionado.

Williford's novel, The Cockfighter (1974), is a fictionalized account of one year in the life of a professional cocker. The book is remarkably accurate in its portrayal of the cultural and technical aspects of cockfighting and has been made into a feature film.

Periodicals

There are currently three major periodicals catering to the cockfighting fraternity, each having a paid circulation of about 6,000 (McCaghy and Neal, 1974): Grit and Steel (\$9 per year) published in Gafney, SC; The Feathered Warrior (\$7 per year) published in DeQueen, ARK; and The Gamecock (\$10 per year) published in Hartford, ARK. These magazines contain articles and columns with information and advice on all aspects of cockfighting. (A series in Grit and Steel by Bryant and Capel reporting the results of the ACS even included an elegant explanation of factor analysis.) In addition, there are advertisements for cockfighting equipment (gaffs, spur saws, scales, carrying cases for roosters, etc.) and curios (belt buckles, auto license plates, wallets, etc. inscribed with pictures of gamecocks). Gamefowl are also advertised with a prime "battle cock" selling for as much as \$150. These magazines appear to serve an important function in maintaining communication between cockers around the country. Titles of recent articles in Grit and Steel include "Histories of Gamefowl," "Meet Our Young Cockers," "Nutrition of the Gamecock," and "How Gamefowl Has Helped My Life."

II. The Cockfighting Subculture

Clifton Bryant and William C. Capel have investigated the social and psychological aspects of cockfighting through the ACS. The following

information is based largely on their work which Dr. Capel made available.

Demographic Variables

Although cockfighting occurs throughout the country, 58% of ACS respondents resided in the Southeast or Southwest. Capel and Bryant found that most ACS respondents reported being raised in rural areas, although 56% indicated that they now live in towns or larger urban areas. The age range of respondents was from less than 15 years old to over 80, with the mean age being 39. The majority of respondents were skilled or semi-skilled blue-collar workers, but 38% held white collar positions. The average education of the cockers was 12 years. Less than 40% had less than an eighth-grade education and 12% had completed college.

Psychological Profiles of Cockers

The ACS included items designed to measure distinctive personality characteristics of cockfighters. Factor analysis was used to define seven factors in the scale: trust-optimism, authoritarianism, cynicism-distrust, fatalism, time urgency, purposelessness, and health optimism. The major finding was that cockfighters showed few differences from other groups from the same cultural background. Capel (personal communication) summarized the findings by saying that the cockers were no different from fans of stockcar racing, a popular southern spectator sport. It is important to note that there was no evidence of pathology in the personality profiles of the cockers. This appears to lay to rest the notion that cockfighters are somehow psychologically "sick." In fact, the groups that cockers differed from most in the personality profiles were heroin addicts and bad credit risks.

Participation in Cockfighting

Cockers tend to be highly involved in the sport. Participants have told me that they would rather fight chickens than do anything else. Bryant and Capel found that 72% of the ACS respondents reported attending fights a few times a month or more. Although there are professional cockers and gamecock breeders, the majority of participants are hobbyists. It was found that although 82% of the ACS respondents raised and fought chickens actively, only 8% reported that they did so as a business. About 8% of respondents reported that they attended fights only as spectators.

When asked why they enjoyed the sport, most cockers said that they were primarily interested in the competitive and husbandry aspects. Only 9% indicated that their interest in cockfighting stemmed primarily from gambling.

Cockers were also asked in the ACS how they had originally become involved in the sport. Most (76%) reported that they had contact with cockfighting when they were growing up. When attending cockfights, one cannot help but be impressed by the presence of young children. Children of cockers often help with the maintenance and conditioning of the roosters, and may aid in the preparation of the cocks prior to the fight. It is not too unusual for 14 or 15 year olds to actually handle the cocks during the fight, and I know of one 14 year old who has a better pit record than the majority of his older colleagues. There is, thus, a socialization process by which youngsters become involved in cockfighting. Bryant and Capel found that 30% of their respondents were 15 or less when they attended their first fight, and only about 6% were over 40 when they attended their first fight.

III. Breeding and Husbandry

Gamecocks

Gamefowl have been selectively bred for thousands of years for aggressiveness and fighting ability, and it has been suggested that chickens were originally domesticated from wild jungle fowl (Gallus sp.) for recreational use (fighting) rather than for food production (Zeuner, 1964). Siegel (1970) has argued that game chickens may have been subjected to selection more against submission than for aggression as a cock that flees from its opponent in the pit is usually killed by its owner.

There are numerous strains of gamefowl having names such as Arkansas Travelers, Clarets, Madigan Greys, Butchers, Allen Roundheads, White Hackles, and many others. Capel (personal communication) recorded the names of over 100 strains of gamecocks. My conversations with Southern gamecock breeders suggest that the purity of the strains is frequently not maintained. Cockers frequently told me that a rooster was, for example, half Claret and half Roundhead. Discussions of various breeding systems can be found in Ruport (1949), Scott (1959), and Finsterbusch (1929).

Although gamebreeders will often interbreed two strains of gamecocks in search of a "gamer" rooster, every attempt is made to keep gamefowl reproductively separate from common domestic strains of chickens. If a gamecock runs in the pit or does not demonstrate bravery (gameness), it is derogatorily called a "dunghill" meaning that it is part commercial chicken.

Selection pressure on gamecocks is intense because of lethal encounters in the pit and artificial selection on the part of the cockfighters.

Each gamecock breeder tries to keep a limited number of "broodcocks." These are cocks which have proven to be skillful and courageous in the pit and are kept solely for breeding purposes. Selection is not as intense on game hens. Some breeders, however, do select for hens that will produce good offspring on the basis of past performances of their progeny. Finsterbusch (1929) said that few breeders give as careful attention to the selection of brood hens as they do their brood cocks, but he said that "gameness, mentality, and fighting disposition are transmitted through the hen "(p. 166) .

There are two age classes of gamecocks. Roosters fought before the age of one year are termed "stags" and are fought in separate matches from older roosters ("cocks"). Cockers say that stags have an advantage over cocks in short matches where speed is important, but that cocks have more stamina and, therefore, an advantage in longer fights.

Housing

The housing given to gamecocks varies with the financial resources of the breeder and his involvement with the sport. Cocks are sometimes kept on "string walks" where they are tethered by one leg by a cord about four feet long to a stake. A shelter of some sort such as an overturned barrel is usually located near the stake so that the bird has access to shade and protection from the weather. More often, however, cocks are kept in separate pens after the age of six to eight months. Some cockers prefer to keep their roosters on "farm walks ." This means leaving a single cock with a farmer to roam at large on his farm. Prior to the onset of the cockfighting season (Thanksgiving to about the 4th of July) the roosters are gathered up for conditioning. The advantage to this system

is that the cock is allowed more exercise during the off season to build his muscles and stamina.

Preparation for Fighting

There are a number of tasks involved in preparing a cock for a fight. If the rooster has never been fought, its comb and wattles must be removed ("trimmed"). This is done by simply cutting them off with shears. This procedure involves surprisingly little bloodshed, and the cocks usually show no sign of discomfort when being trimmed. The comb and wattles are removed so that the opponent will not be able to procure a bill hold on the comb which could help it to spur the cock being grasped. The rooster's natural spurs, which may be several inches long, are also removed by cutting them with a modified hack saw ("spur saw"). A stump about one-half inch long is left which is used to enable the artificial spur to be anchored firmly on the leg.

Some of the cock's feathers may also be removed prior to fighting especially in hot weather. There are several reasons for this. Removal of some of the feathers is said to help cool the animal and reduce overheating. Trimming of feathers also lightens the bird and may enable it to fight against a lighter opponent. Typically, the long feathers of the tail and the wing primaries will be shortened and some plumage removed from the back and around the vent.

Two weeks prior to the fight, the roosters are "put on a keep," a conditioning regime designed to get the bird in peak fighting form. A keep usually involves giving the cock special foods, vitamin supplements, limited water, and special exercises designed to strengthen the animal's muscles. Each cocker has his own keep which may be a well-kept secret and quite

complex. Ruport (1949) lists several typical keeps. Several days before the fight, the animals are usually "sparred." In sparring, two roosters are briefly fought with their spurs covered with thick pads ("muffs") so that the owner can assess how they will fight in the upcoming match.

The final preparation for the fight involves transporting the cocks to the pit. The roosters are transported in specially built carrying cases, and at the pit they are placed in small individual compartments. Each cocker is assigned an individual room in the cockhouse of the pit where he keeps his "entry" of roosters and makes final preparations. It is here that he will weigh and attach the gaffs ("heel") to each cock prior to the fight.

Gaffs

Gaffs are the artificial metal spurs which are attached to the stubbs of the natural spurs of the cock prior to the fight. An interesting discussion of the evolution of the artificial gaff can be found in Finsterbusch (1929). The gaffs favored by most North American cockers resemble a curved ice pick. In the South gaffs $2\frac{1}{4}$ to $2\frac{1}{2}$ inches in length ("long heels") are generally used, while in the North shorter gaffs, $1\frac{1}{4}$ to $1\frac{3}{4}$ inches long, are preferred (Ruport, 1949). Gaffs are usually made of hardened steel and prices range from \$40 to \$60 for a set of two. Typical names for variations in gaff styles are Bayonets, Butchers, and Skeletons. The gaffs are fitted to the feet of the cocks just prior to the beginning of the fight. This process is quite intricate and involves tying the gaffs on the stubbs with leather and waxed string so that they are firmly attached at an optimal angle.

In Latin America and islands in the Pacific a different type of gaff

is used. In these countries a single gaff is attached to the left foot. The gaff is usually longer than in the United States, and the edge as well as the point is sharpened. This type of gaff is appropriately called a "slasher." Slasher fights are uncommon in the United States, at least among the English speaking cockfighting community, although they are sometimes staged as novelty fights.

Types of Fights

There are several types of cockfights which are fought in the United States, some of which are now quite rare. The derby is the most common type of organized cockfight today in the United States, although its origin appears to be relatively modern. In a derby usually between 10 and 30 cockers will enter a preset number of roosters, generally 4, 5, or 6. The cocks that a fighter enters in the derby are called his "entry." The cocker pays an entry fee, frequently \$50 or \$100 which goes into a common pot. The cocks are fought round robin until the cocker who wins the most fights emerges. This individual generally will take home the pot, although sometimes the pot will be divided between the first and second place winners.

The derby is of relatively recent origin probably dating from 1929 (Ruport, 1949). It has been suggested that the emergence of the derby as the dominant form of cockfighting has been responsible for the "democratization" of cockfighting in the United States as it has allowed an individual with a fairly low number of roosters to compete at least several times a year (Capel, personal communication). Some of the other types of fights require each participant to enter far more cocks, making cockfighting in the past largely a rich man's sport. It is of interest to note in this context

that cockfighting is known among devotees as the "Sport of Kings."

Hack fights, sometimes called "brush fights," are informal matches between the roosters of two fighters. Unlike the derby, there is no pot. The participants simply bet that their rooster will beat the other cocker's. Though the fights are informal, there is usually a referee present, and the rules are the same as for other fights. Hack fights are quite popular among modern devotees of the sport.

A main is a fight between only two cockers, each of which enters a fairly large number of cocks, frequently between 9 and 13. As in the derby, the roosters are fought in individual matches until one of the cockfighters has won a majority of the fights. For this reason an odd number of matches comprise a main. Mains are not as common among modern cockers as in the past. They are generally confined to large gamecock breeders who may want to prove the worth of their strain of rooster against a competitor.

The tournament is structured much like the modern derby in that each cocker enters a preset number of roosters also fought in round robin. The difference is that in the tournament each fighter has to enter one cock at each of a number of specified weight classes. This stipulation makes it necessary for each man that enters to have a large number of cocks on hand to "make" each weight. Though the tournament and the main were once the dominant forms of cockfighting, the derby has largely superceded them in popularity.

In the battle royal, a large number of cocks are put together in the pit and allowed to fight until there are only two left which are then fought by the regular rules. Obviously this makes for a rather chaotic situation. The battle royal is uncommon today though it is occasionally staged as a novelty.

The Pit

Cockpits vary in the United States from simple barns to portable pits that can be set up in the woods to elaborate buildings with air conditioning, theater seats, PA systems, and snack bars. In a typical pit in Southern Appalachia there are bleachers with a capacity of 200 or 300 spectators, a refreshment stand, a booth for the score-keepers, and two pits. The "main pit" is where all of the fights are begun and the center of attention of most spectators. The cocks are moved to the "drag pit" if the fight goes more than a few pittings and if there are others waiting to fight. Surrounding the pit area are cockhouses where the roosters are prepared and kept before the fight. There is an admission fee of about \$5 for spectators and cockers. This pays the owner of the pit and expenses such as the fees for the referees. A good referee will make as much as \$100 per day plus expenses at major pits.

Pit Etiquette

Cockfights are often fairly rowdy affairs. The presence of gambling, alcohol, and sometimes weapons makes for a potentially violent situation. Pit operators have developed sets of rules which are designed to reduce the possibility of a serious confrontation between the participants. For example, in many pits there is no drinking of alcoholic beverages allowed in the pit area, and drinking may not be allowed on the grounds at all. There is also social pressure to pay all bets promptly and without altercation. Fights between spectators are surprisingly rare. I have almost never seen serious disputes between cockers handling their roosters in the pit, and a referee's decision is seldom contested. When

fight do occur they are usually dealt with by the ejection of the offending parties from the pit and sometimes their permanent banning from the facilities.

The participants at permanent pits appear to be aware that the law will be less likely to intrude if the fights are well-controlled. Similarly, at least in some areas, the legal authorities are aware that organized cockpits, though technically illegal, offer a place where cockfights can occur with a minimal amount of trouble. My impression is that violence between participants is much more likely to occur in informal hack fights than in the permanent pits. Thus it is in the interest of both the police and the cockers to have a place where cockfighting can occur but where there are strong norms against violence.

Weighing In

Usually a cocker entering a derby will try to arrive at the pit at least several hours prior to the beginning of the fight to allow his roosters to acclimate to new surroundings and recuperate from the journey. If the trip to the pit is long, the cocker may try to have his roosters there several days early. Cockers also try to bring more cocks than they need to fight so that the best can be chosen as the "entry" just before the derby starts. If, for example, a fighter is entering a five-cock derby, he may try to bring nine or ten cocks to the pit and the five that look the best an hour before the fight begins will be entered. The roosters selected to fight will then be weighed, and the cocker will fill out a "weight sheet" for each rooster. These are turned in to the score-keeper who puts a metal numbered band on the leg of each rooster entered. The weight sheets are then used to match up all of the entered roosters by weights. Each cock must be within two ounces in weight of his opponent. If the cocks weigh

over six pounds they are called "shakes" and are not matched for weight.

When it is the cocker's turn to fight, he is instructed to "pick up his weights." At this time he finds out which rooster is to be fought in the upcoming match and who his opponent will be. The cocker then goes back to the cockhouse and heels his cock, a process which may take 15 or 20 minutes. Both contestants bring their cocks to the pit area where they are reweighed and the numbered bands checked to make sure that a different rooster has not been substituted for the one called. In hack fights this procedure is not followed. The contestants simply find someone who wants to fight with a rooster in the same weight class, and the roosters are weighed, heeled, and fought.

The Fight

The actual pit in which the fights are staged usually measures about 15 feet in diameter with a fence about 3 feet high surrounding it, though this may vary from pit to pit. During the fight there are two handlers, the referee, and the two cocks in the pit. The referee's job is to tell the handlers when to fight the roosters, when to pull them apart ("handle"), and time the rest periods. He also keeps the "count" (explained below), and makes sure both handlers abide by the rules. The handlers release and disentangle the cocks at the appropriate times and attend to injuries during rest periods. Rules vary from pit to pit and in different areas of the country. See Ruport (1949) for several sets of rules.

Billing Up: At the beginning of the match, the handlers cradle their roosters in their arms and allow them to peck at each other. This serves to incite the roosters so they will attack.

Pitting: Two parallel lines are drawn by the referee six to eight feet on the pit floor which is usually dirt or clay. The roosters are then

placed by their handlers at their respective score lines and released when the referee gives the command "Pit!" The cocks then fight until the gaffs of one become entangled in the body of the opponent. The referee then stops the pitting with the command "Handle!" The handlers then disentangle the cocks and have a 20 second rest period. The cocks are again pitted at the end of the rest period. This process continues until there is a winner. There is considerable ritual in handling roosters in the pit and in treating animals during the rest intervals. See Ruport (1949) for a discussion of in-fight treatment procedures.

The Count: A fight may be won in three ways: if one of the cocks dies during the fight, if one of the handlers concedes the fight, and through the "count." The count allows a rooster that is not dead to lose a fight if he ceases to attack the opponent by pecking or spurring. If at some point during the match a cock stops attacking for any reason, such as injury, exhaustion, or lack of "gameness," the opposing handler may ask the referee for the count. The referee then begins a count of 10 seconds. If the cock does not attack within the 10 second period, the other rooster has won the pitting and is said to have the count. The cocks are pitted again after a 20 second rest period. If the opponent does not attack for three successive pittings of 10 seconds and one pitting of 20 seconds, he loses the fight.

When one of the roosters does not attack, the cocks are then pitted at the "short score" line for the duration of the fight. At the short score line the roosters are placed behind parallel lines drawn two feet apart instead of the normal six to eight feet, which increases the probability of attack. If the cock who has the count against him (is not attacking) attacks by a peck or a spur, even if it is not directed at the opponent as in the case of a rooster which has been blinded in the fight, the referee

calls "Broke!" This indicates that the count has been broken, and the count begins again. It should be noted that the rules of cockfighting are quite complex and vary from pit to pit. For example in some pits a cock needs a count of three 10 second intervals and a 20 second interval against him to lose the fight, while in others, three 10 second counts will cause the rooster to lose.

Gambling at Cockfights

There are variations in the structure of gambling at cockfights depending on the type of fight (derby or hack fight) and local preferences. Generally there are three ways in which money changes hands at the derbies. As previously discussed, the cocker whose roosters win the most fights in the derby takes home the pot which consists of the entry fees of all of the derby participants. As there may be 30 or 40 entrants in a derby, each paying a \$50 or \$100 entry fee, this can amount to a considerable sum of money. It sometimes happens that two or more entrants will win an equal number of fights. In this case the purse is split among the winners.

A second form of gambling at cockfights involves individual informal bets between the cockers fighting the match and among the spectators. Even in a derby in which the main "money" is the pot, the two opposing cockers in each match will usually agree on a side bet on their own roosters. Spectators also make side bets among themselves. As the cocks are brought into the pit area to be weighed in prior to the onset of the fight, the spectators will begin to call out odds on the cocks which may be accepted by any other spectator. For example, a spectator may shout, "I'll lay a 25 to 20 on the grey." This means that he is offering to bet \$25 against \$20 that the grey cock will win. Someone accepting the bet will usually say something like, "You're on" or simply "You and me." If the grey cock

wins the persons calling out the bet will win \$20 but if the cock is defeated he will lose \$25.

Because it is difficult to make an accurate assessment of a cock's chances of winning simply by looking at it from the stands as it is being weighed, the odds are often based on the reputation of the handler. Betting may continue after the fight begins with the odds shifting as it becomes apparent that one rooster is superior or injured.

Bets are normally paid off soon after each fight, and sometimes bets are paid even before the referee has decided that the fight has officially ended. To someone attending a cockfight for the first time, the betting appears amazingly disorganized. Despite the chaotic appearance of the situation, serious disputes over the payment of bets are quite rare. Though such arguments occasionally occur, there are strong social norms that dictate that bets be paid off promptly and without malice.

At some pits there is a third form of gambling that is only indirectly associated with the fighting of roosters. At these pits there may be a lottery based on the number arbitrarily given to each cocker when he pays his entry fee. Prior to the beginning of the derby, each number will be auctioned off to the highest bidder. The money from the raffle goes into a separate pot, and the person who purchased the number of the winning cocker wins the lottery. For example, if a derby has 15 entrants, the numbers from one to 15 will be auctioned off to the highest bidder before the start of the derby. If entrant number nine wins the derby, the person who has bought that number wins the money in the lottery.

At some pits more traditional forms of gambling such as shooting craps or even pitching pennies is allowed during the sometimes lengthy intervals between fights. As with other aspects of cockfighting there is

local variation. Some pits are very strict about not permitting auxiliary forms of gambling such as lotteries and dice whereas in other pits these activities may be actively encouraged.

Cockfighting and the Law

The laws which pertain to cockfighting are quite diverse. There are laws in 39 states and the District of Columbia which specifically prohibit cockfighting, and the general statutes pertaining to cruelty to animals are interpreted to prohibit the sport in others (McCaghy and Neal, 1974). In six states it appears that cockfights may legally occur (Alabama, Florida, Kansas, Kentucky, New Mexico, and Oklahoma), though there may be some restrictions. For example, in Florida artificial gaffs may not be used legally, nor is gambling permitted. In Kansas, cockfights are barred only on Sunday. Ruport (1949) and Scott (1957) trace the history of laws against cockfighting, and Ruport (1949) summarizes the state laws against cockfighting as of 1949. In 1976 a federal law was passed by the Congress which prohibited the interstate transfer of dogs or chickens for the purpose of fighting. The law provides for fines up to \$5,000 and one year imprisonment for violators. The effect of this law on cockfighting remains to be seen.

In my experience, I found it quite easy to gain admission to cockfights in North Carolina and Tennessee through the sponsorship of area cockers. For the most part aficionados of the sport are eager to discuss their interest in cockfighting and provide information about its many subtleties. They usually do not attempt to conceal their involvement. In many areas of the South one can see teathered or caged cocks openly on display in fields and yards. In general cockers do not feel that the law is a serious

threat or a deterrent to their interests.

This is probably true for several reasons. In rural communities cocking does not appear to be morally condemned even by those citizens who do not participate. It is not perceived as a serious violation of community standards. Also, enforcement of anti-cockfighting laws has relatively low priority for the police.

CHAPTER II

LITERATURE REVIEW: AGONISTIC BEHAVIOR OF CHICKENS

A large number of behavioral studies have used chickens as subjects. A recent review (Wood-Gush, 1971) listed over 250 references on the subject of chicken behavior. There are several excellent surveys of this extensive literature (Fischer, 1975; Guhl and Fischer, 1969; Wood-Gush, 1971). Several specific areas have special relevance to the present study and will, therefore, be reviewed here: behavioral studies of gamecocks, descriptive accounts of the fighting behaviors of chickens, and investigations of the stimuli which are important in mediating fighting and in determining outcome.

I. The Behavior of Gamefowl

The behavior of game strains of chickens has received surprisingly little scientific attention. Fennell (1945) reported the results of observations of gamecocks that he had made some 20 years earlier. His study was quite informal, and the results should be viewed with some caution as his paper is devoid of quantitative information. Fennell said that gamecocks invariably defeated cocks of other strains (Rhode Island Reds, White Leghorns, and Barred Plymouth Rock Hybrids) in paired encounters. He observed "that the games tolerated more punishment, and that they were shiftier, faster, and less clumsy than domestic cocks. Such marked differences in behavior were doubtless dependent on the hereditary background of the cocks" (p. 145). He also reported that the different strains of gamefowl had different methods of attack. Kentucky Dominiques were said to have a high, flying type of attack while Allen Roundheads were

said to have a shifty, ground attack. Fennell also claimed that in paired encounters cocks which had been exercised regularly for several weeks prior to the fight proved to be superior fighters to non-exercised cocks.

Potter (1949) reported the results of an extensive series of experiments in which seven strains of chickens were compared in terms of several measures of inter-strain dominance. Hens of the following strains were used in these tests: Light Brahma, Rhode Island Red, White Wyandotte, White Leghorn, Brown Leghorn, White Cochinchina Bantam, and Brown Red Game. Surprisingly, in light of Fennell's claim that gamecocks always win encounters with the roosters of other strains, Potter found that White Leghorn hens were the most dominant with the games and the Rhode Island Reds about tied for second place. It should be noted that Potter reported that both Rhode Island Reds and White Leghorns were heavier than the games, and that hens rather than cocks were the subjects.

Of special interest is Potter's observation that the fighting behavior of the game hens differed from that of the other strains. The games and the Rhode Island Reds were said to be more persistent in their aggression than the other hens. The games differed from all other strains in that they were never observed to "waltz" (a common behavior in the aggressive and courtship behaviors of chickens in which the animal struts with one wing lowered) in the encounters, and they did not circle their opponents prior to attack. In the game hens, unlike the other birds, attack either occurred immediately or after the hen had stood motionless for up to 2 minutes.

Wiley (1963) studied the ontogeny of behavior in gamecocks from 6 to 13 weeks old. It was noted that during this period males showed more

aggression than females, and that stable dominance hierarchies developed in all-male flocks before all-female flocks (8 weeks of age vs. 11 weeks of age). Strain differences were reported with fighting among male gamecocks reaching a peak at 6 weeks of age and then declining, presumably because of the development of the dominance hierarchy, whereas White Rock males reached a peak in aggressiveness at 8 weeks.

Thompson (1964) demonstrated that the sight of another gamecock was an effective positive reinforcer for fighting cocks. Exposure to a mirror-image did not maintain the (key peck) as effectively as the sight of another rooster. It was also found that cocks would respond more for food and for water than for this type of visual stimulation.

There have been several studies of the physiological differences between gamecocks and the roosters of production strains by Paul Siegel and his associates. Mohapatra and Siegel (1967) reported that blood coagulation times of gamecocks were more rapid than in commercial chickens, and Steeves and Siegel (1968) found that there were differences in the vascular system of gamecocks and White Rocks. The blood vessels were structurally stronger in the games which Steeves and Siegel attributed to the different selection pressures on the strains and the need for gamecocks to have a cardiovascular system which can withstand the high blood pressures which can result from fighting. Harris and Siegel (1967) used radio telemetry to measure physiological parameters during a fight between two gamecocks. Not surprisingly, heart rate was found to correlate with fighting activity with decreases in heart rate accompanying periods in which the cocks were resting. Body temperature was found to increase by about 1 degree (F) during the 15 minute fight. Andrew (1966) noted that testosterone had

similar effects in gamecock chicks and a commercial strain (Hall Sexlink Cross).

II. Descriptions of Agonistic Behavior of Chickens

There are surprisingly few detailed descriptions of the fighting behaviors of chickens in spite of the scores of studies on related topics such as social dominance and the hormonal and genetic correlates of aggression. Wood-Gush (1956) analyzed the 300 paired encounters between over 50 different roosters. He classified the agonistic behaviors into a number of displays (waltz, wing-flapping, tidbitting, preening, and whining calls) and five attack and flight postures (strutting, the high stepping avoidance, the fighting stance, retreating, and full retreat). Wood-Gush proposed that the various displays reflected different degrees of conflict between two incompatible drives: attacking and fleeing.

Kruijt (1964) carefully documented the ontogeny of agonistic and sexual behavior in the Burmese Red Junglefowl (Gallus gallus), a species which is commonly believed to be the progenitor of the domestic chicken and which bears a striking similarity in appearance to game fowl. Rudimentary fighting behaviors emerged quite early. Jumping at other chicks occurred between the 9th and 12th day though kicking was not observed until the 21st day. After three weeks, fighting behaviors began to become ambivalent and incorporate escape patterns and "irrelevant" activities such as ground pecking and head shaking emerged. The development of most adult displays was fairly complete by between 50 and 80 days as the dominance hierarchy became more firmly established.

McBride (1969) described the development of agonistic behaviors of feral chickens. Of special interest are his observations that dominance

fighting would often terminate with the chickens becoming immobile in a standing position. McBride termed this the motionless interaction. He also reported that a fight which resulted in the death of one cock occurred during his observations of penned animals. He stated that such serious fights never occurred in free ranging feral chickens and suggested that the fatality was due to a lack of escape opportunities.

Dawson and Siegel (1967), Guhl (1958), and Guiton (1961) have also described the development of agonistic behavior in chickens.

III. Factors Influencing Fight Outcome

Collias (1943) analyzed the outcomes of 200 paired encounters between White Leghorn hens from different flocks. The order of importance of various factors in determining the winners was absence of moult, comb size, social rank, and weight. Taken together, however, these four factors accounted for only 56% of the variance in fight outcome. Collias suggested that factors such as prior experience at winning or losing, differences in fighting skills, and chance factors such as lucky blows would explain the remaining variability.

Candland, et al. (1969) found that a cock's heart rate increase when first being shown another rooster was predictive of its probability of winning. White Leghorn roosters whose heart rate showed the greatest increase would either fight to a standoff or lose, while cocks having smaller increases in heart rate would either not fight or win.

Marks, Siegel, and Kramer (1960) demonstrated that the presence of a comb was important in mediating dominance in hens by showing that dubbed chickens were subordinant in flocks to undubbed hens. Guhl and Ortman (1953) found that alteration of the head and neck area of chickens was more

disruptive to individual recognition of chickens than other parts of the body. They also reported that comb size was particularly important in influencing dominance status, and it has also been noted that comb type as well as size may influence social rank (Williams, Siegel, and Gross, 1977). Candland (1969) demonstrated that the comb was important in individual recognition. It should be noted that in cockfights the roosters are always dubbed. It is generally claimed that this is to prevent the opposing cock from securing a bill hold on the comb. It is possible, however, that the original reason for dubbing fighting cocks was to help eliminate visual cues which could in part determine fight outcome. It would be of interest to actually fight dubbed and undubbed gamecocks to see how the presence of a comb affects outcome.

Fischer and Hale (1957) used taxidermic models to investigate the role of various stimulus factors in eliciting aggressive and courtship behaviors in male chickens. They found that the sex of the model did not significantly affect the behaviors elicited, and that sexual behaviors were more easily elicited than aggressive behaviors. The position of the model (squatting vs. sitting) was important in determining the response as aggressive behaviors were not directed at squatting models. It was also observed that raised hackles did not necessarily cause aggressive responses. In fact a female model without hackles raised received more aggressive responses than models with raised hackles leading Fischer and Hale to speculate that raised hackles may serve to inhibit fighting.

CHAPTER III

OBSERVATIONS ON THE FIGHTING BEHAVIOR OF GAMECOCKS

Observations were made of the agonistic behavior of gamecocks at organized cockfights. Cockpits were an almost ideal arena in which to conduct behavioral observations as they are well lit, the observations can be made fairly close to the animals, and the encounters are repeatedly staged.

There were, however, some difficulties encountered. For example, it proved impossible to film or take still photographs of the fights at the pits because of the understandable reluctance on the part of some participants to allow themselves to be photographed while partaking in an illegal activity. Some photographs were obtained in fights that were staged expressly for photographic purposes. It would, however, have been useful to obtain more cine photographs of encounters because of the extreme rapidity of the behavior changes during the fights. Other difficulties included distraction from onlookers who were curious as to why one would want to study cockfighting and the blocking of the observer's view of the fights by handlers, referees and spectators surrounding the pit. In general, however, the majority of cockers were quite cooperative and helpful in answering my questions, allowing me to photograph their roosters and in explaining the intricacies of the sport. In the following sections a number of aspects of cockfights and the behavior of gamecocks will be presented and discussed. This includes information on various parameters of the cockfights as well as the observations on the behavior of the roosters.

I. Methods

Over a period of 1½ years approximately 25 organized cockfights were attended at 3 cockpits in North Carolina and Tennessee. In some cases the behavior of the animals was simply observed with no attempt made to record the ongoing behavior. This was particularly true of the initial fights that I attended and in pits where I was not known to the majority of the participants. Eventually at one pit I became well enough acquainted with the regular participants that I was allowed to record observations during the fights. Virtually all of the systematic data reported here was collected at this location. At this pit the fights were held on Saturday nights with the derby usually beginning at about 2200 hrs. On different nights different types of data was obtained. For instance during some derbies data was collected on number of pittings per fight, pit duration, and fight duration, while at other fights the occurrences of immobility postures was recorded.

Most of the data were recorded with a stopwatch and checklist. Attempts to dictate behavioral sequences into a tape recorder proved unsuccessful for the following reason. The pit owner preferred that the tape recorder only be used when observations were made from the scorekeepers booth. Observations from the booth, however, were made difficult by the fact that onlookers often crowded around the pit blocking the view of the cocks. Furthermore, the behavioral sequences during the fights occurred so rapidly as to make accurate dictation difficult.

Several encounters between gamecocks were staged so that films could be made of fighting behavior. In these instances "muffs" (thick pads) were placed over the cocks' natural spurs so as to preclude injury. Two

8mm movie cameras, a Nizo model S 80 and a Minolta Autopack-8, were used to make these films.

II. Ethogram of Fighting Behaviors in Gamecocks

The initial impression that the first time spectator at a cockfight often reports is that the interactions between the roosters are incredibly complex and rapid. The primary impression is one of blurred action. When the contests are slowed through high speed photography, however, patterns emerge and the fights take on an almost choreographed appearance replete with highly synchronized leaps, kick, aerial turns, and feints.

The rate of behavior change in fights varies and in longer fights appears to slow as the animals tire. An analysis of film sequences of staged encounters showed that the rate of change of the fighting behaviors varied between 41.4 per min and 90.2 per min.

A complete analysis of the fighting behaviors of gamecocks is beyond the scope of the present work. However, descriptive information on the fighting behaviors was obtained in the process of analyzing instances of immobility in the filmed sequences. This allowed the construction of an ethogram cataloging commonly observed behavior patterns in fighting gamecocks.

Fighting Behaviors

Spur: leaping into the air from a standing position and kicking the opponent so that the spurs on the legs injure the adversary. Spurring is almost invariably accompanied by wing flapping though the flaps may not always precede the leap. While in the air the cock may make a single blow at the adversary or may make several by moving the feet in rapid alternation (shuffling).

Ground spur: kicking at the opponent while lying on the ground.

Peck spur: a spur which is immediately preceded by a peck. Often a cock will grasp his opponent's hackles by its bill and then spur it. I once observed a rooster which had been blinded in the course of the fight. It could not see the other cock but would peck seemingly at random, and once it made contact and grasped the opponent in its bill it would spur. This demonstrates that the tactile stimulus of the feathers in the bill were a sufficient stimulus for spurring in the absence of visual cues.

Duck: abruptly dropping the head and neck to the ground so as to avoid a spur directed to these regions. This is often accompanied by a raising of the wings. (See wing flash.)

Pull back: pulling the head backwards to avoid being spurred.

Approach: walking toward the opponent. If the opponent also approaches, the head and tail are usually lowered so that they are parallel to the ground and the hackles raised. In this context the wings are often positioned slightly away from the body.

Face: both cocks face each other with the hackles raised and the tail and neck parallel to the ground. It differs from the "approach" in that the animals are not moving toward each other. Occasionally, both will make slight rapid bobbing movements of the head and neck. I suspect that these movements are derived from "tidbitting" (displaced pecking at the ground).

Ground peck (tidbitting): peck directed toward the ground. This behavior was quite infrequent and was only observed in fights when one of the cocks turned away from an injured or immobile opponent and pecked at the floor of the pit.

Wingflash: a brief raising of the wings, sometimes accompanied by

a simultaneous lifting of the tail. Often wing flashes occur after the animals have "faced." In this context it appears to function as a type of feint. The wing flash may also be associated with ducking as an avoidance maneuver.

Head under wing: holding the head under the wing of the other rooster. This was observed in both the filmed fights and during derby fights. The behavior was originally interpreted as being an accidental position. Its fairly frequent occurrence, however, raises the possibility that it may in fact be a "strategy" to allow the cock to rest for a few seconds. In the filmed sequences, the opponent seemed to lose sight of the "hiding" cock and to search for it visually.

Fleeing: running from the opponent. This behavior was rare in fights at pits, but occurred fairly commonly in the fights that were staged for photographic purposes. This suggests that cocks are more likely to show overt flight in situations in which escape opportunities are present.

Immobility: lying on the ground relatively motionless.

Vocalizations

Vocalizations are important in the communication system of chickens, and they have a large vocal repertoire (see the review by Wood-Gush, 1971). It is therefore surprising that vocalizations are emitted only rarely during cockfights. There were, however, three types of vocalizations heard in fights in the course of the study.

Crowing: almost never occurs during the fights. They are occasionally made before fights during the weighing-in procedure or while the roosters are still in the cockhouse.

Squawking: this vocalization is given by cocks that are actively fleeing an opponent. It is not common but when it occurs it almost

invariably signals that the squawking cock has lost the fight.

Clucking: a sound which resembles the clucking of a hen is occasionally given by cocks between pittings or by a cock that has turned away from its opponent. Its significance is unknown.

Discussion

It is of interest to compare the observations of the fighting behaviors of gamecocks reported here with the fighting behaviors of commercial strains of chickens which have been studied by other researchers. Wood-Gush (1956) described the agonistic displays of Brown Leghorn roosters. The primary difference between the fighting behaviors of the Brown Leghorns and gamecocks seems to be the noticeable lack of display postures in the gamecocks. For example, waltzing, a commonly described display in both commercial strains of chicken (Wood-Gush, 1956, 1971) and red jungle fowl (Kruijt, 1964), which have both agonistic and courtship functions, was never observed in cockfights.¹ Similarly, tidbitting which is common in commercial strains was only rarely observed in the cockfights though "facing" which may have been derived from tidbitting was fairly common. It is also of interest to note that Potter((1949) observed the head under wing behavior in game hens but not in the hens of other strains.

Displays given in agonistic contexts are often explained in terms of conflicting behavioral tendencies of animals. Wood-Gush (1956), for example, interpreted the agonistic displays of his Brown Leghorn roosters as reflecting the degree of conflict between the tendencies to attack and to flee. If this interpretation is correct, it is not surprising that

¹I did, however, observe waltzing in a gamecock that was being displayed by its owner indicating that the behavior is in their repertoire.

gamecocks, which have been selectively bred for aggressiveness and against submissiveness, show few displays. In these animals there would be little conflict between the tendencies to attack and to flee.

The ontogeny of the fighting behavior has not been investigated as thoroughly in the game strains as in commercial strains of chickens (Andrew, 1966; Dawson and Siegel, 1967; Guhl, 1958) or red jungle fowl (Kruijt, 1964). Informal observations which I have made of 12 to 20 week old game chickens, however, indicate that displays such as tidbitting are common in the interactions of juvenile gamecocks though they are rare in cockfights.

There are other differences in the fighting behaviors of adult gamecocks and juveniles. Spurring is common among young chickens. The opponents, however, almost never actually make contact with their feet, and the spurs themselves do not develop until after the age of 5 or 6 months. Of greater relevance to this study is the observation that the agonistic interactions of younger chickens frequently terminate with both of the animals standing quite still. McBride (1969) described similar behavior in his study of feral chickens.

Several writers on the subject of domestication and behavior have noted that the topography of behavior patterns is fairly resistant to change through domestication, though the threshold and frequency of a response as well as the stimuli which normally elicit it are more easily modified in the domestication process (Hale, 1963; Ratner and Boice, 1975). I suspect that this is true of the influence of domestication on the fighting behaviors of gamecocks. The frequency of "ambivalent" behavior may have been reduced in adult gamecocks through domestication though they appear with greater frequency in the young animals. More detailed observations comparing the behaviors of gamecocks and other strains of chickens would prove interesting

in examining the effects of differing artificial selection on behavior.

III. Fight Parameters

Fight Duration

Fight durations were extremely variable. The median duration of 59 fights was 345 sec ($\bar{X} = 722$ sec, $SD = 804$ sec), and durations ranged from 8 sec to 58 min. Cockers reported that they have observed fights lasting in excess of 2 hours. A histogram of fight durations is presented in Figure 1. These data were also plotted on log probability paper with the cumulative percentage of the frequencies on the ordinate and the top of the frequency intervals on the abscissa. When this was done the data fell along a fairly straight line indicating that it was logarithmically distributed.

Number of Pittings Per Fight

As discussed in Chapter I, each individual fight is composed of a number of discrete "pittings." Each pitting begins when the referee instructs the handlers to release their birds with the command "Pit!" or "Pit them!" and ends when the referee instructs them to "Handle!" their roosters either because their gaffs are entangled or because one of the cocks has not attacked for the 10 sec time limit. As with fight duration, the number of pittings per fight may vary considerably. In 136 fights the number of pittings per fight ranged from 1 to 98. The median number of pittings in these fights was 12 ($\bar{X} = 19$, $SD = 20$). A histogram showing the distribution of the number of pittings is presented in Figure 2.

As with the data on fight duration, the cumulative percentage of number of pittings per fight was plotted on log probability paper. As with fight duration the number of pittings per fight were found to be logarithmically distributed.

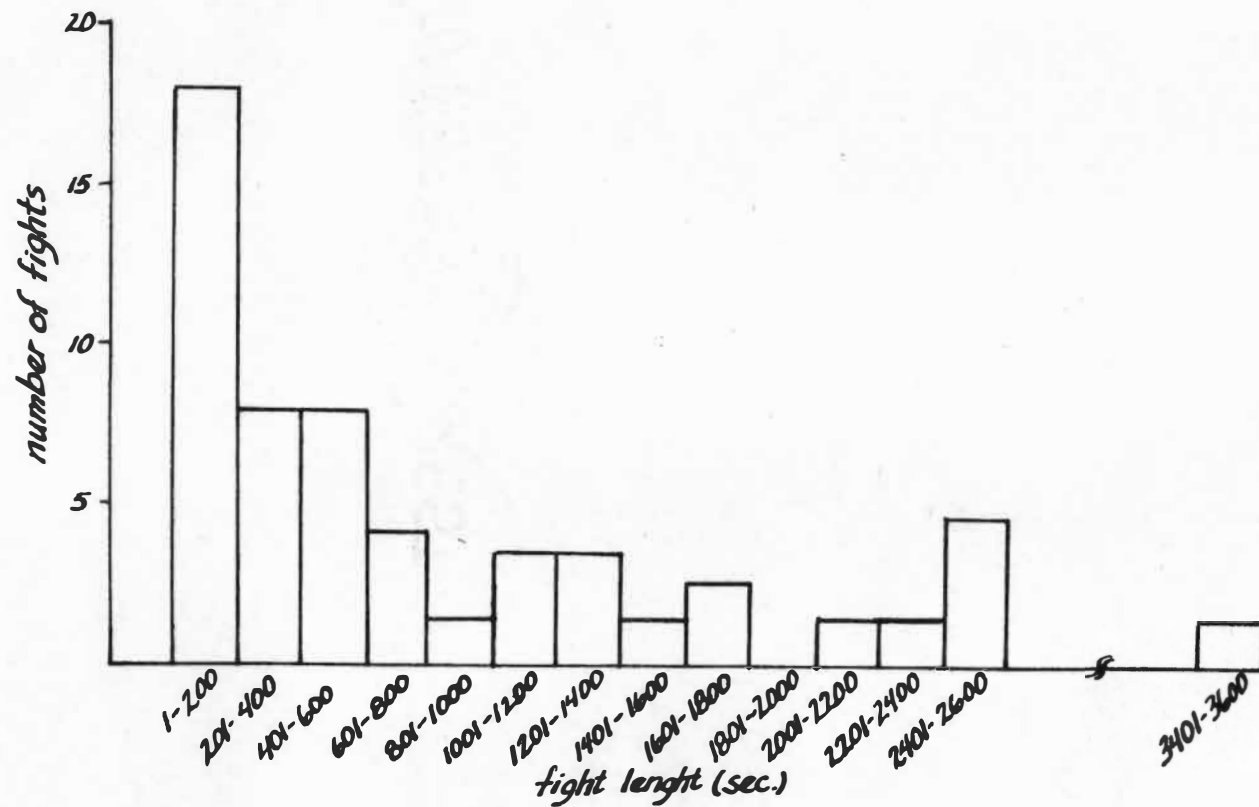


Figure 1. Distribution of total fight lengths. (N = 59 fights).

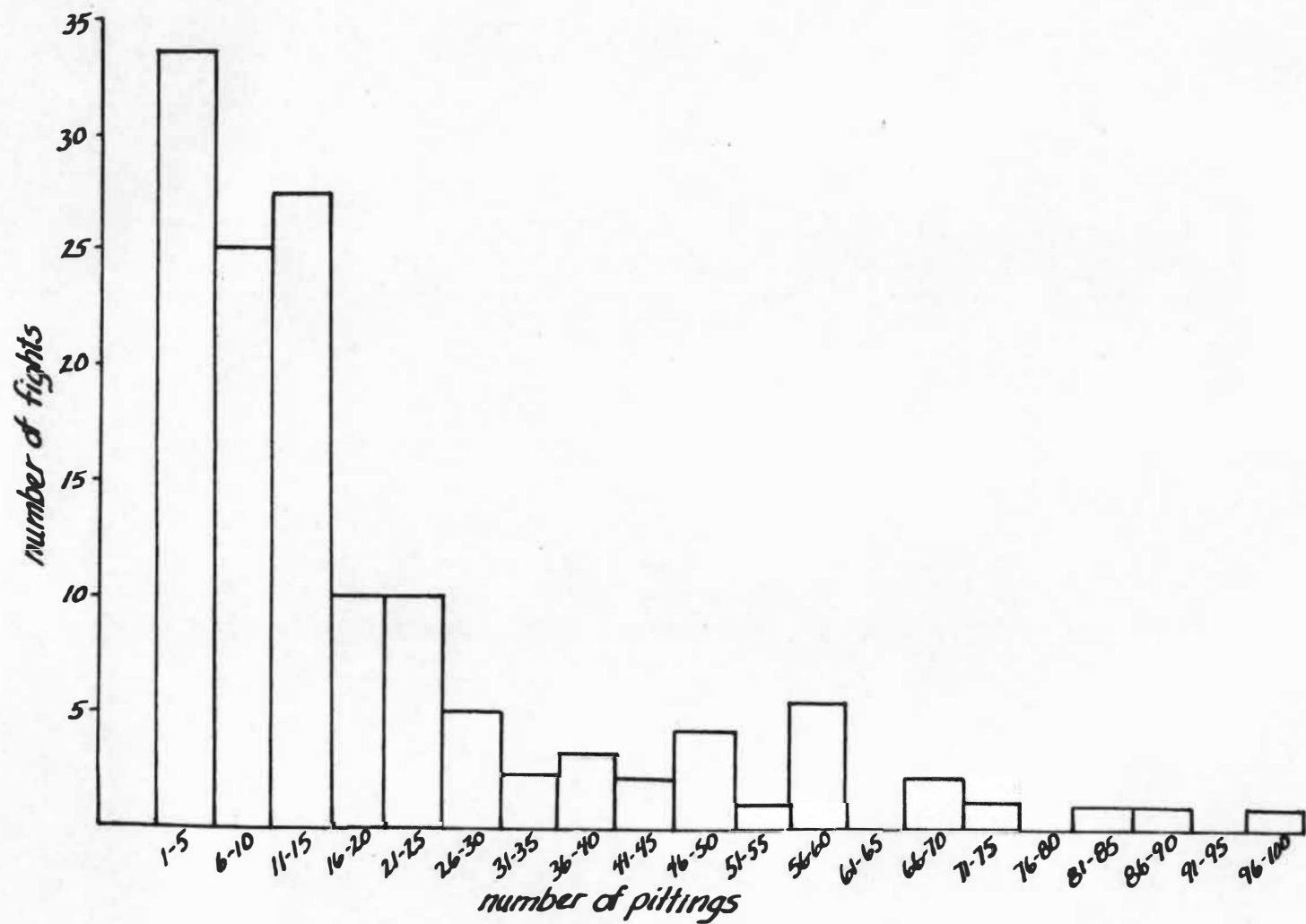


Figure 2. Distribution of the number of pittings per fight in 136 fights.

As expected, the number of pittings in fights was highly correlated with fight duration (Pearson $r = .963$, $P < .001$).

Pitting Duration

Pitting durations tended to be brief, though again, the variability was large. The median pitting duration of 739 pittings from 39 fights was 10 sec ($\bar{X} = 14$ sec, $SD = 12$ sec) with a range of 1 sec to 106 sec. A frequency distribution of pitting durations is shown in Figure 3.

These data were also plotted on log probability paper and as in fight duration and number of pittings were found to lie along a straight line indicating a logarithmic distribution.

Interpitting Rest Interval

Between each pitting there is a rest period in which the handler may rest or try to revive his rooster. In most cases the rest period is 20 sec though in some circumstances a 5 sec rest period is dictated. Although some referees use a stopwatch to insure that the duration of the rest period is accurate many simply estimate the interval. No direct measurements of the rest periods were made in the present study. The average durations of the rest periods could, however, be calculated indirectly by subtracting the sum of the pitting durations for fights from the total fight durations and dividing by the number of rest periods (the number of pittings minus 1). In this manner the mean rest period duration was obtained from 647 rest periods in 20 fights. The mean rest interval was 19.6 sec, remarkably close to the prescribed 20 sec. There was some variability in the mean rest intervals in the different fights which ranged from 8 sec to 33 sec. This is probably due largely to inaccuracies in estimating durations by the various referees.

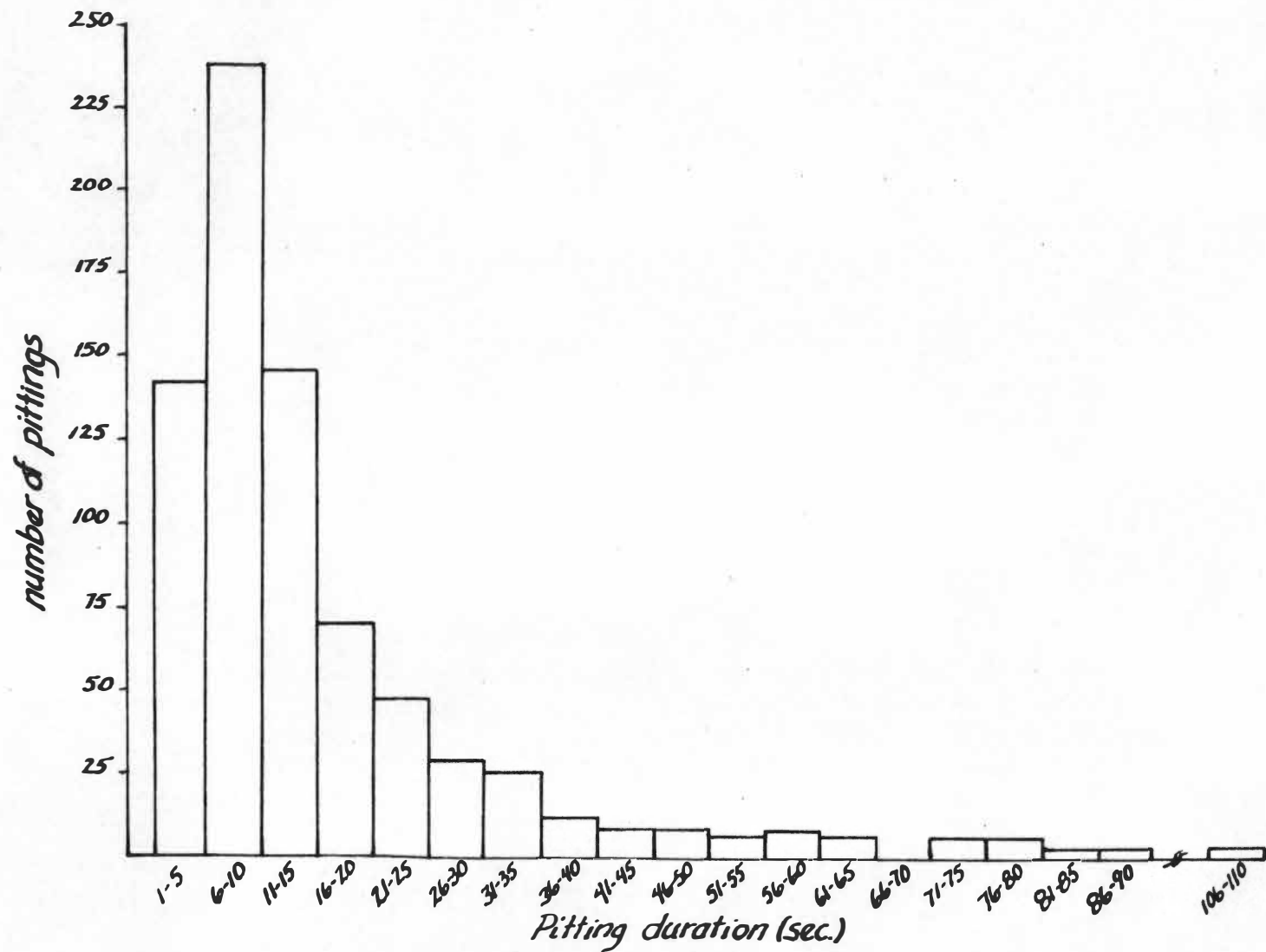


Figure 3. Distribution of pitting duration of 734 pittings.

Percent of Fight Time Spent Fighting

Calculations of the percent of the total fight duration which is actually spent fighting as opposed to the rest periods were also made in 20 fights. The percent of time in pittings ranged from 27-100% (in a case in which the fight was over in 1 pitting). Of the 19 fights having rest periods, an average 42% of the fight duration was spent in pittings while 58% of the time was devoted to rest periods.

Weight

Cockfighters are very much aware that the weight of fighting cocks may affect the outcome of a fight so all roosters are matched for weight prior to the contest. Derby rules specify that cocks should be within 2 oz of each other unless they weigh more than 6 lb. However, roosters are sometimes fought with a 3 or even 4 oz weight difference if a closer match is not available. The roosters are weighed prior to the beginning of the derby so that an opponent can be found within the accepted weight range. This means that the weights recorded on the referee's score sheets will give an estimate of the actual fighting weight as the fight may take place as much as 5 or 6 hours after the original weighing. To prevent the substitution of a heavier rooster or lying about the true weight of a cock, all roosters are reweighed immediately prior to their fight. If a rooster is found to weigh more than the weight specified on the score sheet it is disqualified.

I was able to obtain weights of 146 roosters from the score sheets. The weight data are accurate to within 1 oz, and reflect the weight of the animals at the time of the original weighing rather than during the fight. It is probable that the prefight weight is highly correlated with the fighting weight.

The mean weight of the roosters as obtained from the score sheets was 76.9 oz (SD = 8.0 oz) with a range from 59 oz to 103 oz. A histogram of the distribution of these data is presented in Figure 4 .

Weight and Fight Success

Weight information on 87 fights was compared for closeness of weights of the combatants and the effect of a weight advantage of fight success. This information is summarized in Table 1. Of the 64 fights in which there was a weight difference between the roosters, the heavier cock won 42 while the lighter cock won 22. A Chi^2 test showed this difference to be statistically significant ($\chi^2 = 12.5$, $P = .01$). When the proportion won by the heavier cock was compared for the three weight differences (1 oz, 2 oz, and 3 or more oz) using a Chi^2 test there was no significant difference found ($\chi^2 = .735$).

It could be argued that the weight difference between the two cocks as a percent of their mean body weight would be a more appropriate measure of weight advantage. This was calculated by dividing the weight difference between the cocks by their mean body weight. It might then be expected that in fights in which the heavier cock wins there will be a greater percent body weight difference than in fights in which the lighter cock wins. This was not found to be the case. The mean difference between the cocks as a percent of body weight was 2.07% in the fights in which the heavier cock won and 1.92% in fights in which the lighter cock won. A t-test showed that this difference was not significant ($t = .147$).

The Relation Between Fight Length and Weight

It is possible that the weight of the contestants might be related to

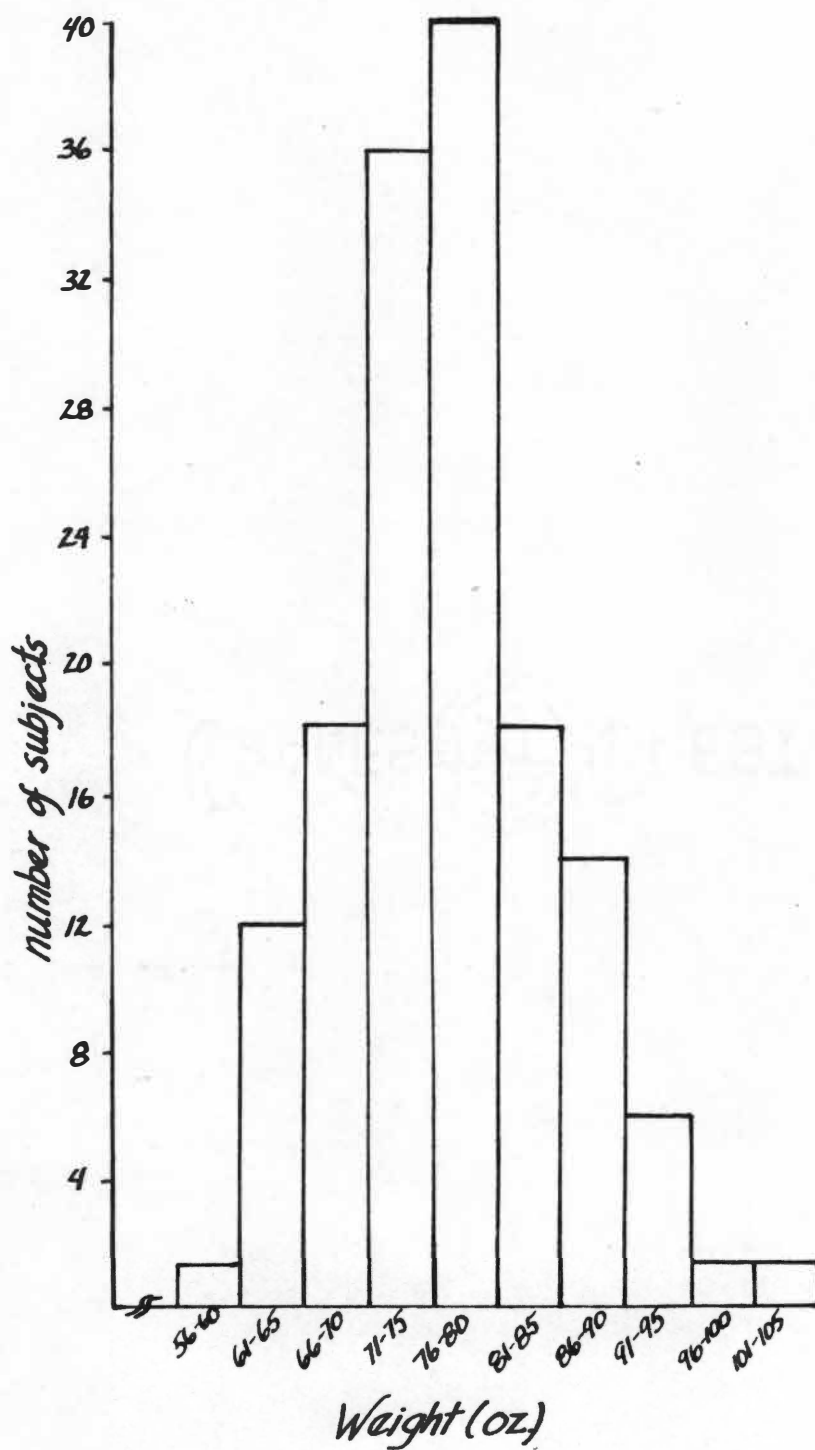


Figure 4. Distribution of weights of 146 roosters prior to fighting.

Table 1. Weight differences between rooster and its relation to fight success

Weight Differences (oz)	N	% of fights	Number of fights won by heavier cocks	% won by heavier cock
0	23	26.4	N/A	
1	39	44.9	24	61.5
2	19	21.8	14	73.7
3	6	6.9	4	66.7

the fight length. To assess this possibility, the correlation between the number of pittings and the mean weight of the opponents was calculated for 72 fights. A slight but statistically significant correlation was found ($r = .309$, $P < .01$).

Survivorship in Fights

Because of the use of artificial spurs and the lack of escape opportunities during fights, cockfights frequently have lethal outcomes. To obtain data on the relative chance of survival of winners and losers, several cockers were asked to keep records on how winning and losing roosters ultimately fared. In this manner, survivorship data was obtained in 66 fights from 11 derbies and 2 hack fights. The outcomes are shown in Table 2. Of the 66 fights, my informants won 36, lost 27, and tied 3. There was a considerable difference in the chances of survival of winners and losers: 94.4% of the winners survived, while only 22.2% of the losers survived. A χ^2 test showed this difference to be highly significant ($\chi^2 = 31.67$, $P < .001$). As can be seen in Table 2, several of the cocks that lost and survived were not kept by their owner but were given away after the fight. These findings indicate that there is intense selection pressure on fighting cocks in the pit.

IV. Immobility Responses in Cockfights

After observations were made at several fights it became evident that a behavioral response quite similar to tonic immobility (TI) as induced by manual restraint in laboratory studies frequently occurred in the encounters. The response was characterized by an abrupt cessation of movement frequently with the animal lying on its back or side. The fact that the cocks appeared quite normal when lifted from the position of immobility

Table 2. Summary of the survivorship of winning and losing roosters in cockfights

Source	Number fought	Won		Lost		Tied	
		Lived	Died	Lived	Died	Lived	Died
RS	11	10			1 ¹		
EY	5	1		2 ²	1		1
EY	4	3		1			
JB	4		1		2	1 ³	
EY	4	3			1		
JB	4	1		1	2		
WR	8	2		1 ⁴	5		
RS	5	4				1	
RS	3	1			2		
JC	4	4					
JB	3	1			2		
WR	7	3	1		3		
EY	4	1		1	2		
TOTAL	66	34	2	6	21	2	1

¹Ran in the pit and was killed by the owner.

²Both were given away after the fight.

³Sold for \$5.00 after the fight.

⁴Given away after the fight.

by the handler indicated that the response was not due to simple fatigue or injury. Often it was observed that the opposing rooster would not take the obvious opportunity to attack its immobile opponent with its gaffs, though sometimes this was observed. More frequently the opposing cock would turn away from the immobile cock or peck at its head and neck, attacks which are generally not injurious.

Systematic observations of this phenomenon were made because of its topographic similarity to TI. The primary method was to record each incidence of the response in the pittings of successive fights. I would record whether or not the immobility response occurred in each pitting of a given fight. When the fight was over I would then begin to observe the next fight. Thus only one fight was observed at a time. This was necessary as there was often more than one fight in progress at any one time at the pit. In this manner data were obtained on the frequency, topography, and duration of the response. The immobility response was also exhibited in two filmed fights allowing an analysis of its effect on the behavior of the opponent.

Definition and Scoring Techniques

The immobility response in the cockfights was difficult to operationally define because of the problems of distinguishing the immobility response per se from lack of movement to other reasons such as injury. For scoring purposes the response was considered to have occurred when there was a relatively abrupt lack of movement in an otherwise active animal that did not show signs of injury. Though this description of the response is somewhat imprecise, the interrater reliability data (p.48) indicated that independent observers could use it with a sufficient degree of agreement. The description excluded the scoring of the response in an injured animal even

if the observer judged that the response did in fact occur. Observers were also instructed that if they were in doubt as to whether or not to count a response that they should not score it. One way of deducing the presence of an injury was to observe the behavior of the cocks during the inter-pitting rest period and at the onset of each pitting. If the animal appeared to be injured during the rest period (e.g. could not stand upright) or did not attack at the onset of the next pitting, it was assumed that the cock was injured or otherwise incapacitated and subsequent immobility was not scored. If an animal did not attack at the onset of a pitting it was possible that he had been injured during the previous pitting, and thus if immobility had been scored on the previous pitting it was invalidated.

There were several drawbacks to this scoring system. The procedure was quite conservative and probably resulted in underestimating the actual incidence of the response. A more serious drawback was that it did not allow for an accurate assessment of the effect of immobility on fight outcome. This was because injured birds, by the rules of the scoring system, were not scored even if the observer "felt" that the response had indeed occurred. Thus the frequency of the response in losers tends to be underestimated. Despite these disadvantages it was believed that they were compensated by the advantages of a conservative scoring system in which immobility due to injury was excluded.

Reliability

To insure that independent observers could agree on whether or not the immobility response had occurred in a given pitting, interrater reliability measures were made at 3 derbies using 3 different observers over a total of 317 pittings. Two of the observers had never attended a cockfight nor made systematic observations of behavior. The third observer had attended a derby

previously and had extensive experience in observing animal behavior. To arrive at estimates of reliability, two observers (the author and the auxiliary observer) simultaneously scored whether or not the immobility response occurred during each pitting. The scores were not compared until after the fight, and the observers did not discuss the fight during the scoring. The first two auxiliary observers were asked to watch the first several fights in the derbies without making observations to accustom them to the situation and the behavior of the roosters.

Two methods of calculating reliability estimates were used. The first method used the number of pittings in which the two observers agreed on whether or not the response occurred divided by the total number of pittings (percentage agreements). In the case of the present study, however, this measure leads to a spuriously high estimate of reliability because of the relative infrequency of the response. One observer could be paying no attention whatsoever, but if he scored every pitting as not having the response there would be agreement on approximately 85% of the pittings.

For this reason a second measure of reliability was also calculated. In this method, cases in which both observers agreed that the behavior in question did not occur are excluded. Thus the percentage of agreement is derived by dividing the number of pittings in which both observers agreed that the behavior occurred by that number plus the number of disagreements. The obtained percentages of agreements are shown for each observer in Table 3. In the table the numbers under the two minus signs are the number of pittings in which both observers agreed that the behavior did not occur. The numbers under the two plus signs are the number of pittings in which the observers agreed that the behavior did occur. A plus and a minus indicate that the observers disagreed on whether or not the response occurred with the writer

Table 3. Interrater reliability coefficients for observations of immobility responses at pittings at cockfights. See the text for an explanation of the table and methods of calculating reliability coefficients.

Observer	Prior Experience	Number of Pittings				Total number of pittings	Reliability Coefficients	
		--	++	+-	-+		Method 1	Method 2
1	NO	101	6	2	2	111	96.4	60.0
2	NO	75	17	0	7	99	92.9	70.8
3	YES	84	20	1	2	107	97.2	87.0
TOTAL		260	43	3	11	317		

scoring that the behavior occurred and the second observer not scoring the data. A minus and a plus indicate that the observer disagreed in the opposite direction.

Frequency of Occurrence

The presence of the immobility response was scored in 1,528 pittings in 86 fights. The response was found to occur in 33 of the fights (38%) and in 227 of the pittings (15%).

Influence of Fight Length

The data was analyzed to examine the effect of fight length (number of pittings) on the incidence of the response. The median number of pittings per fight of the 86 fights in which the presence of immobility of immobility responses was scored was 11.2. Of the 43 fights having 11 or fewer pittings, only 3 (7%) had any incidence of the immobility response; while of the 43 fights having 12 or more pittings, 29 (67%) had at least one instance of the response. A χ^2 test showed this difference to be statistically significant ($\chi^2 = 31.1$, $P < .001$).

It could be argued that the response was more common in longer fights simply because there were more pittings which would afford more opportunities for the response to occur. An analysis of the proportion of the pittings in which the response occurred argues against such an explanation. Of the fights having 11 or fewer pittings, response occurred in only 4 of 235 pittings (1.7%). In the fights having 12 or more pittings, the response was observed in 233 of 1293 pittings (17%). A χ^2 test showed this difference to be statistically significant ($\chi^2 = 36.8$, $P < .001$).

Response Duration

In the majority of cases the immobility response was terminated

"artificially." That is, the immobile cock or its opponent was no longer attacking so that the pitting was ended under the rules of the "count" (see Chapter I). This made it impossible to obtain accurate measures of the duration of the response as it would occur without interference. Despite this, durations were obtained for 58 immobility responses. The mean duration was 10 sec ($SD = 6$) with a range of from 4 sec to 28 sec. It should be remembered that in most of these cases the response was artificially terminated.

Response Topography

Laboratory induced TI in chickens can occur in a number of positions (Gilman, Marcuse, and Moore, 1950) as is the case with the immobility response observed in gamecocks. The number of instances of the response that were categorized as to the position of the animal was 174. The following categories were used: dorsal position, lying on the back with the feet usually extended in the air; horizontal position, lying on the side usually with the feet extended horizontally; ventral position, lying on the stomach with the feet under the body. In 102 of the cases (58.6%) the cock was in the horizontal position; in 63 of the cases (36.2%) it was in the dorsal position; and in 9 cases (5.2%) it was in the ventral position.

The Effect of Immobility Responses on the Opponent

It was frequently noted that immobility on the part of one cock had an effect on the behavior of its adversary. Several different responses to immobility were observed. Occasionally the opponent would attack the immobile cock with its spurs. However, when these attacks did occur they usually appeared to happen at a lower rate than when the

other cock was not immobile. More often the nonimmobile cock would exhibit one or more of the following behaviors: looking up and around, turning away from the opponent, walking away, or pecking intermittently around the head and neck area of the immobile cock. It should be noted that pecking normally does not result in serious injury. On occasion, both cocks were observed to become immobile simultaneously.

It proved difficult to obtain accurate information about the effect of immobility on the opponent's behavior in the derby fights because of the rapidity of the behaviors. However, films were obtained of eight fights which were staged by cooperative cockers to allow the opportunity to obtain movies. In these fights no artificial gaffs were used on the cocks and the natural spurs had been trimmed so that they were only about $\frac{1}{4}$ inch long. Thus there was little chance of injury being inflicted during the encounters. As in derby fights these encounters were broken into segments of between about 10 sec and 1 min, and the animals were allowed to rest in between "pittings."

Immobility responses occurred in 2 of the 8 filmed fights: in 2 of 6 pittings in 1 fight and in 4 of 14 pittings in the other fight. In both fights only one of the animals became immobile. This allowed the rate of attack (spurs) directed at the cock that became immobile to be compared during immobility and when the same cock was not immobile. These data are shown in Table 4.

In both fights the rate of spurring is considerably lower during the immobility response. When the data from the two fights are combined, the rate of attacks received by the immobile cock is almost $\frac{1}{5}$ that of when the same animal is not immobile. Conclusions from these data should be reached with caution due to the small number of observations. However, they

Table 4. Results of analysis of two filmed fights showing the effect of immobility on the rate of spurs directed at a fighting cock

Fight	No immobility			Immobility		
	Duration	Number of spurs	Rate (spurs/min)	Duration	Number of spurs	Rate (spurs/min)
1	59	28	28.2	40	7	10.2
2	269	79	17.4	98	2	1.2
Total	328	107	19.8	138	9	4.2

provide some support for the impression gained in the derby fights that immobile cocks are subjected to fewer attacks.

Discussion

Is the immobility response observed in cockfights the same phenomenon as TI? The responses are topographically similar and six of nine characteristics of TI listed by Gallup and Masser (1977) are clearly present in gamecock immobility responses - rapid onset, muscular rigidity, hypnotic gaze, lack of responsiveness, no loss of consciousness, and defensive reaction upon termination. Two other criteria, waxy flexibility and Parkinsonian-like tremors may be present but difficult to detect in cockfights. The last of Gallup and Masser's criteria, occasional fatality, is extremely uncommon in laboratory TI studies. One case of death during an immobility episode was observed in a staged cockfight when the animals had virtually no chance of inflicting injury as their natural spurs had been removed and the stubs covered with thick pads. Thus most, if not all, of the diagnostic criteria for TI are also present in the immobility responses as observed in cockfights. The only clear difference between the two responses is that TI is induced in laboratory studies by manual restraint which is not the stimulus inducing the response in gamecocks.

Prestrude (1977) suggested that TI might function in interactions between conspecifics. A number of recent ethological studies have shown that intraspecific agonistic encounters end in the death of one of the participants more often than was previously thought (e.g. Geist, 1971; Schaller, 1972). It is also known that the submissive postures which reduce the probability of attack in intraspecific encounters frequently incorporate immobility. For example, Grant and Mackintosh (1963) reported that frightened guinea pigs freeze in response to approach by aggressive conspecifics, and that rats

sometimes become cataleptic in agonistic encounters and remain so after the opponent has left the area. Lorenz (1952) included a sketch of a turkey in a submissive posture that closely resembles immobility responses observed in cockfights, and noted that the posture was effective in inhibiting attack by a rival. Such observations, along with the observations of immobility responses in fighting cocks reported here, suggest that theories relating TI to predator defense should perhaps be broadened to include agonistic encounters between members of the same species when there is a possibility of lethal outcomes. The theory that TI has evolved solely as a defense against predators and not dangerous conspecifics is not parsimonious and does not fit observations of immobility in intraspecific encounters.

Several speculations on the evolutionary origins of submissive postures and TI are suggested by these observations. First, it is possible that submissive postures that incorporate immobility may have originated via a TI-like response which would reduce the probability of attack by both predators and conspecifics by removing movement cues. Ewer (1968) discussed the possibility that death feigning evolved from appeasement postures, but seemed to doubt this on the basis that death feigning was evoked by interspecific enemies. The present observations suggest that this is not always the case, and more thought needs to be given to the idea that TI and submissive postures may be evolutionarily related.

Second, fatigue and exhaustion, which would be expected to be the result of the fleeing and fighting components of encounters with members of the same or different species, may have been important in the evolution of TI. Morris (1956) suggested that the displays of birds which involve feather postures may have evolved originally from thermoregulatory behaviors. Similarly, a fleeing, fighting animal may collapse simply from

exhaustion. Such a collapse, however, may result in a loss of movement cues, sparing the organism from subsequent attack. Natural selection might be expected to exaggerate the immobility and eventually emancipate it from the original context - exhaustion. (See Brown, 1975 for a discussion of the processes which can lead to the evolution of displays.) Fatigue would be an almost universal physiological process in response to attack and flight and might explain the existence of TI in the diverse taxa in which it occurs. It would be of interest to examine the effects of fatigue on TI in the laboratory, but it may prove difficult to design experiments in which the level of fatigue can be manipulated independently of variables such as fear and arousal.

PART II

COMPARISONS OF THE BEHAVIOR OF GAME, RHODE ISLAND RED, AND WHITE LEGHORN
CHICKS WITH REGARDS TO TONIC IMMOBILITY AND OPEN FIELD BEHAVIOR

CHAPTER IV

TONIC IMMOBILITY

Tonic immobility (TI) or animal hypnosis is a state of relative motionlessness and lack of responsiveness which is usually produced in animals by restraint and/or inversion. The response occurs in many species ranging from invertebrates to primates and has received considerable attention from behavioral scientists and physiologists. Indeed, a recently compiled bibliography which attempted to list all known references to TI (Maser and Gallup, 1977) included over 800 references in nine languages. References to TI date back to the Talmud (Klemm, 1971) although Kirchner's 1646 reference or Schwenter's 1636 reference to "bewitching" in fowl is usually credited as being the first published account of TI (Gilman and Marcuse, 1949).

There are a number of excellent reviews of TI available (Chertok, 1968; Gallup, 1974; Gilman and Marcuse, 1949; Klemm, 1971; Ratner, 1967; Volgyesi, 1966), and no attempt will be made here to completely review the extensive TI literature. Rather, I will concentrate on four areas of interest: theories of TI, genetic influences, methodological problems inherent in TI experiments, and problems associated with TI terminology.

I. The Problem of Terminology

Maser and Gallup (1977) noted that there were over 30 different labels given to TI and expressed concern over the recent proliferation of such terms. The most common names for the phenomenon include tonic immobility, a term coined in 1923 by Crozier (Hoagland, 1928), death

feigning and animal hypnosis. Less commonly encountered terms include catelepsy, immobility reflex, contact defensive immobility, fright paralysis, rho and many others. Some of these terms such as fright paralysis, animal hypnosis and death feigning imply a theoretical framework for the response, while others such as rho, immobility reflex and tonic immobility are more neutral. (See Gallup, 1974; Klemm, 1971; and Ratner, 1967 for additional synonyms.) I suggest that this lack of consensus on terminology is not trivial but reflects fundamental confusion on what constitutes the phenomenon.

This confusion is reflected in the behavior that different authors accept as TI. Ratner (1967), for example, cited a 1952 paper by Jackson as an example of TI. An examination of Jackson's paper, however, reveals that it simply reported that when giving warning calls robins may remain rigid for several minutes. Few authorities would identify this response as TI, and Masser and Gallup (1977) apparently chose to omit this reference from their comprehensive bibliography. Similarly, Ratner (1967) reported that Crane found "immobility reactions" in 15 species of mantids. He went on to say that "for the purpose of gross description the behavioral characteristic of prolonged immobility for an otherwise very active animal is taken as the defining characteristic of animal hypnosis" (p.554). In a posthumous paper, however, Ratner (1977) excluded all but one of Crane's responses in mantids as examples of TI. This occurred because the defining characteristic of TI was revised by Ratner in the later paper and included three distinct criteria:

1. Immobility occurs after handling or restraint.
2. Immobility is more than momentary and involves a special position.

3. During immobility the animal is less responsive to stimulation.

Several authorities, including Ratner (1967) and Peiper (1963) noted that more than one behavioral phenomena may be included by the term animal hypnosis. Lefebvre and Sabourin (1977) indicated that a number of responses which have in the past been subsumed under the blanket term TI on closer examination have few similarities with the behaviors produced by the classical TI induction methods: inversion and restraint. Their analysis of passive defensive behaviors ("death feigning") as exemplified by the American opossum and the hognosed snake is especially acute. They suggested that passive defense differs from TI in that no physical contact is needed to elicit the response, it is found only in a few isolated species, the response has a species characteristic topography and is frequently accompanied by secondary defensive behaviors such as regurgitation. Lefebvre and Sabourin thus make a convincing case that "death feigning" and TI should not be conceptually lumped together. They make similar cases for several other responses which involve immobility.

Immobility as a behavior can be due to a variety of processes and can occur in diverse contexts. Sleep, serious injury, freezing in response to distant predators, certain submissive postures, responses to cutaneous pressure (which occurs in some species of mammals when a parent transports the young by the nape of the neck and in copulation in response to a neck bite of the male) are all behavioral states having immobility components. In addition, many animals spend much of their time not overtly moving. This is particularly true of certain ectotherms, such as reptiles. Should these responses be distinguished from TI? If so, and I think most researchers would agree that they should, how does one

differentiate those behavioral processes to be included under the rubric TI from those that should not?

Two methods have been used to define TI and some, such as the above mentioned criteria of Ratner (1977), have incorporated both. The first method is to define TI by the procedures used to induce it. This is the operational approach. As the standard method of producing TI in experimental investigations is by inversion and manual restraint TI is defined as the state of immobility which results when an animal is restrained and subsequently released. This type of definition has the advantage of being precise and operational, and is perfectly suitable as long as one's interest in the phenomenon is limited to the confines of the laboratory. As soon as one attempts to relate TI as so defined to the world in which animals live, however, difficulties become apparent.

Ratner (1967) emphasized the necessity of restraint in the induction of TI, but in order to explain apparent instances of TI when no manual restraint was evident, he broadened the meaning of the term restraint to include "entrapment with or without actual tactile pressure on the organism" (p. 564). Ginsburg (1973) invoked the entrapment concept to explain the immobility response that occurs in cobras when confronted by their natural enemy the mongoose before physical contact is initiated. I suggest that this broadens the concept of restraint so as to make it meaningless. It could thus be argued that the freezing response of a rat in an open field maze is an example of TI because the rat is "entrapped" within the confines of the box.

A second method of defining TI is by describing the topography of the response, the most typical characteristics being lack of movement and responsiveness. This type of definition is useful in that it is broad

enough to encompass phenomena observed outside of the laboratory. It may be too broad in that it may not allow for sufficient distinctions between immobility behaviors. Such diverse responses as the temporary rigidity in Jackson's robin while giving the warning call, the "cataleptic" responses observed in rats and guinea pigs in response to loud sounds (Kolpakov, 1977; Miller and Murray, 1966), death feigning in snakes and opossums, and even the immobility which follows withdrawal into the shell by a box turtle could be included in the same category with restraint-induced TI.

There appears to be no simple solution to the problem of defining TI in a manner that will (1) include the phenomena, and only the phenomena, that one intuitively wants to include and (2) be sufficiently flexible to allow its use in studies outside the laboratory. TI may be somewhat analogous to drive in that, despite criticism of it as a unitary concept, it persists because of heuristic value. As with other ill-defined terms, however, it may create more confusion than it resolves. This is particularly true of a concept such as TI which has so many diverse labels.

In regard to the experiments and observations presented here, the term TI will be restricted to manually induced immobility as produced in laboratory experiments. Similar responses observed in natural settings (cockfights) will be labeled simply "immobility responses". It may be argued that this distinction is trivial and creates additional terminological confusion. I feel that it will avoid the premature categorization of responses that has occurred in the past.

II. Theories of Tonic Immobility

Spatial disorientation

In many studies TI is produced by inversion, and several early writers have attempted to account for the response as a reflex due to the spatial disorientation resulting from rapid postural changes (Gilman and Marcuse, 1949). However, the fact that TI can be reliably induced with the subject's body in an upright position (Gilman, Marcuse, and Moore, 1950; Rovee and Luciano, 1973) effectively refutes this notion. In addition, Hoagland (1928) reported that the destruction of the inner ear in lizards did not abolish the response.

Hypnosis

TI originally received the label "animal hypnosis" during the period Mesmer was attracting popular attention with his ideas on "animal magnetism" (Ginsburg 1973). It has been maintained that TI in animals and hypnotic phenomena in humans are related (Hoskovec and Svorad, 1969; Volgyski, 1966) and that TI is a useful experimental model of human hypnosis (Draper and Klemm, 1969). Most current researchers tend to view the similarities between the two processes as superficial, and the hypnosis theory of TI generally has not received much support (Crawford, 1977; Gallup, 1974; Ratner, 1967). Gallup and Masser (1977) have argued that even the name "animal hypnosis" has stood in the way of rigorous investigations of the phenomenon because it "has tended to attract people satisfied with impressionistic data, and it has probably caused reputable scientists to ignore or avoid reference to the phenomenon" (p. 337). They suggest that TI is analogous to catatonia in humans rather than hypnosis.

Sleep

Explanations of TI in terms of sleep have been suggested (Krojanker, 1969; Svorad, 1957). There are several lines of evidence refuting this hypothesis. Though Ratner (1967) reported that EEGs in immobile frogs and guinea pigs resemble sleep patterns, more current research has not supported this similarity. The EEG patterns associated with TI, in fact, may be quite different than in sleep states. Carli (1977) concluded from his study of the EEG patterns associated with TI in rabbits that there is no typical pattern, and that the EEG is related to the animal's activity prior to the induction of TI.

Additional studies have shown that the lack of responsiveness characteristic of TI is not due to a lack of sensory processing, but is the result of efferent inhibition. Gallup (1974) stated that "animals appear able to receive, associate, process, store, and retrieve information during tonic immobility " (p.844). This also refutes the sleep hypothesis of TI.

Cerebral inhibition

This theory proposes that TI results from an inhibition of the cerebral cortex by lower brain stem centers. Originally suggested by Pavlov, the theory does have modern proponents (Prestrude and Crawford, 1970; Prestrude, 1977). A related theory is Klemm's (1971) model of TI in which the cortex is viewed as suppressing immobility control centers in the brain stem reticulum. Several lines of evidence support the idea of cortical involvement in suppressing TI. These include findings that TI is potentiated in decorticate animals (McGraw and Klemm, 1969), animals in which KCl has been applied to the surface of the cortex (Teschke, Masser, and Gallup, 1975) and in young rats prior to the full development of the neocortex (McGraw

and Klemm, 1969; Prestude, 1977). The fact that TI appears to be inversely correlated with the degree of cortical development in species is taken as evidence of cortical involvement in TI (Klemm, 1977; Prestrude, 1977). Physiological theories of TI which incorporate cortical factors cannot, of course, be applied to the response as it occurs in invertebrates.

Fear

The relationship of fear to immobility is reflected by such colloquial phrases as "scared stiff," "paralyzed with fear," and "frightened to death." The idea that TI is a response to fear dates back about 100 years and is attributed to Preyer (Gilman and Marcuse, 1949). In recent years, the fear hypothesis has been revived largely through the research of Gordon Gallup and his colleagues. Gallup (1977) has reviewed much of the recent literature relating to the relationship of TI and fear.

In general it has been found that in chickens manipulations designed to increase fear increase TI duration. Exposure to shock (Gallup, Creedmore, and Hill, 1970; Gallup, Nash, Potter, and Donegan, 1970; Nash and Gallup, 1975), loud noise (Gallup, Nash, Potter, and Donegan, 1970), suspension over a visual cliff (Gallup and Williamson, 1972), and looming objects (Ginsburg, Braud, and Taylor, 1974) potentiate TI. Conversely, manipulations which reduce fear such as handling and habituation (Gilman, Marcuse, and Moore, 1950; Nash and Gallup, 1976; Ratner and Thompson, 1960) and tranquilizers (Gallup, Nash, and Brown, 1971) tend to reduce TI durations. Correlations have also been reported between TI durations in various strains of chickens and their "emotionality" (Gallup, Ledbetter, and Masser, 1976).

The fear hypothesis has not been free of criticism. Smith and Klemm (1977) and Klemm (1977) cite several findings which seem at variance with

the fear hypothesis. TI for example occurs in rabbits in which the brain stem has been transected so as to inactivate the limbic system which is the neural substrate for fear. They also report that in several species, tranquilizers potentiate rather than attenuate the response. Prestrude (1977) also criticized the fear hypothesis as being too restrictive and ignoring other possible situations in which immobility may occur such as in social interactions between conspecifics.

The fear hypothesis may also be faulted on conceptual grounds. To say that TI is caused by fear is not a particularly enlightening statement. It should in all fairness be noted that Gallup (1974) has acknowledged the conceptual limitations of the fear hypothesis saying "that as an explanatory device fear raises more questions than it answers, but to view tonic immobility as being related to fear provides one of the most powerful predictive frameworks currently available " (p. 842).

Predator defense

Darwin (1891) suggested that TI, which he thought was brought on by the paralyzing effects of fear, had adaptive value in that the immobile animal mimicked death so as to avoid attack by a predator. This hypothesis was criticized on the grounds that it implied conscious intent on the part of the animal. For instance, Gilman and Marcuse (1949) said in regard to this hypothesis, "Criticism can be raised to the possibility of such voluntary behavior being within the intellectual range of subhuman species" (p. 161). However, Ratner (1967) correctly indicated that it is not necessary to assume that the immobile animal has any knowledge or insight as to the effects of the behavior. On the contrary, it is only necessary that animals which become immobile in predatory situations survive and

have a reproductive advantage over nonimmobile animals.

Ratner suggested that TI is the final component in a four-tiered hierarchy of anti-predator behavior strategies with the behavior of prey depending on the distance of the predator. On first perceiving a distant predator, animals freeze so as to minimize their chance of being perceived. If the predator approaches to within a critical distance the animal will flee, and when the distance of the predator approaches zero the animal fights. TI was conceptualized in this theory as the final, last ditch effort by the prey to escape being eaten, and was said to be induced by prolonged physical contact with the predator. Rovee and Hill (1977) revised Ratner's model in several ways. For example, vigilance rather than freezing was said to be the initial strategy of the prey animal.

The predator defense theory of TI is frequently tied to the idea of death feigning. It should, however, be noted that the theory does not hinge on the assumption that the animal is actually mimicking death. As Hoagland (1928) indicated, many predators are apparently unable to visually perceive nonmoving prey. Hoagland found that horned toads (Phrynosoma marmorata) had difficulty capturing nonmoving mealworms (Tenebrio larva). Similarly, Herzog and Burghardt (1974) demonstrated that prey movement was a significant factor in the predatory interactions between young snakes (Coluber constrictor mormon) and crickets (Acheta domestica).

The predator defense theory of TI has also been faulted on the grounds that immobility will usually make it more likely that the prey will be killed and eaten (Prestrude and Crawford, 1970). Anecdotal as well as experimental data, however, show that this is not the case. M. R. Herzog (personal communication) observed a domestic cat attack a beetle of an unknown species.

During the attack the beetle became immobile in a dorsal position. Subsequently the cat soon appeared to lose interest in the insect and turned away. When the beetle was righted by the observer it walked away apparently unharmed. Gallup (1977) reported similar observations in interactions between domestic cats and anoles.

Sargeant and Eberhardt (1975) in a definitive experimental demonstration of the beneficial effects of TI in predatory encounters, presented 50 live ducks of 5 species to red foxes (Vulpes fulva). All of the ducks showed some immobility when attacked ranging in duration from 20 sec to 14 min. More importantly, 29 of the ducks survived the initial capture. It was observed that the immobile ducks appeared alert and often took advantage of escape opportunities.

A number of laboratory studies have also implicated the role of predation in TI. Gallup, Nash, Donegan, and McClure (1971) found that chickens immobilized in the presence of a stuffed hawk had longer durations than controls. It was also reported in this study that placing a hood over the hawk's head or even pieces of tape over its eyes diminished the effectiveness of the model in potentiating TI. Gallup, Nash, and Ellison (1971) found that TI could be greatly prolonged by suspending two artificial eyes over the subject. In these experiments all of the subjects were born and reared in the laboratory and had had no previous experience with predators. This may be taken as a demonstration of the innate character of the response.

In summary, of the six theories which have been proposed to explain TI, two have been discredited (the spatial disorientation and sleep theories) and one has relatively few current supporters (hypnosis). The remaining three (the cortical involvement, fear, and predator defense theories) all

have some supporting data and current proponents. It should be noted that these theories are not mutually exclusive. The cortical inhibition theory is concerned with a physiological explanation of TI. The fear hypothesis deals with the motivational and stimulus control of the response. The predator defense theory attempts to explain the function and evolution of the behavior. It is misleading to conceive of these theories as explaining TI at the same level of analysis.

III. Genetic Influences on TI

There are a number of ways to assess the extent of genetic influence over a particular behavioral trait. These include the study of twins, strain differences, hybrids, and selective breeding for the trait (Alcock, 1975). Two of these techniques, comparisons between strains and selective breeding, have been used to demonstrate the role of genetics in TI.

The first study of genetic factors in TI incorporated both of these methods using rats as subjects. McGraw and Klemm (1973) examined strain differences in TI by testing rats of the standard Tryon strains (maze bright and maze dull). The maze bright rats were found to have longer TI durations and shorter induction times than the maze dull rats. McGraw and Klemm also selectively inbred "susceptible" and "insusceptible" strains of Wistar rats. Significant differences in both induction time and duration of TI were found in the third and forth generations.

Gallup (1974) criticized the McGraw and Klemm study on the grounds that it did not incorporate controls for the effects of the postnatal environment by cross-fostering the rat pups. Gallup undertook a selective breeding study using chickens, a species in which the postnatal environment can be more effectively controlled as they can be raised without parental

care. Gallup bi-directionally selected chickens for long and short TI durations. Large differences were achieved in the F_1 generation. Gallup reported a realized heritability estimate of .59 and .58 respectively for the low and high duration birds. This is an unusually high realized heritability for a behavioral trait, and paradoxically presents problems for the "survival value" theory of TI as traits having high survival value tend to be relatively uniform throughout a population and thus have fairly low genetic variance. To account for the findings of high TI heritability in chickens, Gallup suggested that the domestication process had freed TI from the pressures of natural selection leading to greater variability in the trait via genetic drift. Gallup also reported that there were no differences between the low and high TI birds in the number of inductions needed to induce immobility, and suggested that duration and number of inductions may be unrelated measures of TI.

Benoff and Siegel (1976) examined TI differences in four strains of Japanese quail (Coturnix coturnix japonica) that had been selectively bred for mating ability and a randomly bred control strain. Strain differences were found in the duration of TI and in the percentage of birds becoming immobile on the first trial although the differences were not related to mating ability per se as one of the high and one of the low mating ability strains had the longest TI durations. They suggested, contrary to Gallup, that the additive genetic variation of heritability in TI was relatively small. This supported the notion that at least in Japanese quail TI is a "fitness trait" and has adaptive value.

Several additional studies have shown differences in TI between established strains of chickens. Gallup, Ledbetter, and Masser (1976) compared

four strains of chickens, White Leghorns, Babcock B-390, Production Reds, and Plymouth Rocks, and found that the White Leghorns had much longer TI durations than the other strains. As in Gallup's 1974 study there were no differences found in the number of trials required to induce immobility between the strains. When White Leghorns and Production Reds were interbred the offspring were found to have TI durations intermediate between the parent strains. The authors suggested that the obtained differences in TI were related to differences between the strains in "emotionality." This was supported by data showing differences between the White Leghorns and Production Reds in several open field measures. Nash (1978) replicated the finding of strain differences between White Leghorns and Production Reds in TI duration. Nash and Gallup (1976) found that Production Reds habituated more quickly than White Leghorns to TI induction procedures. Taken together these studies provide strong support for the idea that TI is under genetic influence.

IV. Methodology in TI Studies

The study of TI poses several methodological problems which have been dealt with in different ways in the numerous TI experiments. Questions involving the choice of species, induction methods, and dependent variables will of necessity influence the outcome of the investigation. The effects of parameters such as circadian rhythm and the influence of external stimuli in the testing situation pose problems for the conscientious investigator. It would be difficult to discuss the methodology of every TI study, and in this section studies which are representative of a standard methodology will be presented. Table 5 summarized the TI experimental procedures used in 37 recent TI studies.

Table 5. Summary of experimental procedures in selected TI studies. For dependent variables "D" stand for duration, "x" stands for the percentage of subjects becoming immobile, and "#" stands for the number of trials needed to induce TI

Study	Species	Dependent Variable	Maximum number of Inductions	Induction Time (sec)	Ceiling Time (sec)
Benoff and Siegel (1976)	Japanese quail	D, % showing TI on 1st trial	5	15	
Boren and Gallup(1976)	chickens	D	5	15	
Braud and Ginsburg (1973)	chickens	D, %		15	900
Boice and Williams (1971)	frogs	D		until S stopped stopped moving	1800
Borchelt and Ratner (1973)	bobwhite quail	D, %		15	
Doty (1969)	bobwhite quail	D	2	15	1200
Draper and Klemm (1967)	rabbits	heart rate		15	
Gallup (1972)	chickens	D	5	15	
Gallup (1973)	chickens	D	1	15	
Gallup (1974)	chickens	D	5	15	
Gallup, Cummings, and Nash (1972)	chickens	D	1	15	
Gallup, Ledbetter and Masser (1976)	chickens	#, D, %	5	15	
Gallup, Nash, and Ellison (1971)	chickens	D	1	15	900
Gallup, Nash, Donegan, and McClure (1971)	chickens	D, %, #	5	15	
Gallup, Nash, and Wagner (1971)	chickens D	D	1	5,15,30,60	
Ginsburg (1975)	chickens	D, %		15	
Ginsburg, Braud, and Taylor (1974)	chickens	D, %			
Hennig and Dunlap (1977)	rats	D, %	20	up to 30	

Table 5 (continued)

Study	Species	Dependent Variable	Maximum number of Inductions	Induction Time (sec)	Time (sec)
Hennig, Dunlap and Gallup (1976)	lizards	D, %	as many as necessary	20	
Hatton and Thompson (1975)	chickens	D		15	1800
Kaufman and Rovee-Collier (1978)	chickens	D	1	10	
McGraw and Klemm (1973)	rats	D, Induction time	3	Max. of 600 of attempts	
Masser, Gallup, Thom, and Edson (1975)	chickens	D	5	15	7200
Nash (1978)	chickens	D	1	15	1800
Nash and Gallup (1976)	chickens	D, %	5	15	
Oakley and Plotkin (1975)	rabbits	%, D	3	"released immediately"	
Prestrude and Crawford (1970)	lizards		20		
Ratner and Thompson (1960)	chickens	D;	3	15	240
Rovee, Chiapparelli, and Kaufman (1977)	chickens	D	2	15	
Rovee, Kaufman, and Collier (1976)	chickens	D	2	15	
Rovee, Kaufman, Collier and Kent (1976)	chickens	D, %	2	10	
Rovee and Kleinman (1974)	chickens	D		5	
Rovee and Luciano (1973)	chickens	D, %		5	900
Tortora and Borchelt (1972)	Japanese quail	D, %		10	
Teschke, Masser, and Gallup (1975)	rats	D of 20 trials	20	until TI with a max of 45 sec	
Vestal (1975)	deermice	%, #a		15	

Species

With a few exceptions such as the European wren (Armstrong, 1955) and the black snake (Coluber constrictor constrictor) (Prestrude, 1977) almost every species that has been tested for the presence of TI has proven responsive to some degree. Some species, however, have been more popular than others as subjects in TI experiments. (TI may or may not occur in humans. See Crawford's 1977 paper.)

The domestic chicken (Gallus gallus) has been the most common species in recent TI studies. Different strains have been used by various investigators though the Production Red and White Leghorn strains appear to be the most common. In most studies chickens between the ages of one and four weeks are used presumably because of the ease of maintaining chicks in laboratories. Two other species of gallinaceous birds which have also been used in TI studies are Japanese quail (Benoff and Siegel, 1976) and Bobwhite quail (Borchelt and Ratner, 1973; Doty, 1969; and Tortora and Borchelt, 1972).

Several species of reptiles have been used as subjects including the lizards Iguana iguana (Prestrude, 1977; Prestrude and Crawford, 1970) and Anolis carolinensis (Hennig, Dunlap, and Gallup, 1976). Crawford (1977) and Prestrude (1977) reported TI in several species of snakes.

The most frequently used mammals in TI investigations are rats (McGraw and Klemm, 1973; Prestrude, 1977) and rabbits (Carli, 1977; Klemm, 1977; Ratner, 1958). Hennig (1978) recently reported TI in squirrel monkeys.

There is some difficulty in making comparisons across species in TI. Though certain phenomena associated with TI such as habituation effects seem to be similar in many species (Crawford, 1977), others are not. For example, Masser, Gallup, Hicks, and Edson (1974) found that a tranquilizer, chlorpromazine, decreased TI durations in chickens. Smith and Klemm (1977),

however, reported that it had the opposite effect in rabbits. Similarly, in contrast to chickens which appear to show greater susceptibility to TI in the days following hatching (Rovee and Kleinman, 1974) rats are decreasingly susceptible in the days following birth (Klemm, 1971; Prestrude, 1977). In chickens the optimal period of restraint for TI induction is 15 sec (Gallup, Nash, and Wagner, 1971) but in the rabbit, it is 60 sec (Simovonov and Paikan, 1969) and in the rat it is 30 sec (Ratner, 1967). (See the papers by Crawford, 1977; Prestrude, 1977; Ratner, 1977; and Volgyeski, 1966 for discussions of phylogenetic correlates of TI.)

Induction Techniques

The standard induction technique in TI studies is manual restraint accompanied by inversion. In the majority of recent investigations, 15 sec manual restraint is applied before the animal is gently released, though restraint durations of 5 sec (Rovee and Luciano, 1973; Ternes, 1977), 10 sec (Rovee, Kaufman, Collier, and Kent, 1976; Tortora and Borchelt, 1972), and 20 sec (Hennig, Dunlap, and Gallup 1976) have been reported. In a study of the ontogeny of TI in rabbits, Oakley and Plotkin (1977) induced what was called TI by releasing the subjects immediately in a container containing a bed of sawdust. In a second experiment, the rabbits were subjected to 15 sec of manual restraint at which time they were gradually released over the next 15 sec. Hennig and Dunlap (1977) induced TI in rats by restraining them until immobility was evident or until 30 sec had elapsed.

Several studies have used restraint time needed to induce TI as a measure of the response. Boice and Williams (1971) held frogs (Rana pipiens) in an inverted position until movement ceased with a ceiling time of

180 sec McGraw and Klemm (1973) restrained rats until they became immobile 3 times for a minimum of 4 sec.

In a few studies TI appears not to have been induced by manual restraint at all. Crawford's (1977) investigation of TI in tarantulas (Aphonopelma californica) produced TI by inverting the animals after they had been placed in a closed cylinder. In the same study what was supposedly TI was induced in a fish (Astronotus ocellatus) simply by placing an open hand in front of the animal without touching it. Vestal (1975) reported TI in two species of juvenile deermice (Peromycus sp.) while the animals were covered by a half cylinder of lead in an optokinetic chamber. The same response was said to be produced in adults when the experimenter grasped them firmly by the scruff of the neck and inverted them for 15 sec.

In most TI studies using chickens and lizards the experimental animals are immobilized on a flat surface. In many of the studies using mammalian subjects, however, the animals are tested for immobility in a trough which tends to prolong immobility durations (Carli, 1977; Hennig and Dunlap, 1977; Klemm, 1977; Ratner, 1958).

The maximum number of induction trials allowed each animal also varies from experiment to experiment. In a number of studies the maximum number of trials is not reported, though it may be that the animals were subjected to a single induction trial (Borchelt and Ratner, 1973; Doty, 1969; Ginsburg, 1975). In most TI studies either a single attempt is made to induce TI, or the induction procedure is repeated until the animal becomes immobile with a maximum of 5 trials. There are exceptions. For example, Hennig and Dunlap (1977) allowed a maximum of 20 trials. Rovee, Kaufman, and Collier (1977) and Rovee, Kaufmann, Collier, and Kent (1976) permitted

a maximum of two induction trials. Crawford (1977) allowed six induction trials in his tarantula study. Hennig, Dunlap, and Gallup (1976) reported that their induction procedure with anoles (Anolis carolinensis) was repeated "as many times as necessary in order to produce immobility episodes of at least 10 sec durations " (p. 315).

Measures of TI

Several different dependent variables have been used as measures of TI.

Duration: The most common measure of TI is duration of the response which is usually timed from the moment the animal is released from restraint until it spontaneously regains a standing position. There are exceptions. Salzen (1963) and Doty (1969) measured duration from the beginning of the 15 sec restraint period, and the animal was scored as having a minimum TI duration of 15 sec even if no immobility occurred. In several studies by Rovee and her colleagues, TI duration was measured from 5 sec after the end of the restraint period (Rovee, Kaufman, and Collier, 1977; Rovee, Kaufman, Collier, and Kent, 1976.)

The primary difficulty with duration as a measure of TI is that it can be extremely variable. Chickens may remain immobile for over 9 hours (personal observation). This presents practical problems for the investigator as well as statistical difficulties. There are several possible solutions to the problem of variability of TI durations. One is to reduce the maximum duration of the response. This is most frequently accomplished by the imposition of a ceiling time which puts an upper limit on TI durations. Ceiling times have varied greatly in different studies from as low as 15 sec (Gilman, Marcuse, and Moore, 1950) to as high as 2

hours (Masser, Gallup, Thorn, and Edson, 1975). The most typical ceiling times are 15 min and 30 min. While short ceiling times have the advantage of being convenient for the experimenter who may wish to test many animals in a single session, they may obscure real differences between experimental groups (Gallup, Creedmore, and Hill, 1970).

A second way to limit TI durations to a manageable level is by habituating the subjects to the induction procedure prior to the administration of the experimental conditions (Gallup, Nash, Potter, and Donegan 1970). For example, Gallup, Nash, and Ellison (1971) investigated the effects of the visual presence of artificial eyes on TI durations in chickens. Before the experimental conditions were instituted, all birds were habituated by being given 5 TI inductions per day until they remained immobile for less than 60 sec on the first habituation trial on two consecutive days.

Several methods have also been used to statistically cope with the variability and skewed distributions of TI durations. Prestrude (1977) argued that the mean is often not an accurate representation of TI durations in studies where ceiling times have resulted in badly skewed data. He suggested that the median is more representative in this situation though it cannot be used if less than half of the animals become immobile.

A number of investigators have used mathematical transformations on their data to make it conform to the assumptions of parametric statistics. Kaufman and Rovee-Collier (1978) and Nash (1978) used logarithmic transformations on their TI duration data, and Nash and Gallup (1975) transformed their data by the use of reciprocals of TI durations.

Percent of subjects becoming immobile: The percent of animals susceptible to the TI induction procedure of the experiment is a frequently reported measure of TI (e.g. Braud and Ginsburg, 1973; Prestrude, 1977). Other versions of this measure have also been reported such as the percent of subjects remaining immobile for a given time (Gallup, Nash, Donegan, and McClure, 1971) or the number of animals remaining immobile to the ceiling time (Hatton and Thompson, 1975).

Number of trials needed to induce TI: The mean number of trials to TI induction is sometimes used as a measure of TI susceptibility (e.g. Benoff and Siegel, 1976; Boren and Gallup, 1976; Hennig, Dunlap and Gallup, 1976). However, Gallup (1974) and Gallup, Ledbetter, and Masser (1976) reported that differences found between groups in TI durations were not reflected by the number of trials needed to induce the response. In the later study, it was suggested that the measures of TI duration and susceptibility, as measured by the number of inductions needed to induce the response, may be independent measures of TI.

Time to induce TI: Several studies have used the duration of restraint necessary to produce TI as a dependent variable (Boice and Williams, 1971; McGraw and Klemm, 1973). As Gallup (1974) has indicated, this has the disadvantage of being difficult to employ objectively as manual restraint must be released in order to judge whether the animal is in fact immobile.

Effects of Circadian Rhythms

A number of recent studies have produced evidence of marked periodicity in TI in rats (Hennig and Dunlap, 1977), anoles (Hennig and

Dunlap, 1978), toads (Bufo marinus) and tarantulas (Cyrtopholis portoricae) (Ternes, 1977), and chickens (Rovee, Chiapparelli, and Kaufman, 1977; Rovee, Kaufman, and Collier, 1976). Few researchers, however, have reported explicit controls for circadian effects in TI experiments.

There are several ways to control for the periodicity of TI, and they involve distributing circadian effects across experimental groups. One way is to match subjects in each experimental group in terms of the time of day of testing. Thus for each subject tested at nine o'clock in Group A, a subject would be tested at the same time on a different day in Group B. Practically, this has the disadvantage of requiring the institution of a ceiling time and it may involve wasting time waiting for the next test time to arrive. For example, if the experimenter decides to test animals each half hour, he must wait that long to test the next animal even if the preceding subject has a very short TI duration.

An alternative way of controlling for the effects of time of day on TI is to alternate either randomly or systematically the order of selection of the test animals. Using this method, no ceiling needs to be instituted, and the next animal can be tested immediately after the termination of the preceding animal.

Effects of Experimenter Presence and Other Extraneous Stimuli

In the typical TI experiment, the experimenter sits quietly in front of the subject which is usually immobilized on a table top or in a three-sided induction box. Several investigators have reported that the visual presence of an experimenter affects the duration of the response (Gallup, Cummins, and Nash, 1972; Nash, 1977). In the Nash study, it was found that it was the presence of the experimenter during immobility itself, and not during the induction procedure that potentiated TI durations. The Gallup,

Cummings, and Nash study demonstrated that direct eye contact between the subject and the experimenter increases the duration of TI more than if the experimenter keeps his eyes averted.

Many TI experiments have not reported whether or not the experimenter averted his eyes during testing. In some studies, however, it has been reported that the experimenter did avert his eyes during testing (e.g. Benoff and Siegel, 1976; Gallup, 1973), while in others the experimenter purposely maintained direct eye contact with the subjects during testing (e.g. Braud and Ginsburg, 1973; Ginsburg, 1975). Similarly, Gallup, Cummings, and Nash (1972) found that the spatial proximity of the experimenter and subject had a significant effect on TI duration. With this in mind, it is unfortunate that some recent TI experiments have not reported the subject-experimenter distance, or even if the experimenter was in view of the subject (e.g. Hennig and Dunlap, 1977; Oakley and Plotkin, 1977).

A number of investigators have demonstrated the effects of visual stimuli on TI durations. For example, Gallup, Nash, Donegan, and McClure (1971) showed that the visual presence of a stuffed hawk increased TI durations in chickens. On the other hand, that some visual stimuli can decrease TI durations was shown by Doty (1969) who found that bobwhite quail when tested inside a moving optokinetic drum had shorter durations than when tested inside a nonmoving drum.

Hatton and Thompson (1975) investigated the effects of sound level on TI durations and found that moderate intensities (70db) potentiated the response, but that high intensities (90db) caused a startle reaction which terminated TI. Interestingly, at an intermediate level (80db) some animals terminated TI while in others TI was potentiated. Similarly, Ginsburg, Braud, and Taylor (1974) found that sudden presentation of a fear stimulus

(a looming object) terminated the response in less fearful (habituated) chickens, but had no effect on more fearful (non-habituated) chickens. They suggested that the effect of external stimuli may be to prolong TI in fearful subjects, while producing termination in less fearful subjects.

Findings of this nature pose a significant problem for TI researchers. The effects of external stimuli have not been controlled for adequately in most TI studies. A door closing, a conversation, or the sound of experimental animals waiting to be tested in an adjacent room can be expected to have effects on the duration of TI. Fidgeting by the experimenter who is often expected to sit motionless with eyes averted in front of the immobile animal would seem to be inevitable when there is no ceiling time put on TI duration.

It is important to note, especially in light of the studies by Ginsburg, Braud, and Taylor (1974) and Doty (1969) that the effects of extraneous stimuli cannot be assumed to operate equally on all groups of subjects. For example, it is likely that the longer that an animal is immobile the greater the probability of its being exposed to an extraneous stimulus which might potentiate or attenuate the response. Thus the effects of such stimuli may interact with existing differences between groups of subjects producing exaggerated experimental effects. Marginal differences could in fact become statistically significant. Though these effects have been acknowledged by some researchers (e.g. Braud and Ginsburg, 1973) they have rarely been adequately controlled for.

There are ways of controlling for irrelevant stimuli in TI studies. Gallup, Cummings, and Nash (1972) and Nash (1977) observed chicks through a one-way wide angle lens inserted in a plywood barrier which separated subject and experimenter. Kaufman and Rovee-Collier (1978) recorded

immobility durations automatically through the use of photocells. Another way of eliminating extraneous visual cues is through the use of remote video monitors which allow the observation of the subject from an adjacent room. Observations can also be made through a one-way mirror though it is known in chickens that a mirror image can prolong immobility (Gallup, 1972). Various means also exist of minimizing the potential effects of environmental sounds. Doty (1969) tested subjects in a sound-attenuated induction chamber with white noise in the experimental chamber. The use of relatively short ceiling durations would also reduce the differential effect of these stimuli on TI duration. However, as discussed above, this may also result in loss of significant information. Measures of TI, such as trials to induction are probably less influenced by extraneous stimuli than duration.

In conclusion, experimental procedures in which TI duration is measured by an experimenter sitting with eyes averted in front of an immobile subject in a room which is not sound-attenuated may result in unevenly potentiated durations. It is unlikely that this effect will be constant for all animals because individuals or groups which tend toward long durations will have a greater chance of being exposed to outside stimuli. This may result in an exaggeration of experimental effects.

CHAPTER V

EXPERIMENT 1: TONIC IMMOBILITY IN GAME AND COMMERCIAL STRAINS OF CHICKENS

I. Introduction

Although strain differences have been reported in the susceptibility of chickens to TI, game strains have not been included in these comparisons. Several lines of reasoning stemming from the fear hypothesis lead to the prediction that gamecocks should be less prone to immobility than commercial chickens. Virtually all of those who have written on the subject of gamefowl have commented on their apparent bravery and courage. Fennell (1949) reported gamecocks to be invariably dominant over commercial chickens in encounters. (It should be remembered however that Potter (1949) did not find this to be true with hens.) Crawford (1977) reported that in White Leghorns the dominant chicks were less susceptible to immobility than subordinates.¹ Gamecocks, being presumably less fearful and more dominant than other strains, would therefore be less prone to TI.

The observations of immobility in cockfights reported in the preceding chapters lead to the opposite prediction: that game chicks would be more susceptible to immobility because of greater selection pressure for immobility in the pit. In addition, whereas domestic chickens from "factory farms" are largely protected from the pressures of predation in highly managed environments, game chicks are usually allowed to freely roam in poultry yards for at least several months after hatching. During this

¹It should be noted, however, that Crawford used 3 week old chicks in this study, while dominance hierarchies usually do not appear until 8 or 9 weeks.

time they are often subjected to fairly intense predation by dogs, cats, foxes, hawks, etc. Several cockers in fact have told me that they prefer not to raise chicks in brooders because they feel that the additional selection pressure of predation enhances the strain, and that it is the strongest chicks that will survive and become "battle cocks."

Professional poultry farmers, on the other hand, breed in bulk and do as much as possible to protect their chicks from predation. Thus the fact that immobility responses may enhance a cock's chance of survival in the pit, and the fact that game strains are more likely than intensely produced domestic chickens to experience predation where immobility may enhance survival led to the hypothesis that game chicks will be more susceptible to TI than commercial chicks. The present experiment was undertaken to test this hypothesis using gamecock chicks (GCs) and two strains of chickens which are commonly raised by commercial poultry people, Rhode Island Reds (RIR) and White Leghorns (WL). The RIR strain was originally developed in New England by crossing Red Malay Game, Leghorn, and Asiatic native stock. The WL strain is an older breed which originated in Europe (American Poultry Association, 1953). WLs are said to be a "flighty" strain while RIRs are reported to be "docile" (Joseph M. Mauldin, personal communication). Gallup, Ledbetter, and Masser (1976) refer to WLs as "emotional" and RIRs as "unemotional."

II. Methods

Subjects

The subjects were 32 RIR chicks, 30 WL chicks, and 32 GC chicks. All were 2 weeks of age at the onset of testing. The chicks were hatched in a forced air incubator maintained at 37.8° C and transferred to a commercial brooder in the laboratory at 1 day of age. This was the only time

that the chicks were handled prior to testing. The RIR eggs were procured from Barr's Hatchery (Knoxville, TN); the WL eggs were from the University of Tennessee farm and the GC eggs were donated by Mr. Ralph Spurling of Riceville, TN.

The WLs were hatched on March 1, 1978 and tested on March 15, 1978 and March 16, 1978. The GCs were hatched on April 6, 1978 and tested on April 20, 1978 and April 21, 1978, and the WLs hatched on April 21, 1978 and were tested on May 3, 1978 and May 4, 1978. The chicks were maintained on a 24 hour light schedule throughout the experiment.

Apparatus

Because of problems associated with observer movement and other extraneous environmental stimuli TI was monitored via a remote video system. Testing took place in a small room (1.7m X 2.2m X 2.5m) maintained at 29° C. The animals were immobilized in a three-sided induction box (36cm X 24cm X 24cm). A video camera (Sony model AVC-3400) mounted on a tripod so that the lens was 1.4m distance from the center of the induction box was used to record the trials. It was connected with a video recorder (Sanyo model VTR 1350) in the adjacent room. A video monitor (Sony model TV 115) also in the adjacent room was used by the experimenter to observe the state of the subject. TI durations were recorded on a Time and Date Generator (Javelin model J312T) which projected the immobility times onto the video monitor. A "gray" noise generator¹ was on at all times during the trials to mask environmental sounds. The noise was measured at 83 db (A weighted) in the center of the room with the meter oriented toward the ceiling.

¹Manufactured by David Murray for this experiment.

Each chick was removed from the brooder and moved in a cardboard transporting box (14cm X 14cm X 14cm) to the testing room which was located across the hall. The chick was then removed from the transport box and placed in the induction box. The chick was grasped with both hands around the body and legs and held on its left side on the floor of the box. This was done in such a way that it was facing the rear of the box. The chick was held in this position for 15 sec and gently released. If the chick regained an upright position in 5 sec the induction procedure was immediately repeated. If the chick did not remain immobile after 5 induction trials, it was given a duration of 0. During the induction procedure, the experimenter averted his gaze from the chick.

The duration of TI and the number of trials for TI induction was recorded. After each trial, the chick was weighed, banded with a plastic leg band, and replaced in the brooder from which it had been taken.

To control for the effects of circadian rhythm the chicks were tested every thirty minutes beginning at 0900 and continuing until 1700 each test day. This necessitated the use of a 25 min ceiling time on all trials.

III. Results

Histograms of the TI durations for each group are presented in Figure 5, and the median duration for each group is shown in Table 6. An examination of the figures shows that the durations were not normally distributed, thus nonparametric statistics were used in the data analysis. A Kruskal-Wallis test showed the strain differences in duration to be significant ($H = 16.60$, $P < .001$). A post hoc multiple comparison designed for use with the Kruskal-Wallis test (Gibbons, 1976) was used to compare

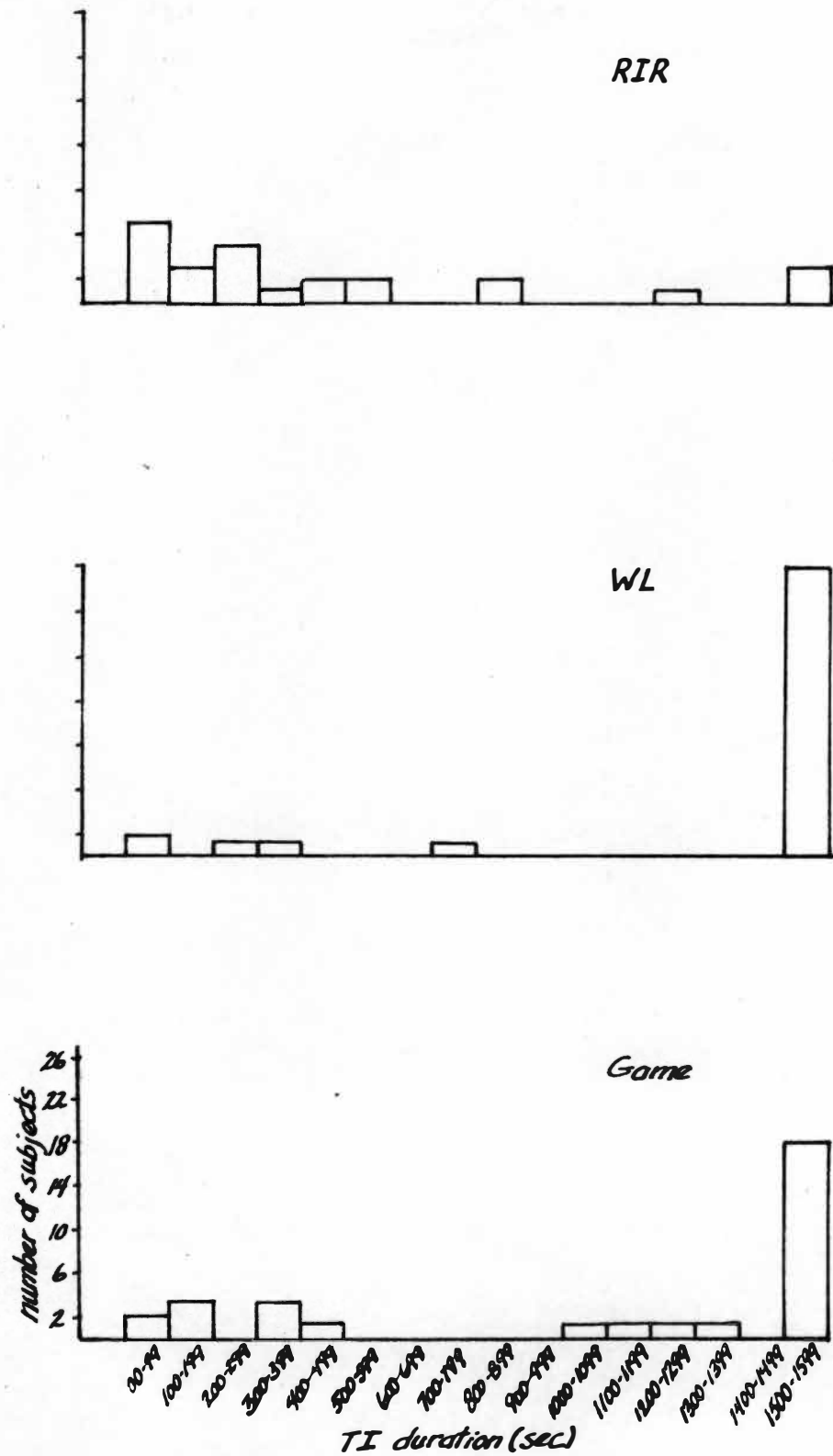


Figure 5. Distributions of TI durations of three strains of chickens using a 1500 sec ceiling time.

Table 6. Median TI duration and number of subjects becoming immobile in the first induction trial in Experiment 1

Strain	Median TI duration	Subjects becoming immobile on first trial:	
		Number	%
RIR	400.5	17	53.1
WL	1440.5	25	83.3
GAME	1416.3	28	87.5

the durations of the three groups using a .05 experiment wise error. This showed that both the GCs and the WLs had significantly longer TI durations than the RIRs, but that they did not differ from each other.

The number of chicks becoming immobile on the first trial was used as an index of the susceptibility of the strains. The number and percentage of animals in each group becoming immobile in the first trial are also presented in Table 6. A χ^2 test showed the differences to be statistically significant ($\chi^2 = 11.68$, $P < .01$) between the three strains in the number of chicks becoming immobile on the first trial.

IV. Discussion

The hypothesis that GC chicks would show greater TI than the other strains was not verified by the experimental results. Although the GCs did have longer TI durations than the RIRs they did not differ from the WLs. The findings of significant strain differences in TI durations between the RIRs and WLs replicated the results of Gallup, Ledbetter, and Masser (1976) and Nash (1978). The finding that there were strain differences in the percentage of subjects becoming immobile in the first trial is interesting. Benoff and Siegel (1976) made similar findings in their study of the influence of genetic factors on TI susceptibility in Japanese quail, and Ratner and Thompson (1960) reported that factors which affected duration also affected susceptibility as measured by the percentage of animals becoming immobile. Gallup (1974) and Gallup, Ledbetter, and Masser (1976) however, found that strain differences in TI duration were not reflected by the number of trials required to induce the response. They interpreted this lack of strain difference susceptibility to the possibility that susceptibility and duration may be independent measures

of TI. In the present experiment, strain differences in susceptibility were found.

Although the results did not support the hypothesis that TI would be more prevalent in the GCs because of greater selection pressure, neither did they support the alternative hypothesis, that GCs would be less susceptible because they are less "fearful" and more aggressive. The results, in fact, indicated that the GCs were more like the supposedly more fearful WLs than the less fearful RIRs. One possible explanation of the results was that the 25 min ceiling duration masked possible differences between the WLs and the GCs. To examine this possibility, a second experiment was undertaken.

CHAPTER VI

EXPERIMENT 2: TONIC IMMOBILITY IN GAME AND COMMERCIAL STRAINS OF CHICKENS

I. Introduction

This experiment was undertaken to replicate Experiment 1 with the following changes in the housing and testing of the animals. Instead of housing and testing each group of subjects separately, the chicks were incubated and housed in mixed strain groups and tested for TI using a longer (120 min) ceiling time. There were several advantages to the procedural changes. There was greater certainty that the early experiences of the subjects were the same because they were housed together. Because of the increased ceiling time, it was anticipated that differences between groups that may have been masked in Experiment 1 might emerge, and a longer ceiling time would allow for meaningful measures of variability. To control for the effects of circadian rhythm in the experiment the chicks were tested in a preset order.

II. Methods

Subjects

The subjects were 29 WL, 27 RIR, and 27 GC chicks. The eggs were obtained from the same sources as in Experiment 1 and were incubated simultaneously in the same incubator. The chicks were maintained in three brooders with roughly equal numbers of each strain in each brooder. Testing began when the chicks were 14 days old.

Procedure

The procedure in Experiment 2 was the same as in Experiment 1 with several exceptions. Chicks were tested in a preset order RIRs, WLs, and GCs, and testing on each day began with a different strain. By this method circadian rhythm effects were spread across groups. A ceiling of 120 min was placed on TI duration. This was necessary because earlier observations had shown that chicks can remain immobile for as long as 9 hours. Even with the ceiling set at 120 min, it was found that many of the subjects remained in the state of immobility for the ceiling duration. Thus testing was by necessity extended over a period of two weeks instead of the two days required to test each group in Experiment 1. The final difference between the experiments was that chicks were not replaced into their original brooder after testing. The last chick in the brooder was not used in the experiment.

III. Results

The median TI durations of the 3 groups are presented in Table 7 . A Kruskal-Wallis H test showed the differences to be statistically significant ($H = 32.7$, $P < .001$). A multiple comparison of the groups (Gibbons, 1976) showed a different pattern than was obtained in Experiment 1. As in the previous experiment the RIRs and the WLs did differ significantly ($P < .05$). The GCs, however, did not differ from the RIRs but were significantly different from the WLs ($P < .05$).

The number and percentage of chicks becoming immobile in the first trial are also shown in Table 7. A χ^2 test indicated that the strain differences in susceptibility to the induction procedure were statistically significant ($\chi^2 = 14.46$, $P < .001$). Distributions of TI durations are presented in Figure 6 .

Table 7. Median TI duration and number of subjects becoming immobile on the first induction trial in Experiment 2

Strain	Median TI duration	Subjects becoming immobile on first trial:	
		Number	%
RIR	440.5	8	29.6
WL	4200.5	22	75.9
GAME	867.2	19	70.4

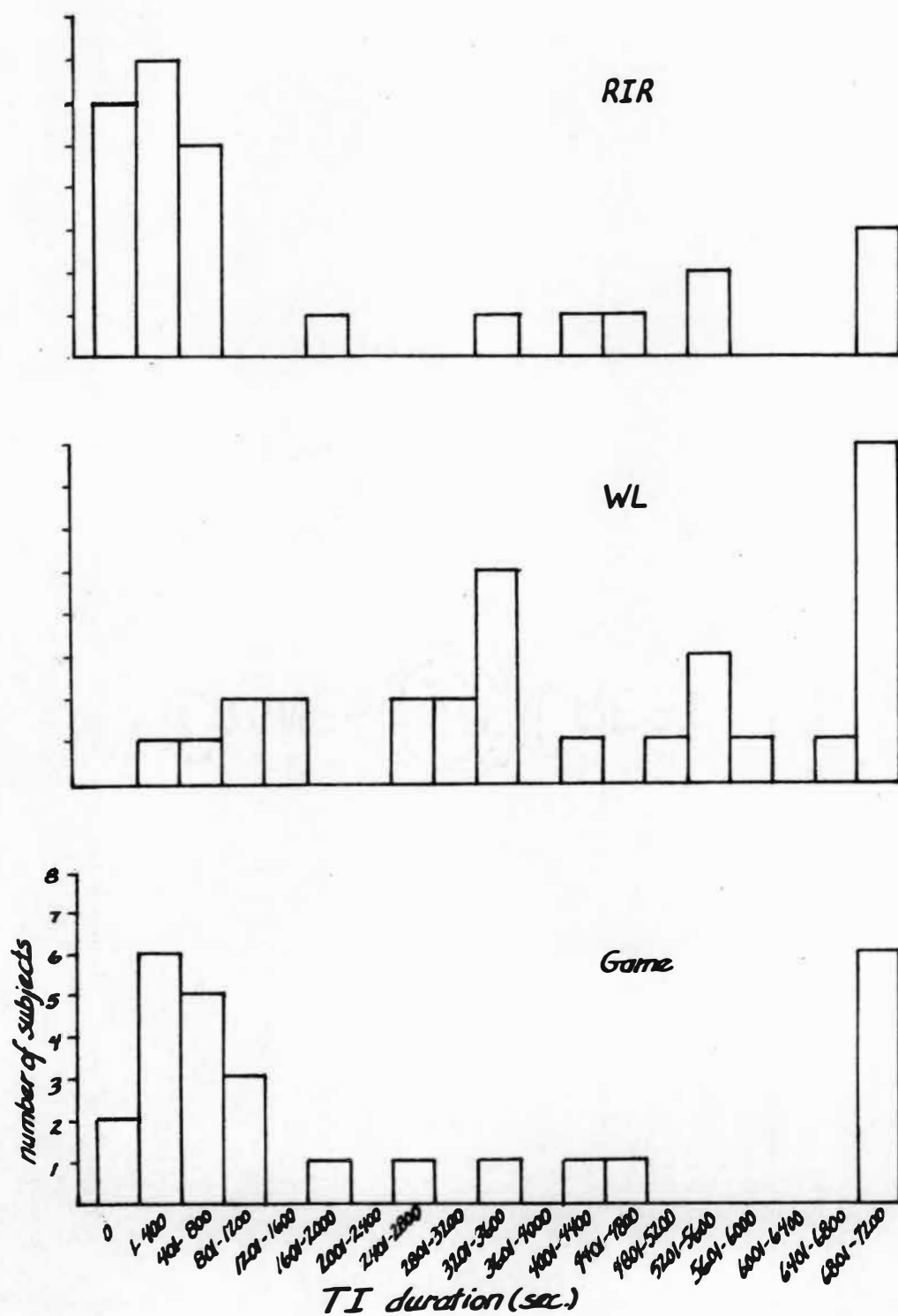


Figure 6. Frequency distribution of TI duration of three strains of chickens using a 7200 sec ceiling time.

IV. Discussion

As in Experiment 1, the results of the present experiment did not support the hypothesis that GCs would be more susceptible to TI than production strains because of greater selection pressure for TI in intra- and inter-specific encounters. Neither, however, was the hypothesis that GC chicks would be less prone to TI because of lessened fear and increased aggressiveness supported. In both experiments the median TI duration of the GCs was between the "emotional" WLs and the "unemotional" RIRs. In the second experiment, however, the median duration for the GCs did not significantly differ from the RIRs, while in the first experiment they were not significantly different from the WLs. The data on the number of chicks becoming immobile in the first trial, however, were consistent in both experiments with GCs and WLs appearing more susceptible to TI than RIRs, but not differing from each other.

CHAPTER VII

EXPERIMENT 3: STRAIN DIFFERENCES IN OPEN-FIELD BEHAVIOR

In the previous experiments GC chicks were found to have TI durations between those of WLs and RIRs though in Experiment 1, the durations were not significantly different between the GCs and the WLs, and in Experiment 2 there was not a significant difference between the GCs and the RIRs. Gallup, Ledbetter, and Masser (1976) reported that strain differences in TI duration between Production Reds and WLs were paralleled by differences in several parameters of open field behavior. They interpreted their findings as differences in the "emotionality" of the two strains. Other studies have also demonstrated the existence of differences between strains of chickens in behavior in the open field situation (Jones, 1977a & b; Murphy, 1977; Phillips and Siegel, 1966).

In light of these findings it was felt that a comparison of the open field behavior of RIRs, WLs, and GCs would be of interest. The "bravery" and "courage" of gamecocks are often alluded to, and open field behavior is often viewed as a measure of fearfulness.

I. Methods

Subjects

The subjects were 5 and 6 day old RIR, WL and GC chicks incubated and hatched as in Experiment 2. The eggs were obtained from the same sources as in Experiment 2. There were 20 chicks of each strain housed together as in Experiment 2. The chicks were housed in mixed strain groups in two commercial brooders with 30 chicks per brooder.

Apparatus

The animals were tested in a standard open field apparatus which consisted of a wooden box 60cm in height and 75cm on each side. The floor was painted white with black lines marking 25 squares 15cm on each side. The sides of the box were painted grey.

The animals being tested were observed remotely with the video system described in Experiment 1. The video camera was suspended from the ceiling 2.5m from the floor of the box allowing an overhead view of the test area. A Uher tape recorder (model 4400) was used to record the trials so that an accurate measure of vocalizations of the subjects could later be obtained.

Procedure

The subject to be tested was placed in a cardboard transport box as in Experiments 1 and 2 and carried to the testing room. It was then placed in the center square of the open field, and the observer quietly left the room, closing the door. The subject's behavior was monitored from the adjacent room via the video monitor and the following information was recorded: latency to leave the center square, ambulation (the number of squares entered during the trial), and number of defecations. The latency to the first peep (distress call) and the total number of calls emitted during the trial were later transcribed from the tape recordings of the trials. Each trial lasted 10 min, and following the end of the trial the chick was weighed and placed in a holding brooder.

All trials were conducted between 1700 and 2400 hours to avoid

normal noises characteristic of the laboratory during work hours. Despite this precaution, loud noises did occur while seven of the animals were being tested (2 WLs, 2 GCs, and 3 RIRs). The data from these animals were not included in the analysis. Following each trial the floor of the open field was wiped with a damp paper towel.

II. Results

The medians, means, and SDs of each variable for the three strains are presented in Table 8. An examination of the data showed that on most of the five variables the scores were not normally distributed nor were the distributions of the scores the same for all of the strains. For these reasons nonparametric statistics were used in the analysis of the data. For each variable a Kruskal-Wallis Test (Gibbons, 1976) was used to examine the presence of strain differences. As such differences were found for each of the variables, a post hoc test designed for use with the Kruskal-Wallis Test was used to allow comparisons to be made between each of the three strains (Gibbons, 1976 pp. 181-192). An overall experiment wise error rate of .05 was chosen as the level of significance of the multiple comparisons. The results are summarized in Table 9. For all of the variables, significant differences were obtained between the RIRs and the WLs. The position of the GCs varied. On some of the variables the GCs were not significantly different from the RIRs, and on some they were not different from the WLs. On each of the variables, however, the GCs had medians intermediate between the two other strains. The results for the various indices are summarized:

Table 8. Medians, means, and standard deviations for dimensions of open field behaviors in three strains of chickens (N = 20 for each group)

Dimension	RIR			WL			GAME		
	Median	$\bar{X}$	SD	Median	$\bar{X}$	SD	Median	$\bar{X}$	SD
Latency to move	275.5	333.5	169.3	570.0	571.2	65.3	555.5	420.1	216.8
Ambulation	35.8	38.3	42.1	2.2	.6	1.5	3.4	12.8	25.3
Latency to peep	39.1	100.9	166.7	538.0	468.2	188.0	50.5	198.3	243.1
Number of peeps	782.8	677.5	340.9	68.7	90.7	166.6	299.5	425.2	411.1
Number of defecations	2.3	1.7	1.3		.4	.6		.8	1.1

Table 9. Summary of results of Kruskal-Wallis Test of overall strain differences in open field behavior and of post hoc individual comparisons. An X indicates a significant difference between strains with an experiment wise error of .05

Dimension	Overall Significance	WLvsRIR	WLvsGame	RIRvsGame
Latency to move	H=12.50(p<.01)	X		
Ambulation	H=15.40(p<.001)	X		X
Latency to peep	H=20.74(p<.001)	X	X	
Number of peeps	H=18.01(p<.001)	X	X	
Number of defecations	H=9.11(p<.02)	X		X

Latency to leave the center square: A significant difference was obtained between the 3 strains ($H = 12.50$, $P < .01$). The post hoc comparison showed that the WLs had greater latencies to leave the center square than the RIRs, but the latencies of the GCs were not significantly different from the other two strains.

Ambulations: A significant overall strain difference was obtained ($H = 15.40$, $P < .001$). Significant differences were found between the RIRs and both of the other strains but not between the GCs and WLs.

Number of peeps: A significant overall difference was found between the strains in number of peeps ($H = 18.01$, $P < .001$). The post hoc comparison indicated that the WLs differed from both the GCs and the RIRs though the RIRs and the Games did not differ.

Peep latency: A significant overall difference between the strains was found in latency to the first peep ($H = 20.70$, $P < .001$), with the WLs differing from both of the other strains. The GCs did not differ significantly from the RIRs.

Number of defecations: An overall difference was found in the number of defecations that occurred during the trials ($H = 9.11$, $P < .02$). The post hoc comparisons indicated that the RIRs defecated more than the GCs and the WLs, but that the GCs and WLs did not differ from each other.

Freezing: Freezing was defined as showing no behavior changes during the trial. That is, the subject did not ambulate, defecate, or peep. Nine of 18 WLs (50.0%), 3 of 18 GCs (16.7%) and 1 of 17 RIRs (5.6%) showed this pattern. A χ^2 Test showed the proportion of subjects showing this pattern in the three strains was significantly different ($\chi^2 = 10.11$, $df = 2$, $P < .01$).

As expected, many of the variables were highly correlated. Table 10 presents the inter-correlation of the five variables. All of these are significant ($P < .001$, $df = 51$).

III. Discussion

The obtained differences between RIR and WLs on the open field variables replicated the findings of Gallup, Ledbetter, and Masser (1976). Differences were also found between these two strains for the two measures of latency to peep and number of peeps which were not recorded in the Gallup, Ledbetter, and Masser study. The GCs fell between the RIRs and the WLs on all of the measures as they did for the duration of TI in the preceding experiments. The pattern of the obtained differences, however, is somewhat problematic. The GCs were significantly different from the WLs but not the RIRs on the vocalization measures but were different from the RIRs and not the WLs on the measures of ambulation and defecation.

The open field behavior of rats has often been interpreted as reflecting the "fear" or "emotionality" of the animal (Murphy and Wood-Gush, 1978). Ambulation (number of squares crossed) was said to be negatively correlated with the level of fear while defecation was taken to be positively correlated with the level of fear. In a recent review of the literature on the open field behavior of rats and mice, however, Archer (1973a) found that much of the experimental data linking fear with the usual open field behavioral variables was equivocal and contradictory, and suggested that in rodents open field measures provide insufficient evidence for a unitary concept of fear.

There have been a number of experiments in which the open field behavior of chickens has been investigated under a variety of conditions.

Table 10. Correlation coefficients between dimensions of open field behavior in chickens. All are statistically significant ($p < .01$, $df = 51$)

	Movement latency	Number of defecations	Number of peeps	Peep latency
Ambulation	-.724	.755	.684	-.466
Latency to move		-.721	-.858	.667
Number of defecations			.706	-.502
Number of peeps				-.778

These studies have produced conflicting results as to the relationships between the various behavioral parameters used as indicators of "fear" such as activity (latency to move and/or number of squares entered), vocalizations, and defecation.

Activity: Virtually all of the studies of chick open field behavior have suggested that activity, usually measured by the number of squares entered, is negatively correlated with the level of fear, emotionality, etc. Archer, 1973 b and c; Candland, Nagy, and Conklyn, 1963; Candland and Nagy, 1969; Faure, 1975; Gallup, Ledbetter, and Masser, 1976; Ginsburg, Braud and Taylor, 1974; Jones, 1977a and b; Phillips and Siegel, 1966). The results of the present study are consistent with the findings of these studies.

Defecation: Candland and Nagy (1969) and Candland, Nagy, and Conklyn (1963) suggested that defecation in the open field situation was positively correlated with fear in chickens, an assumption that is frequently made for rats (Archer, 1973a). More recent work, however, has suggested that defecation is positively correlated with ambulation and therefore is more likely an indicator of decreased fear (Faure, 1975; Gallup, Ledbetter, and Masser, 1976). In two separate studies, Jones (1977a and b) found no differences in the frequency of defecation in experimental and control animals when exposed to a novel environment. The results of the present study in which a fairly high positive correlation was found between defecation and ambulation are consistent with the hypothesis that defecation is a sign of reduced fear in chicks.

Peeping: As with defecation investigators have disagreed about the relation between peeps and fear. The commonly used term "distress call" (Andrew, 1964; Collias and Joos, 1953) implies a close relationship between

the vocalization and fear and positive correlations between the number of peeps and fear have been claimed by some investigators (Andrew, 1964; Archer, 1973b and c; Candland, Nagy, and Conklyn, 1963; Candland and Nagy, 1969; Cummins, et al. 1974; Fullerton, Berryman, Sluckin, 1970). A number of recent investigators, however, have claimed the opposite: that fear suppresses distress calls in chickens (Faure, 1975; Ginsburg, Braud, and Taylor, 1974; Jones, 1977a and b; Montevicchi, Gallup, and Masser, 1973). The presence of strong positive correlations between the number of peeps and ambulation found in the present study lends additional support to this hypothesis.

It should be noted that the notion of "fear" as a measurable entity has been called into question. Murphy (1978) in reviewing the problems of recognizing and measuring fear in chickens suggested that "extreme caution is needed in comparing the effectiveness of different stimuli and the amount of fear or exploration represented by different responses." She also indicated the confused usage of fear as a concept noting that the term has been used to describe responses, stimuli, and motivational states. Purton (1978) has recently discussed the confusion that such a "conflation" of usages of a term can produce.

Murphy's warnings about the conceptual and practical difficulties inherent in the use of fear as an explanatory concept in animal behavior is well taken and researchers interested in "fear" as a determinant of open field behavior or as an explanation of TI may find themselves subject to potentially serious criticisms.

In the present study the GCs were not clearly less "fearful" in the open field than the two commercial strains. In vocal behavior the GCs were similar to the "unemotional" RIRs and were significantly different

from the WLs. In ambulation and defecation on the other hand, the opposite pattern was shown with the GCs being significantly different from the RIRs and not the WLs. In latency to move from the center square, the GCs were intermediate between the two other strains and not significantly different from either.

What conclusions can be drawn from this complex pattern of results? The first is that the fact that GCs have been bred for aggressiveness does not mean that they will be less "emotional" in the open field situation. It is of interest in this respect that Potter (1949) in a series of paired encounters between hens of various strains including GCs, RIRs, and WLs found that WLs were the most successful in winning the encounters. Again, the limitations of the open field as a general measure of "fearfulness" are apparent. GCs are "brave" in cockfights in the sense that they continue to fight even when mortally injured. This is not reflected in their performance in the open field. It should be noted in this regard that comparative studies of the success of roosters of different strains in a situation similar to that of a cockfight has not been carried out. It is conceivable, though unlikely, that WL roosters would do well as fighting cocks.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The observations and experiments reported answer some questions and at the same time suggest new avenues for research. Perhaps the most significant finding of the study is that an immobility response topographically similar to tonic immobility (TI) produced in laboratory studies by manual restraint occurs with some degree of regularity in cockfights. The probable function of the response is suggested by the results of the analysis of filmed gamecock encounters. It was found that an immobile cock was less likely to be attacked by an opponent indicating that the immobility serves as an appeasement display which has the effect of reducing the probability of attack.

It was noted that the response was disproportionately more common in longer fights. This suggests that fatigue and exhaustion may be related to the probability of the occurrence of the response. If this is the case a possible evolutionary connection between fatigue and TI may exist. Animals fighting or fleeing adversaries of the same or of a different species might eventually become exhausted. If an animal then collapsed from this exhaustion, the resulting lack of movement could serve to inhibit further attack as movement is an important stimulus factor in mediating predatory behavior. The animal might survive a potentially lethal encounter because of exhaustion and collapse. It is possible that immobility could in the process of behavioral evolution become "emancipated" from its original status as a byproduct of fatigue and exhaustion. As the processes of fatigue and exhaustion are almost universal in animals, such a scenerio could explain the presence of

immobility behaviors in a wide variety of taxonomic groups.

The observations of immobility in cockfights led to the laboratory experiments on strain differences in TI and open field behavior reported in Part II. Previous research had shown that relatively "emotional" strains of chickens such as White Leghorns (WLs) have longer TI durations than "unemotional" strains such as Production Reds (Gallup, Ledbetter, and Masser 1976). Experiment 1 compared gamecock chicks (GCs) with Rhode Island Reds (RIRs) and WLs on the measures of TI duration and susceptibility. It was found that the GCs had significantly longer TI durations than the RIRs but did not differ from the WLs. The WLs had longer TI durations than the RIRs replicating the study of Gallup, Ledbetter, and Masser (1976). The data on susceptibility as measured by the percent of Ss in each group which became immobile on the first trial reflected the duration findings with the RIRs being less susceptible than the other two strains. The GCs and the WLs did not differ on this dimension.

Experiment 2 was a replication of Experiment 1 using a longer TI ceiling time (7200 sec) and with the subjects reared in mixed strain groups. The data on TI susceptibility was consistent with the findings of the first experiment with the WLs and GCs being more susceptible to the induction procedure than the RIRs. The duration data, however, differed from the results in Experiment 1 in that the GCs did not differ from the RIRs. Both the GCs and the RIRs had shorter TI durations than the WLs.

Experiment 3 was designed to examine possible strain differences in open field behavior, a traditional measure of "fear" or "emotionality." Gamecocks are often referred to as being extraordinarily "brave." In light of this it might be expected that they would differ from the production strains on open field dimensions. However, all of the open field behavioral

variables measured (ambulation, latency to move from the center square, number of peeps, peep latency, and number of defecations) the median score for the GCs was between the so called "emotional" WLs and the "unemotional" RIRs. The GCs were significantly different from the WLs in latency to peep and number of peeps, but were significantly different from the RIRs in ambulation and defecation. The RIRs and WLs differed significantly on all of the variables.

Gamecocks have historically been subjected to different kinds of selection pressures than commercial strains such as RIRs and WLs and have been selectively bred for the characteristics of aggression, lack of submission, stamina, and fighting ability. The commercial strains have been selected for such characteristics as rapid weight gain, high egg production, and lack of broodiness. These differences in selective breeding were not however reflected in any simple way in the experiments presented here. The hypothesis that GCs would be more susceptible than the commercial strains to TI induction procedures because of more intense selection for immobility behaviors both in the pit and in the poultry yard from predation was not supported, and neither was the hypothesis that GCs would be less "fearful" in the open field situation than the commercial strains because they have been bred for "bravery." On the majority of both the open field dimensions and the TI variables the differences between the commercial strains and the GCs were smaller than the differences between the two commercial strains.

It would be of interest to compare the fighting behaviors of the three strains used in these experiments to examine the effects of selection on behavioral dimensions that are perhaps more directly relevant. It would

also be of interest to compare the fighting behaviors of gamecocks to those of red junglefowl to examine the effect of domestication on specific behaviors.

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APPENDIX

GLOSSARY OF COCKFIGHTING TERMS

Battle royal - a fight in which a large number of cocks are simultaneously placed into the pit. This makes for a rather chaotic fight. Battles royal are not common but are sometimes fought as a novelty event using second rate or crippled cocks.

Billing up - this occurs at the onset of a fight when the two roosters are allowed to peck at each other for a short time while being held by their handlers prior to being released.

Brood cock - a cock used solely for breeding purposes. A brood cock is usually a rooster which has proven himself skillful and courageous in the pit.

Brush fight - Usually a hack fight fought informally in a barn, backyard, etc., rather than in an organized pit.

Cock - (also battlecock, acecock) a game rooster over one year old.

Cocker - an individual who breeds, maintains, and fights gamecocks.

Cockhouse - (1) a small out building in which a cocker keeps his roosters two weeks prior to each fight so that they can be given special food and exercise. (2) the facility in a cockpit where the roosters are kept until it is their turn to fight.

Cockpit (pit) - (1) an organized facility for fighting roosters which usually includes seats for spectators, refreshment stands, parking facilities,

cockhouses, etc. (2) the actual area in which the cocks are fought.

This is usually a round, elevated "pit" with a dirt or clay floor surrounded by a low fence.

Derby - a type of fight in which a number of cockers (usually between 10 and 30) enter a preset number of cocks or stags (usually between 4 and 6), which are matched for weight and fought in individual matches. The cocker whose roosters win the most fights wins the derby.

Drag pit - a secondary pit in a cockfighting facility to which an ongoing fight is moved if it appears that it will be lengthy. This allows a new fight to begin in the main pit.

Dunghill - a derogatory term usually applied to roosters who run from their opponent in the pit or otherwise make a poor showing in combat. It implies that the cock is not pure game but has some commercial chicken in its bloodline.

Entry - the set of cocks that a cockfighter enters into a derby or main.

Entry fee - the money that a cocker is required to pay to enter a derby. The money goes into the "pot" which is awarded to the cocker who wins the most matches. A typical entry fee would be \$50 or \$100.

Farm walk - maintaining cocks by allowing them to range freely with hens until it is time to "put them up" prior to the beginning of the cockfighting season. This allows the cocks to get more exercise than if they are maintained in coops in the "off season."

Fly pen - a large cage in which cocks may be placed several weeks prior to

a fight so that they have sufficient room to fly and thus exercise their wing muscles.

Gaffs - the artificial spurs which are attached to the stumps of a cock's natural spurs prior to a fight. They are usually made of steel.

Gameness - bravery, courage. A cock which has proven to be brave in battle is said to have the elusive quality of "gameness." Sometimes such a cock will be said to be "dead game."

Hackfight - an individual match between the roosters of two cockers which is not part of a larger event such as a derby or main. Usually each cocker will bet on his own rooster with the winner taking the money.

Hackles - the feathers around a chicken's head and neck.

Handle = (1) a command of "handle" is given by the referee to instruct the handlers to pick up their roosters at the termination of a pitting. (2) To handle is to be in the pit with the roosters during a fight, releasing them and picking them up at the appropriate times and treating their injuries when possible during the interpitting rest periods.

Handler - the individuals who handle the cocks during fights.

Heel, to - to attach the gaffs to a cock's legs.

Keep - the special foods, diet supplements, medications, and exercise regime given to cocks usually during the two weeks prior to a fight. Often cockers will have individual formulas for keeps which are well-kept secrets.

Long heels - spurs $2\frac{1}{4}$ to $2\frac{1}{2}$ inches long. Long heels are the normal gaffs

used in cockpits in the South. They are pointed at the tips but do not have a sharpened edge (knife edge).

Main - a type of fight in which two usually prominent cockers enter a pre-set number of cocks, usually between 9 and 13, which are then fought in individual matches. The winner of the main is the cocker who wins the majority of the matches. Mains were once the most popular type of fight though they have in recent years been largely replaced by the derby.

Main pit - the central cockpit in a facility in which all of the fights are begun.

Man fighter - a cock that will attack a man. This can be a problem during fights.

Muffs (boxing gloves) - leather pads used to cover a cock's natural spurs. Muffs are used to prevent injury when cocks are sparred.

Naked heels - cockfights in which the cocks fight without gaffs. Naked heel fights are uncommon in the US.

Pit - (1) See cockpit (2) The command given by the referee which instructs the handlers to release their cocks at the beginning of a pitting.

Pitting - a "unit" of a fight. Each pitting begins when the roosters are released by their handlers and terminates when the cocks cease to fight for a specified period of time or when their gaffs become entangled. The cocks are then given a short rest period before the onset of the next pitting.

Rattles - an injury involving a puncturing of the lungs. This creates an audible sound when the animal breathes, hence the term.

Referee - individuals who are in the pit with the cocks and the handlers during the fights to instruct the handlers when to release and pick up the roosters, make the count, and insure that the rules are obeyed.

Score line - lines drawn on the dirt floor of the cockpit by the referee behind which the roosters are released at the onset of each pitting.

Shake - a cock weighing over six pounds.

Short heels - gaffs $1\frac{1}{4}$ to $1\frac{1}{2}$ inches long. Short heels are uncommon in Southern pits but are the normal type of gaff used in the North.

Shuffle - a type of attack in which the attacker leaps into the air and spurs the opponent several times with both feet in rapid succession. The ability to shuffle is a highly desired characteristic in a cock.

Slasher - a gaff which has a knife edge. Slasher fights are the normal fights in Latin America but are usually only fought as novelty matches in the US.

Spar - a practice fight. Most cockers will briefly spar cocks several days prior to a match to assess the cock's readiness to fight.

Spur - the natural horn-like appendage on a cock's shin. Spurs are quite sharp and may be several inches long. They are removed when the cocks are young so that gaffs may be attached to the stumps.

Stags - a game rooster less than one year old. Stags are usually fought in special matches against other stags.

Tournament - a type of fight in which a number of cockers will enter cocks

at preset weights. It is a predecessor of the modern derby and differs from the derby in that in the later the weights of the cocks are not specified ahead of the derby as they are in the tournament. Tournaments are rarely fought today.

Trim - (1) to remove the comb and wattles from a rooster. This is done so that the opponent cannot grasp the comb with its bill. (2) to remove (cut) some of the feathers from the wing, tail, and body to reduce the rooster's weight and to allow it to remain cool during a fight.

Uncouple - an injury in which a cock cannot use its legs. Uncoupling is said by cockers to be due to injury to the spinal cord or lower back.

VITA

Harold Albert Herzog, Jr. was born in Miami, Florida in 1946. He attended public schools in Florida and New Jersey. He studied psychology at Alderson-Broaddus College and the American University of Beirut where he received a Bachelor of Arts degree in 1968. After several years as a psychiatric technician in the United States Army he began graduate school at the University of Tennessee and received a Master of Arts degree in 1971. He is presently an assistant professor of psychology at Mars Hill College. When not otherwise occupied he tries to play clawhammer banjo, manufacture malt beverages, and catch trout.