ACTIVITY AND AGGRESSION IN CAPTIVE BLUE-WINGED TEAL (*Anas discors*)

by

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ABSTRACT

M.Sc. Ruth Stoddart Renewable Resources

Activity and aggression in captive blue-winged teal (Anas discors)

The behavior of captive blue-winged teal (Anas discors) was studied using time-activity data collected from mid-April to mid-October in 1983 and 1984. Data were grouped into three daily and five seasonal periods.

The effects of sex, time of day and season on behavioral frequencies were examined using G tests. Both males and females showed distinct daily behavioral patterns within each seasonal period, and sexual differences existed in each daily period within a seasonal period. Each sex exhibited distinct seasonal behavior patterns.

The form, frequency and intensity of aggressive behaviors changed through the study period. Paired birds were always more aggressive than unpaired birds. Males were more aggressive than females until mid-incubation. Unpaired males engaged in "active" aggressive behaviors most often during incubation. Females with ducklings were actively aggressive. Intraspecific encounters were more frequent on the more densely populated side of the pen, and interspecific aggression was rare on both sides.

The adaptive significance of observed behavior patterns was discussed in terms of the maximization of reproductive fitness by each sex.

RESUME

M.Sc. Ruth Stoddart Ressources Renouvelables

Activité et aggression chez les sarcelles à aile bleues (*Anas discors*) en captivité

Le comportement de la sarcelle à aile bleue (*Anas discors*) a été étudié en captivité. Un budget saisonnier temps-activité fût documenté durant la période alant de la mi-avril à mi-octobre pour les années 1983 et 1984. Les données ont été groupées en trois sections journalières et cinq périodes saisonnières.

Les interactions entre le sexe, l'heure du jour, les saisons et les fréquences de comportement furent analysées à l'aide de testes de "G". Les mâles et les femelles ont montré des variations saisonnières de comportement et des tendances journalières durant chaque saison. Des différences significatives fûrent démontrées entre les deux sexes pour chaque section journalière durant chaque saison.

Le genre, la fréquence, et l'intensité d'aggressivité ont changé au cours de la saison. Les canards accouplés étaient toujours plus aggressifs que les individues non-accouplés. Les mâles étaient plus aggressifs que les femelles jusqu'au milieu de la période d'incubation. L'aggressivité des mâles

non-accouples augmente durant la période de couvée. Les femelles, ayant leurs canetons, étaient aggressives. La fréquence d'interaction intraspécifique était plus élevée du côté de la volière où la population était plus dense, et l'aggression interspécifique n'a été notée que très rarement dans les deux côtés de la volière.

La valeur évolutive des comportements observés est discutée en terme de maximization d'aptitude de reproduction ("reproductive fitness") des deux sexes.

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PREFACE

Bennett's (1938) study was the first detailed published account of the natural history of the blue-winged teal (Anas discors). In the following years, other authors have dealt with various aspects of the biology of this species.

Collias and Collias (1963), Swanson and Meyer (1977) and DuBowy (1985) discussed the feeding habits of blue-winged teal. Bioenergetics work was done by Owen (1969, 1970) and Sugden (1974). Miller (1976) described the nesting habits of this species, and she, along with Connelly (1977), Stewart and Titman (1980), and Connelly and Ball (1984) have detailed partial time-activity budgets for blue-winged teal. Territorial and aggressive behaviors in blue-winged teal have been studied by Bailey et al. (1978) and Stewart and Titman (1980).

To date, no prolonged intensive study of marked individual blue-winged teal of known age and breeding status during the summer residency period exists. The purpose of this work, therefore, was to develop a complete time-activity budget for captive blue-winged teal, and, in doing so, to examine territorial and aggressive behavior in this species.

As permitted by the Faculty of Graduate Studies, this thesis includes the texts of two manuscripts to be submitted to journals for publication. The first, presented in Section

I, describes the effects of time of day, reproductive status and sex of a bird upon time spent in various activities. Seasonal changes in the form, frequency and intensity of aggressive interactions as related to sex and reproductive status were examined in Section II. Both manuscripts will be submitted to the "Canadian Journal of Zoology" with Dr. R. D. Titman as coauthor. Data collection and analyses were conducted independently by this author.

The quantification of activities presented here will be baseline data useful for comparison with future studies in the wild, particularly those dealing with the energetics of blue-winged teal.

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SECTION I:

A time-activity budget for blue-winged teal (*Anas discors*) breeding in captivity

ABSTRACT

The behavior of a group of captive blue-winged teal (Anas discors) was studied in 1983 and 1984 by means of a time-activity budget. Quantitative data were collected from mid-April to mid-October in both years, in a flight pen located in the Macdonald College Wildlife Area, Ste. Anne de Bellevue, Quebec. Data were grouped into three daily periods (sunrise to two hours after sunrise, two hours after sunrise to two hours before sunset, and two hours before sunset to sunset), and into five seasonal periods (pre-laying, laying, incubation, post-hatch and post-fledge). Behavioral frequencies were analyzed to determine if daily and seasonal variations existed among birds of different sex and reproductive status.

Both male and female birds showed definite daily activity patterns in each of the seasonal periods. Males generally slept significantly more at mid-day than at any other time. Females always fed significantly more in the evening than at other times of day.

Significant differences were also found between the following behavioral frequencies in male and female birds in a daily period within a particular seasonal period. Prior to incubation, males swam and were alert and aggressive more than females throughout the day. Females fed more than males in the evening. Incubating females foraged when not on their

nests. Females with broods swam and were alert more than their mates throughout the day. At this time, males fed and slept more than females. Once the ducklings had fledged, males slept and were out of sight more than females, while females swam more than males in the morning and at mid-day. Behavior of both sexes was similar in the evening.

Definite seasonal trends were found in male and female activity patterns. Males fed significantly more in the pre-laying period, and swam and were alert and aggressive most during egg-laying. The amount of time which males spent loafing, sleeping and preening increased through the season. Females fed significantly more prior to incubation, and were most aggressive while laying. Females with broods were most alert.

INTRODUCTION

Many aspects of the ecology of a species can be better elucidated by determining the proportions of time individuals devote to various activities. The amount of time, and therefore energy, which an individual allocates to different activities ultimately influences its reproductive success. Thus, natural selection seems to have favored individuals which make optimal use of available environmental resources and in doing so maximize their fitness. Observed patterns of time budgeting can therefore be explained by a consideration of the adaptive significance of the timing and duration of different activities (Ashkenazie and Safriel, 1979).

Time-activity budgets have been detailed for many species, with several recent studies concerning dabbling ducks, including those of McKinney (1967) and Afton (1979) on shovelers (Anas clypeata), Dwyer (1975) on gadwall (A. strepera), Asplund (1981) on mallards (A. platyrhynchos), and Seymour and Titman (1978) and Hickey and Titman (1983) on black ducks (A. rubripes). For blue-winged teal (Anas discors) there exist some partial time budgets. Miller (1976) examined female incubation behavior, Connelly's (1977) study concerned breeding pairs, and Stewart and Titman (1980) looked at aggressive behavior. No prolonged, intensive study of individually marked blue-winged teal of

known breeding status exists at present. This study quantifies behaviors of blue-winged teal at various times of day and through the summer residence period. The results will provide a complete time-activity budget for comparison to activity work in wild populations, and use in future energetics studies.

The objective of this study was to determine, using time-activity budgets, whether time spent by blue-winged teal in various behaviors is influenced by time of day, sex and reproductive status of the bird. Due to the differing effects of sexual selection, male and female dabbling ducks ensure their reproductive fitness in different manners. This is the result of dissimilarities in parental investment by each sex (Trivers, 1972). Early in the breeding season, males spend much time defending territories which allows their mates to acquire the energy required for laying and incubation by feeding undisturbed (Titman, 1981). Prior to laying, females participate to some extent in territorial defence, but are generally most aggressive when protecting young ducklings (Asplund, 1981).

In view of the above, the hypothesis tested in this study was that time spent in various activities changes with time of day, sex and reproductive status of the bird. Three predictions were examined:

(i) Within a particular seasonal period, that time spent in performing each behavior in each separate daily

period by (a) paired male birds (b) paired female birds will differ in each of the three daily time periods.

(ii) Within a particular seasonal period, that time spent in performing each behavior in each separate daily period will differ between paired male and female birds.

(iii) On a daily basis, that time spent in performing each behavior by (a) paired male birds (b) paired female birds will differ through each of the five seasonal periods.

MATERIALS AND METHODS

This study was conducted in 1983 and 1984 in a flight pen similar to McKinney's (1967) design. The pen was located in the Macdonald College Wildlife Area, Ste. Anne de Bellevue, Quebec (45°24' N, 73°57' W). A wall divided the pen into two 30 X 30 X 4 m visually isolated halves, each containing a pond lined with bentonite. Water was pumped in as necessary from a nearby well, and depth varied from about 1 m in early spring to about 15 cm in mid-summer. Natural vegetation, consisting mainly of horsetails (Equisetum spp.), smartweeds (Polygonum spp.),water plantain (Littorella spp.) and tall

grasses was allowed to grow in the pen, and regularly trimmed to a height of 15 cm after ducklings hatched. Each side of the pen was provided with a small wooden feeder box (30 X 10 X 10 cm) containing cracked corn and pigeon grit available ad lib.. Four pairs each of wild stock mallard and blue-winged teal were obtained from the Delta Waterfowl and Wetlands Research Station, Delta, Manitoba in early April, 1983. Three pairs each of mallards and blue-winged teal were released into the east side of the pen, and one pair of each species, along with a pair of wild black ducks from Alexandria, Ontario, was placed in the west side. Numbers of mallards and blue-winged teal were allocated in the same way in 1984. However, in 1984 all of the mallards were new stock from Delta. On the west side of the pen were an adult male and female blue-winged teal from 1983, and on the east side were two adult females from 1983, a male hatched in the pen in 1983, two first year males and a first year female. Birds which were used in both years had overwintered in a barn in a single flock.

In 1983, all birds were marked for individual identification with leg bands and/or nasal saddles modelled after those of Bartonek and Dane (1964). Identification of birds with only leg bands became very difficult once the birds had moulted and became indistinguishable from each other. Therefore, patagial tags made from different colors of Saflag , similar to those used by Anderson (1963), were

put on all of the blue-winged teal. This marking method was used again for the blue-winged teal in 1984.

Observations were carried out from a permanent blind attached to the pen from mid-April to mid-October in 1983 and 1984. Observations were done daily during two, two-hour periods, seven days a week, with starting times staggered to cover all daylight hours in a week. Each pair of birds was observed directly or with binoculars for two continuous 15 m sessions during a two hour period. A Sony TCM5 tape recorder and stop watch were used to record start and stop times of each behavior to the nearest second. Behaviors quantified were those described by Dwyer (1975), and are listed in Table 1. Occurrence of all behaviors was mutually exclusive.

No nocturnal observations were done, as the necessary equipment was unavailable. Blue-winged teal are known to feed at night, particularly between sunset and midnight (Swanson and Sargeant, 1972). Thus, it is likely that observed frequencies of this behavior, along with others such as swimming, would differ had a total daily time-activity budget been compiled.

Tapes were transcribed after each observation session, and the total number of minutes and number of minutes per hour spent in each behavior calculated for each bird. Data for four paired males and seven paired females from the two years were totalled for each of three daily time periods: sunrise to two hours after sunrise (AM), two hours after

sunrise to two hours before sunset (MID), and two hours before sunset to sunset (PM). These daily divisions were used because ducks are known to exhibit crepuscular activity peaks (Winner, 1972).

Behavioral frequencies for males and females were divided into five seasonal periods: pre-laying, laying, incubation, post-hatch and post-fledge (Table 2). The pre-laying period was considered to begin when the birds were introduced into the pen and ended when each female began to lay. Laying encompassed the time from deposition of the first egg to the day the clutch was completed, and incubation the day after completion of the clutch to the day prior to hatch. Observations on laying and incubating females were only made for time spent off the nest. The post-hatch period lasted from the day of hatch until fledging of ducklings in 1983, and, as no ducklings survived to fledge, until the last duckling of a brood died in 1984. The last seasonal period, post-fledge, began with fledging (1983) or death of ducklings (1984), and finished with the termination of observations in October. Although the last two seasonal divisions relate to the female reproductive cycle, they correspond to pre- and post-moult periods for paired males, and so they were used for both sexes.

Using a R X C contingency test (R X C: Rohlf, 1983), each prediction was tested to determine if differences were present in the total number of minutes spent in each

behavior. If differences were found, a goodness of fit test (GOODFT: Rohlf, 1983), was then used to ascertain where the differences were and whether or not they were significant.

RESULTS

I DAILY TRENDS

1. PRE-LAYING

Time spent in feeding by paired male and female blue-winged teal differed significantly through the three daily time periods, being greatest in the evening (Table 3). Females fed more than their mates only in the evening (Table 4). Sleeping was most prevalent at mid-day in both sexes (Table 3), and males slept less than females in all three daily periods (Table 4). During the pre-laying period, swimming and alertness occurred most often in the morning in males and females, decreasing toward nightfall (Table 3). Males engaged in these two behaviors more than females in all daily periods (Table 4). Time spent in aggressive interactions was unrelated to time of day for both sexes (Table 3), although males were more aggressive than females throughout the day (Table 4). Flight frequencies did not

vary with sex or time of day (Tables 3 & 4).

2. LAYING

Laying female blue-winged teal fed significantly more in the evening than at other times of day; however, male feeding frequencies did not differ significantly in the three daily time periods (Table 5). Females fed more than their mates at mid-day and in the evening (Table 6). As in the pre-laying period, both sexes slept most at mid-day (Table 5). Males slept significantly more than females at mid-day and in the evening (Table 6). Swimming and aggressive behaviors were observed most in male birds in the morning, but did not differ significantly through the day in females (Table 5). There were no significant differences in time spent alert in either sex through the day (Table 5). Males swam and were alert more than their mates throughout the day, and were more aggressive than females in the morning and at mid-day (Table 6).

3. INCUBATION

During incubation, both sexes fed most in the evening and slept at mid-day (Table 7). Females were out of sight least in the evening (Table 7), and more than males in all three daily periods (Table 8). Swimming and aggressive interactions were observed most often in males in the

morning (Table 7), and these birds were most alert in the evening (Table 7). Males foraged, slept, swam and were alert more than females throughout the day, and were more aggressive than their mates in the morning and at mid-day (Table 8).

4. POST-HATCH

Both male and female blue-winged teal fed and swam most often in the morning in the post-hatch period (Table 9). Male birds fed and slept more than females throughout the day (Table 10). Once their ducklings had hatched, female birds were most aggressive in the morning and most alert in the evening (Table 9). Females were alert significantly more than males in all three daily periods, and more aggressive than males in the morning and at mid-day (Table 10)

5. POST-FLEDGE

During the final seasonal period of observation, both sexes swam and preened most often in the morning, slept and were out of sight most at mid-day, and foraged most often in the evening (Table 11). Males slept more than females in the morning and at mid-day (Table 12).

II SEASONAL TRENDS

A comparison of the total amount of daily time spent by paired males in each behavior through the five seasonal periods showed significant differences in each behavior through the study period (Table 13). Feeding was most frequent in the pre-laying period and decreased to a relatively constant level through the remainder of the season. Males slept least, and were alert and aggressive most while their mates were laying. Time spent sleeping increased through the season, while that in swimming, alertness and aggression decreased. Pre-laying levels were between those for laying and incubation for all four of the previous behaviors. Increasing through the year, loafing frequencies were greatest during the post-hatch period, and lowest after ducklings had fledged. Preening time decreased from pre-laying to laying, increased sharply with the onset of incubation, and decreased again through the remainder of the season. Males flew most in the pre-laying and laying periods, less in incubation, and not at all after ducklings had hatched. Displays were observed most often prior to laying, and ceased after incubation began. Time out of sight increased steadily through the season, peaking in the post-fledge period.

For females, significant differences also existed in time spent in each behavior through the five seasonal periods (Table 14). The birds fed for similar amounts of time prior

to and during laying, with feeding frequencies reaching their lowest point in incubation and increasing to original levels by the time ducklings had fledged. Sleeping, loafing, swimming and preening decreased from pre-laying to incubation lows, and increased in the post-hatch period, with all but sleeping decreasing again at post-fledge. Time spent in flying and being alert decreased until incubation, peaked after ducklings had hatched, and dropped off when females left their broods. Aggressive behaviors were most prevalent during laying, being lower prior to laying and in the post-hatch period, and least during incubation and after ducklings had fledged. Frequency of displays was greatest in pre-laying, declining until incubation, after which no displays were observed. The amount of time for which females were not visible increased to an incubation high, then decreased through the remainder of the season.

DISCUSSION

I DAILY TRENDS

The amount of time spent by both male and female blue-winged teal in various activities differed significantly

throughout the day. Additionally, sexual differences in behavioral frequencies were found in each of the three daily periods. These differences are related to sexual differences in the energetic costs of reproduction (Afton, 1979).

A) PRE-LAYING

Egg production requires an energy expenditure of 50 to 70% more than the average daily energy requirement for normal activity in female birds (King, 1973), and female blue-winged teal rely mainly upon exogenous resources accumulated on the breeding grounds to produce a clutch of eggs, as do mallards (Afton, 1979). This energy is gained by intensive foraging prior to laying the first egg, as noted in other species of dabbling ducks by Seymour and Titman (1978), Afton (1979), and Hickey and Titman (1983), among others. In this study, however, females fed significantly more than males only in the two hours prior to sunset. There are two possible explanations for this result: food was available ad lib., so females may not have had to feed as intensively to meet their energy requirements, and/or 1984 data may have biased the results. Because the ducks overwintered indoors in 1983/84 with unlimited food, the females may have been heavier in the spring than is normal for wild birds, and therefore did not need to feed as extensively to build up reserves prior to laying. Both sexes fed more as the day progressed. Such an evening feeding peak

was also seen in wild mallards (Titman 1981). The evening feeding peak in this study coincided with the emergence of protein-rich insects necessary to replenish depleted energy reserves (Danell and Sjoberg, 1977).

Females slept more than their mates in all three daily periods, possibly in order to conserve energy necessary for laying and incubation. Mid-day peaks in the amount of time asleep seen in both sexes provide a "rest" from intensive morning and evening feeding, and also serve in thermoregulation. Blue-winged teal are able to withstand large temperature extremes due to their dense plumage (Owen, 1970). However, activity during the warmest part of the day in summer would necessitate an additional energy expenditure for cooling by panting and extra water consumption (Owen, 1970). Daily sleeping peaks were also observed by McKinney (1967) for shovelers and Dwyer (1975) for gadwall.

During the breeding season, male blue-winged teal defend exclusive territories which allow their mates to feed undisturbed (Stewart and Titman, 1980). This ensures the male's reproductive fitness by increasing the probability that any progeny will be his. Territory defence requires a large energy expenditure, which would have been even greater in this crowded captive situation than in the wild, due to increased aggression resulting from compression of territories (Stoddart, ms). These birds normally occupy territories averaging 0.69 ha in size (Stewart and Titman,

1980). The conditions in the pen also resulted in high levels of female aggression. This may explain why females spent less time feeding than expected in the morning and at mid-day. As in this study, Afton (1979) and Hickey and Titman (1983) noted that males engaged in behaviors necessary to territory defence more than females throughout the day. Time devoted to activities performed by males in territory defence reduces the amount of time available for other behaviors. This appeared to occur in this study, as the frequency of feeding by males increased through the day, while male defensive behaviors decreased. In the wild, flights are also associated with a male's defence of his territory (Stewart and Titman, 1980). However, in this study flights were very restricted in frequency and duration because of the artificial enclosure. Thus, the small sample size prevented any discrimination of differences between sexes and/or time of day for flights in all seasonal periods.

B) LAYING

As females began to lay, the behaviors of both sexes remained similar to those observed in the pre-laying period. These results are consistent with trends observed in black ducks (Seymour and Titman, 1978), and mallards (Asplund, 1981). Although follicular development was probably complete

by the third day of laying (King, 1973), the females still had to consume enough food to meet the nutritional demands of egg production and laying. Eggs are laid in the morning hours, (McKinney, 1965), and some incubation may occur late in the laying phase (Dane, 1966). Because of these factors, females were out of sight, probably incubating, for consistent amounts of time through the three daily periods.

Through defence of a territory, male blue-winged teal protect their genetic investment by defending their laying mates from predation and potential forced copulation attempts by other males (Stewart and Titman, 1980). The females are also allowed sufficient time to feed undisturbed. In spite of the fact that females were feeding most at this time, the decrease in aggression observed in males in the evening may possibly be attributed to an increase in the time spent feeding (Hickey and Titman, 1983), although there was no significant difference in male foraging frequencies throughout the day. Alternatively, male blue-winged teal may need to re-confirm their territories at the beginning of each day, resulting in the increase in aggression and greater visibility observed in the morning. Later in the day, with territories re-established, neighboring birds may avoid each other, thus the evening decrease in aggression frequencies seen here.

C) INCUBATION

In all three daily periods during incubation, male birds were more active than females. This is because females were not seen, that is, they were presumed to be incubating, much of the time. Male blue-winged teal defend territories, and their mates, with decreasing intensity until the third week of incubation (Stewart and Titman, 1980). In this study, incubating birds were off the nest feeding most often in the evening, and males were alert most often at this time. However, Miller (1976), Seymour and Titman (1977), and Asplund (1981) observed morning feeding peaks in incubating blue-winged teal, black ducks and mallards, respectively. Afton (1979) suggests that incubating shovelers spend most of their time foraging when off the nest, because, being relatively small, they lack sufficient stored reserves to carry them through incubation. Being even lighter than shovelers, incubating female blue-winged teal probably rely on energy gained by foraging to an even larger extent, as is evidenced by the proportionately greater amount of time spent feeding (Afton, 1979). In this study, the amount of time females spent feeding when off the nest, was comparable to the 60% observed for wild blue-winged teal by Miller (1976). Females probably fed more in the evening because of a need to gain reserves for overnight incubation. It is unlikely that the birds fed at night, as it is important that the eggs be kept warm and protected from predation at

this time (Miller, 1976).

D) POST-HATCH

Wild male blue-winged teal normally desert their mates during the third week of incubation, and often move some distance from the brood-rearing area, forming all-male aggregations. Such movement was not possible in this captive situation, although single-sex groups did form. Male activity patterns were similar to those described by Oring (1964) for pre-flightless flocks of dabbling ducks. The amount of time which males spent in feeding and sleeping while females were rearing broods represents an attempt to regain energy lost during the period of territory defence, as suggested by Titman (1981), and to begin to build up the reserves necessary for moult and migration.

The increase in defensive behavior seen in females with ducklings serves to protect the female's genetic investment from potential predators and harassment by other ducks. The decrease in female aggressive behavior in the evening was proportional to the increase in feeding and being alert at this time.

E) POST-FLEDGE

As in black ducks (Hickey and Titman, 1983), fall

activity budgets of male and female blue-winged teal were very similar. Owen (1968) observed similar trends in wild blue-winged teal, and attributed this behavior to the flightlessness of the birds and corresponding deposition of premigratory fat reserves. As the birds are not territorial at this time of year, flights and aggressive interactions were not seen at any time of day. The lack of consistent trends in the amounts of time devoted to each behavior by males and females in each of the three daily periods is again evidence of the similarity in the activities of both sexes at this time.

II SEASONAL TRENDS

Seasonal trends in waterfowl activity aid in the elucidation of the adaptive significance of performing specific behaviors more or less often at various times of the year. In this study, significant differences were found in the amounts of daily time spent in each activity through five seasonal periods in male and female blue-winged teal.

Wild dabbling ducks arriving on the breeding grounds must forage voraciously in order to replenish energy reserves depleted by migration, and to obtain enough energy for territory defence and egg-laying. Dwyer (1975) and Krapu (1981) suggest that energy requirements for male birds

establishing territories are considerably higher than at other times of the year, due to the high costs of aggressive behaviors necessary in territorial defence. Laying and incubation cause significant energetic demands to be placed on breeding females (Ricklefs, 1974). As in wild black ducks (Seymour and Titman, 1978), shovelers (Afton, 1979), mallards (Asplund, 1981, Duebbert et al., 1983), and blue-winged teal (Miller, 1976, Stewart and Titman, 1980, Connelly and Ball, 1984), captive male blue-winged teal fed most during the pre-laying period. Females foraged primarily prior to the onset of incubation, while incubating birds spent the majority of their time foraging when off the nest. Behaviors associated with male territorial defence were most frequent while females were laying, as females are most susceptible to forced copulation attempts at this time (Cheng et al., 1982). Females with ducklings were alert and aggressive more than in any other seasonal period.

Young and Boag (1982) stated that mallards should increase food consumption, decrease energetically expensive activities, and rely on stored body reserves in order to meet the energetic demands of moult resulting from increased feather growth and decreased insulation. Comfort movements, sleeping and loafing should therefore increase during the moult, with other activities decreasing proportionally, as seen in wild blue-winged teal (Owen, 1970), shovelers (Afton, 1979), and black ducks (Hickey and Titman, 1983).

The captive birds in this study behaved similarly in the post-hatch period when moulting began. All birds slept more and swam less in the post-fledge period, the time of primary regrowth and premigratory fat deposition.

Many of the problems inherent in captive studies as described by McKinney (1967) were seen in this study: birds were artificially crowded, their movements, especially flights, were restricted, and individuals were exposed to almost constant sight of each other. Additionally, food was not evenly distributed through the pens. As a result, productivity was poor, as only six ducklings survived to fledge from 80 blue-winged teal eggs laid in the two year study period.

The results of this study, though, are comparable to those obtained in wild populations of dabbling ducks. General behaviors of this group of captive blue-winged teal, such as mating and egg-laying, followed those described for wild birds of the same species. Miller (1976), Connelly, (1977), and Stewart and Titman, (1980) all observed similar partitioning of time for various activities in wild blue-winged teal. This work represents the first attempt to follow the activities of a group of marked individuals of known reproductive status from time of spring arrival to that of fall departure. Although the number of birds observed was small, and no nocturnal observations done, a complete diurnal time-activity budget for blue-winged teal

has been developed. Once specific energetic costs for each behavior described in this study are determined for blue-winged teal, a complete energy budget for this species can be compiled, providing a more thorough understanding of the species' ecology.

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TABLE 1: Blue-winged teal behaviors categorized in this study

BEHAVIOR	DESCRIPTION
feed	any feeding on land or water
sleep	bird with head under wing
loaf	bird resting
swim	swimming or walking on land
preen	bathing and preening
fly	all flights
alert	bird looking around with head up
aggression	all aggressive behaviors
display	courtship displays and copulations
not seen	bird out of sight

TABLE 2: Seasonal divisions used in data analysis for captive blue-winged teal, 1983 and 1984. Odd numbers represent male birds, even numbers represent females. Birds 1 and 2 are from the west side of the pen, all others from the east side. Numbers in brackets designate mates for each bird, dash inside bracket for unmated birds. More than one number in brackets indicates pairing with more than one mate.

1983	PRE-LAYING	LAYING	INCUBATION	POST-HATCH	POST-FLEDGE
1(2)	04/05-23/05	24/05-03/06	04/06-25/06	26/06-13/08	25/08-19/10
3(4)	04/05-24/05	25/05-07/06	08/06-03/07	04/07-13/08	25/08-19/10
5(6,8)	04/05-04/06	05/06-18/06	19/06-08/07	09/07-13/08	25/08-19/10
2(1)	04/05-23/05	24/05-03/06	04/06-25/06	26/06-13/08	25/08-19/10
4(3)	04/05-24/05	25/05-07/06	08/06-03/07	04/07-05/07	05/07-13/08, 25/08-19/10
6(5)	04/05-04/06	05/06-18/06	19/06-08/07	09/07-15/07	16/07-13/08, 25/08-19/10
8(5)	04/05-19/05	20/05-31/05	01/06-24/06	25/06-13/08	25/08-19/10
1984					
1(2)	19/04-31/05	01/06-11/06	12/06-02/07	03/07-06/07	(escaped 06/07)
3(4,8)	19/04-22/06	23/06-01/07	02/07-27/07	28/07-14/08	15/08-01/10
5(-)	19/04-22/06	23/06-01/07	02/07-19/07	20/07-14/08	15/08-01/10
7(-)	19/04-22/06	23/06-01/07	02/07-19/07	20/07-14/08	15/08-01/10
2(1)	19/04-31/05	01/06-11/06	12/06-02/07	03/07-06/07	
4(3)	19/04-10/06	11/06-27/06	28/06-19/07	20/07-14/08	15/08-01/10
6(-)	19/04-22/06	23/06-01/07	02/07-19/07	20/07-14/08	15/08-01/10
8(3)	19/04-22/06	23/06-01/07	02/07-27/07	28/07-02/08	03/08-01/10

TABLE 3: G tests comparing percentages of time/h spent in various behaviors in each of 3 daily time periods within the pre-laying period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 2 for all)

	PAIRED MALES DAILY PERIOD				PAIRED FEMALES DAILY PERIOD			
BEHAVIOR	A.M.	MID.	P.M.	G value	A.M.	MID.	P.M.	G value
feed	39.0	40.8	53.6	G=50.451 P<0.001	42.0	41.9	62.0	G=143.702 P<0.001
sleep	2.5	18.8	10.2	G=31.938 P<0.001	6.0	23.6	12.8	G=356.514 P<0.001
loaf	4.8	2.3	2.3	G=23.398 P<0.001	4.1	1.4	1.4	G=56.688 P<0.001
swim	30.8	18.7	18.3	G=72.835 P<0.001	23.7	12.6	9.5	G=170.219 P<0.001
preen	8.5	8.1	6.5	G=4.604 0.10<P<0.25	11.3	10.8	7.0	G=31.426 P<0.001
fly	0.3	0.1	0.1	G=2.084 0.25<P<0.50	0.2	0.1	0.1	G=3.109 0.10<P<0.25
alert	5.6	2.6	2.1	G=31.925 P<0.001	3.3	1.0	0.7	G=58.337 P<0.001
aggression	1.4	1.0	0.6	G=4.417 0.10<P<0.25	0.2	0.2	0.1	G=0.945 0.50<P<0.75
display	0.3	0.1	0.0	G=7.536 0.01<P<0.025	0.3	0.1	0.0	G=10.307 0.005<P<0.01
not seen	6.7	7.4	6.4	G=2.459 0.25<P<0.50	8.6	8.3	6.4	G=10.524 0.05<P<0.01

TABLE 4: G tests comparing percentages of time/h spent in various behaviors within a daily time period within the pre-laying period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 1 for all)

	A.M.			MID.			P.M.		
	male	female		male	female		male	female	
BEHAVIOR			G value			G value			G value
feed	39.0	42.0	G=2.666 0.05<P<0.10	40.8	41.9	G=0.624 0.25<P<0.50	53.6	62.0	G=7.392 0.005<P<0.01
sleep	2.5	6.0	G=24.538 P<0.001	18.8	23.6	G=47.840 P<0.001	10.2	12.8	G=5.856 0.01<P<0.025
loaf	4.8	4.2	G=0.610 0.25<P<0.50	2.3	1.4	G=19.261 P<0.001	2.3	1.4	G=3.281 0.05<P<0.10
swim	30.8	23.7	G=12.921 P<0.001	18.7	12.6	G=117.910 P<0.001	18.3	9.5	G=45.554 P<0.001
preen	8.5	11.4	G=7.337 0.005<P<0.01	8.1	10.8	G=33.747 P<0.001	6.5	7.0	G=0.600 0.25<P<0.50
fly	0.3	0.2	G=0.142 0.50<P<0.75	0.1	0.1	G=1.751 0.10<P<0.25	0.1	0.1	G=0.010 0.90<P<0.95
alert	5.6	3.3	G=8.747 0.001<P<0.005	2.6	1.0	G=66.602 P<0.001	2.1	1.0	G=12.674 P<0.001
aggression	1.4	0.2	G=15.874 P<0.001	1.0	0.2	G=48.321 P<0.001	0.1	0.1	G=5.776 0.01<P<0.025
display	0.3	0.3	G=0.000 P>0.999	0.1	0.1	G=0.043 0.75<P<0.90	0.0	0.0	G=0.000 P>0.999
not seen	6.7	8.6	G=4.146 0.025<P<0.05	7.4	8.3	G=3.842 0.025<P<0.05	6.4	6.4	G=0.021 0.75<P<0.90

TABLE 5: G tests comparing percentages of time/h spent in various behaviors in each of 3 daily time periods within the laying period for captive paired male and female blue-winged teal. 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 2 for all)

	PAIRED MALES DAILY PERIOD				PAIRED FEMALES DAILY PERIOD			
BEHAVIOR	A.M.	MID.	P.M.	G value	A.M.	MID.	P.M.	G value
feed	39.7	37.9	40.4	G=0.866 0.50<P<0.75	36.2	42.5	51.7	G=19.498 P<0.001
sleep	5.0	14.0	5.6	G=47.099 P<0.001	5.9	6.6	2.6	G=16.732 P<0.001
loaf	7.0	3.1	1.9	G=18.152 P<0.001	0.2	0.4	0.0	G=4.320 0.10<P<0.25
swim	34.1	20.0	11.7	G=53.638 P<0.001	6.2	5.5	5.6	G=0.146 0.90<P<0.95
preen	9.5	5.6	2.4	G=19.187 P<0.001	3.4	3.7	0.6	G=21.046 P<0.001
fly	0.2	0.1	0.1	G=0.213 0.75<P<0.90	0.0	0.1	0.0	G=0.258 0.75<P<0.90
alert	1.7	3.2	2.9	G=3.448 0.10<P<0.25	0.1	0.4	0.0	G=4.822 0.05<P<0.10
aggression	2.6	1.7	0.2	G=9.867 0.005<P<0.01	0.5	0.3	0.0	G=3.209 0.10<P<0.25
display	0.2	0.0	0.0	G=1.466 0.25<P<0.50	0.1	0.1	0.0	G=0.863 0.50<P<0.75
not seen	0.0	14.4	34.8	G=199.989 P<0.001	47.3	40.6	39.5	G=3.414 0.10<P<0.25

TABLE 6: G tests comparing percentages of time/h spent in various behaviors within a daily time period within the laying period for captive-paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 1 for all)

	A.M.			MID.			P.M.		
	male	female		male	female		male	female	
BEHAVIOR			G value			G value			G value
feed	39.7	36.2	G=0.639 0.25<P<0.50	37.9	42.4	G=7.412 0.005<P<0.01	40.4	51.7	G=6.566 0.01<P<0.025
sleep	5.0	5.9	G=0.429 0.50<P<0.75	14.0	6.6	G=92.298 P<0.001	5.6	2.6	G=4.702 0.025<P<0.05
loaf	7.0	0.2	G=43.723 P<0.001	3.0	0.4	G=81.824 P<0.001	1.9	0.0	G=12.884 P<0.001
swim	34.1	6.2	G=113.388 P<0.001	20.0	5.5	G=297.349 P<0.001	11.7	5.6	G=9.436 0.001<P<0.005
preen	9.5	3.4	G=15.346 P<0.001	5.6	3.7	G=13.697 P<0.001	2.4	0.6	G=5.155 0.01<P<0.025
fly	0.2	0.0	G=0.730 0.25<P<0.50	0.1	0.1	G=1.246 0.25<P<0.50	0.1	0.0	G=0.625 0.25<P<0.50
alert	1.7	0.1	G=8.588 0.001<P<0.005	3.2	0.4	G=90.161 P<0.001	2.9	0.0	G=19.429 P<0.001
aggression	2.6	0.5	G=8.223 0.001<P<0.005	1.7	0.3	G=34.773 P<0.001	0.2	0.3	G=0.676 0.25<P<0.50
display	0.2	0.1	G=0.108 0.50<P<0.75	0.0	0.1	G=0.033 0.75<P<0.90	0.0	0.0	G=0.000 P>0.999
not seen	0.0	47.3	G=329.314 P<0.001	14.4	40.6	G=401.124 P<0.001	34.8	39.5	G=1.533 0.10<P<0.25

TABLE 7: G tests comparing percentages of time/h spent in various behaviors in each of 3 daily time periods within the incubation period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 2 for all) (G = *****: G>1000)

	PAIRED MALES DAILY PERIOD				PAIRED FEMALES DAILY PERIOD			
	A.M.	MID.	P.M.		A.M.	MID.	P.M.	
BEHAVIOR				G value				G value
feed	49.4	28.9	51.0	G=146.160 P<0.001	2.9	3.6	8.2	G=41.686 P<0.001
sleep	7.5	23.0	9.1	G=174.101 P<0.001	0.0	0.2	0.0	G=8.518 0.01<P<0.025
loaf	3.6	4.4	3.3	G=3.385 0.10<P<0.25	0.0	0.0	0.0	G=0.462 0.75<P<0.90
swim	20.2	9.9	16.1	G=68.132 P<0.001	1.1	0.6	0.8	G=3.609 0.10<P<0.25
preen	13.1	11.8	10.5	G=2.652 0.25<P<0.50	1.7	1.4	2.2	G=4.137 0.10<P<0.25
fly	0.1	0.0	0.0	G=0.451 0.75<P<0.90	0.0	0.0	0.1	G=0.951 0.50<P<0.75
alert	1.4	0.8	1.9	G=8.384 0.01<P<0.025	0.0	0.0	0.0	G=0.652 0.50<P<0.75
aggression	1.2	0.3	0.2	G=11.725 0.001<P<0.005	0.1	0.0	0.1	G=0.617 0.50<P<0.75
display	0.0	0.0	0.0	G=0.291 0.75<P<0.90	0.0	0.0	0.0	G=0.811 0.50<P<0.75
not seen	3.4	20.8	7.6	G=236.364 P<0.001	94.2	94.2	88.6	G=***** P<0.001

TABLE 8: G tests comparing percentages of time/h spent in various behaviors within a daily time period within the incubation period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 1 for all) (G = *****: G>1000)

	A.M.			MID.			P.M.		
	male	female		male	female		male	female	
BEHAVIOR			G value			G value			G value
feed	49.4	2.9	G=552.551 P<0.001	28.9	3.6	G=***** P<0.001	51.0	8.2	G=332.629 P<0.001
sleep	7.5	0.0	G=116.509 P<0.001	23.0	0.2	G=***** P<0.001	9.1	0.0	G=125.380 P<0.001
loaf	3.6	0.0	G=55.539 P<0.001	4.4	0.0	G=385.899 P<0.001	3.3	0.0	G=43.812 P<0.001
swim	20.2	1.1	G=232.283 P<0.001	9.9	0.6	G=623.758 P<0.001	16.1	0.8	G=166.072 P<0.001
preen	13.1	1.7	G=107.353 P<0.001	11.8	1.4	G=583.318 P<0.001	10.5	2.2	G=55.945 P<0.001
fly	0.1	0.0	G=0.283 0.50<P<0.75	0.0	0.0	G=1.159 0.25<P<0.50	0.0	0.1	G=0.010 0.90<P<0.95
alert	1.4	0.0	G=17.748 P<0.001	0.8	0.0	G=59.366 P<0.001	1.9	0.0	G=26.620 P<0.001
aggression	1.2	0.1	G=13.958 P<0.001	0.3	0.0	G=14.289 P<0.001	0.5	0.1	G=3.429 0.05<P<0.10
display	0.0	0.0	G=0.000 P>0.999	0.0	0.0	G=0.202 0.50<P<0.75	0.0	0.0	G=0.000 P>0.999
not seen	3.5	94.2	G=28.341 P<0.001	20.8	94.2	G=***** P<0.001	7.6	88.6	G=332.629 P<0.001

TABLE 9: G tests comparing percentages of time/h spent in various behaviors in each of 3 daily time periods within the post-hatch period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 2 for all)

	PAIRED MALES DAILY PERIOD				PAIRED FEMALES DAILY PERIOD			
BEHAVIOR	A.M.	MID.	P.M.	G value	A.M.	MID.	P.M.	G value
feed	51.9	36.7	40.1	G=49.800 P<0.001	25.6	24.2	30.8	G=10.932 0.001<P<0.005
sleep	16.1	26.8	25.5	G=37.523 P<0.001	3.6	6.2	3.0	G=26.237 P<0.001
loaf	4.4	3.9	7.0	G=14.537 P<0.001	2.4	3.8	5.7	G=12.935 0.001<P<0.005
swim	6.8	4.1	2.7	G=20.444 P<0.001	13.3	10.0	6.3	G=24.127 P<0.001
preen	14.4	8.1	14.7	G=56.926 P<0.001	6.1	8.9	7.1	G=11.381 0.001<P<0.005
fly	0.0	0.0	0.0	G=1.658 0.25<P<0.50	0.4	0.1	0.0	G=6.485 0.025<P<0.05
alert	0.8	0.3	0.3	G=4.129 0.10<P<0.25	18.6	16.8	22.3	G=11.192 0.001<P<0.005
aggression	0.0	0.0	0.0	G=0.267 0.75<P<0.90	0.7	0.2	0.2	G=7.543 0.01<P<0.025
display	0.0	0.0	0.0	G=0.000 P>0.999	0.0	0.0	0.0	G=0.000 P>0.999
not seen	5.6	20.2	9.7	G=166.125 P<0.001	29.3	29.9	24.7	G=9.852 0.005<P<0.01

TABLE 10: G tests comparing percentages of time/h spent in various behaviors within a daily time period within the post-hatch period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 1 for all) (G = *****: G>1000)

	A.M.			MID.			P.M.		
	male	female		male	female		male	female	
BEHAVIOR			G value			G value			G value
feed	51.9	25.6	G=78.728 P<0.001	36.7	24.2	G=179.096 P<0.001	40.1	30.8	G=12.692 P<0.001
sleep	16.1	3.6	G=75.288 P<0.001	26.8	6.2	G=945.819 P<0.001	25.5	3.0	G=189.390 P<0.001
loaf	4.4	2.4	G=5.255 0.01<P<0.025	3.9	3.8	G=0.037 0.75<P<0.90	7.0	5.7	G=1.519 0.10<P<0.25
swim	6.8	13.3	G=20.351 P<0.001	4.1	10.0	G=171.083 P<0.001	2.7	6.3	G=12.657 P<0.001
preen	14.4	6.1	G=30.470 P<0.001	8.1	8.9	G=2.174 0.10<P<0.25	14.7	7.1	G=25.995 P<0.001
fly	0.0	0.4	G=2.714 0.05<P<0.10	0.0	0.1	G=4.729 0.025<P<0.05	0.0	0.0	G=0.128 0.50<P<0.75
alert	0.8	18.6	G=185.457 P<0.001	0.3	16.8	G=***** P<0.001	0.3	22.3	G=258.024 P<0.001
aggression	0.0	0.7	G=7.843 0.005<P<0.01	0.0	0.2	G=11.711 P<0.001	0.0	0.2	G=1.903 0.10<P<0.25
display	0.0	0.0	G=0.000 P>0.999	0.0	0.0	G=0.000 P>0.999	0.0	0.0	G=0.000 P>0.999
not seen	5.6	29.3	G=163.627 P<0.001	20.2	29.9	G=125.615 P<0.001	9.7	24.7	G=60.398 P<0.001

TABLE 11: G tests comparing percentages of time/h spent in various behaviors in each of 3 daily time periods within the post-fledge period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 2 for all)

	PAIRED MALES DAILY PERIOD				PAIRED FEMALES DAILY PERIOD			
BEHAVIOR	A.M.	MID.	P.M.	G value	A.M.	MID.	P.M.	G value
feed	47.2	30.7	53.4	G=220.345 P<0.001	46.8	36.4	57.3	G=235.476 P<0.001
sleep	10.8	30.6	15.4	G=302.749 P<0.001	15.1	23.8	14.0	G=178.699 P<0.001
loaf	1.1	1.4	1.7	G=1.640 0.25<P<0.50	2.3	1.6	1.6	G=7.326 0.025<P<0.05
swim	1.6	0.7	0.5	G=13.093 0.001<P<0.005	2.6	1.8	0.9	G=25.919 P<0.001
preen	13.9	6.0	9.4	G=96.378 P<0.001	10.8	7.0	6.5	G=51.223 P<0.001
fly	0.0	0.0	0.0	G=0.000 P>0.999	0.0	0.0	0.0	G=0.000 P>0.999
alert	0.3	0.1	0.1	G=4.153 0.10<P<0.25	0.4	0.1	0.3	G=11.664 0.001<P<0.005
aggression	0.0	0.0	0.0	G=0.000 P>0.999	0.0	0.0	0.0	G=0.000 P>0.999
display	0.0	0.0	0.0	G=0.000 P>0.999	0.0	0.0	0.0	G=0.000 P>0.999
not seen	25.0	30.5	19.6	G=61.785 P<0.001	21.9	28.7	19.4	G=115.892 P<0.001

TABLE 12: G tests comparing percentages of time/h spent in various behaviors within a daily time period within the post-fledge period for captive paired male and female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 1 for all)

	A.M.			MID.			P.M.		
	male	female		male	female		male	female	
BEHAVIOR			G value			G value			G value
feed	47.2	46.8	G=0.166 0.50<P<0.75	30.7	36.4	G=52.721 P<0.001	53.4	57.2	G=1.701 0.10<P<0.25
sleep	10.8	15.1	G=12.129 P<0.001	30.6	23.8	G=94.788 P<0.001	15.4	14.0	G=1.517 0.10<P<0.25
loaf	1.1	2.3	G=6.819 0.005<P<0.01	1.4	1.6	G=1.043 0.25<P<0.50	1.7	1.6	G=0.046 0.75<P<0.90
swim	1.6	2.6	G=4.059 0.025<P<0.05	0.7	1.8	G=50.556 P<0.001	0.5	0.9	G=2.850 0.05<P<0.10
preen	13.9	10.8	G=8.166 0.001<P<0.005	6.0	7.0	G=8.211 0.001<P<0.005	9.4	6.5	G=10.430 0.001<P<0.005
fly	0.0	0.0	G=0.000 P>0.999	0.0	0.0	G=0.000 P>0.999	0.0	0.0	G=0.000 P>0.999
alert	0.3	0.4	G=0.017 0.75<P<0.90	0.1	0.7	G=0.589 0.25<P<0.50	0.1	0.3	G=1.650 0.10<P<0.25
aggression	0.0	0.0	G=0.227 0.50<P<0.75	0.0	0.0	G=1.329 0.10<P<0.25	0.0	0.0	G=0.000 P>0.999
display	0.0	0.0	G=0.000 P>0.999	0.0	0.0	G=0.000 P>0.999	0.0	0.0	G=0.000 P>0.999
not seen	25.0	21.9	G=4.599 0.025<P<0.05	30.5	28.7	G=5.463 0.01<P<0.025	19.6	19.4	G=0.095 0.75<P<0.90

TABLE 13: G tests comparing percentages of daily time (/h) spent in various behaviors through 5 seasonal periods for captive paired male blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 4 for all) (G = *****: G)1000)

SEASONAL PERIOD	PRE-LAY	LAY	INCUB	POST-HATCH	POST-FLEDGE	
BEHAVIOR						G value
feed	42.3	38.4	34.2	38.6	35.8	G=115.551 P(0.001
sleep	15.6	12.0	19.4	25.6	26.1	G=544.254 P(0.001
loaf	2.6	3.5	4.2	4.2	1.4	G=206.988 P(0.001
swim	20.2	21.1	12.0	4.2	0.8	G=***** P(0.001
preen	8.0	5.8	11.8	9.4	7.4	G=171.323 P(0.001
fly	0.1	0.2	0.1	0.0	0.0	G=33.064 P(0.001
alert	2.9	3.0	1.0	0.4	0.1	G=267.435 P(0.001
aggression	1.0	1.7	0.4	0.0	0.0	G=287.848 P(0.001
display	0.1	0.1	0.0	0.0	0.0	G=28.852 P(0.001
not seen	7.2	14.5	17.0	17.6	28.3	G=***** P(0.001

TABLE 14: G tests comparing percentages of daily time (/h) spent in various behaviors through 5 seasonal periods for captive paired female blue-winged teal, 1983 & 1984. G tests based on total number of minutes spent in each behavior. (d.f. = 4 for all) (G = *****: G>1000)

SEASONAL PERIOD						
	PRE-LAY	LAY	INCUB	POST-HATCH	POST-FLEDGE	
BEHAVIOR						G value
feed	44.7	42.8	4.0	25.1	40.3	G=***** P<0.001
sleep	19.9	6.1	0.2	5.6	21.5	G=***** P<0.001
loaf	1.8	0.3	0.0	3.9	1.7	G=590.131 P<0.001
swim	13.5	5.6	0.7	9.9	1.8	G=***** P<0.001
preen	10.4	3.3	1.5	8.4	7.4	G=986.621 P<0.001
fly	0.1	0.1	0.0	0.1	0.0	G=27.052 P<0.001
alert	1.3	0.3	0.0	17.6	0.3	G=***** P<0.001
aggression	0.2	0.3	0.0	0.2	0.0	G=84.590 P<0.001
display	0.1	0.1	0.0	0.0	0.0	G=38.613 P<0.001
not seen	8.1	41.2	93.6	29.3	26.7	G=***** P<0.001

CONNECTING STATEMENT

Section I described a two-year time-activity budget for captive blue-winged teal. Quantitative data on the frequencies of 10 behaviors through five seasonal periods were presented. Daily, seasonal and sexual variations in the behavioral frequencies were examined.

In Section II, data concerning seasonal changes in the form, frequency and intensity of aggressive behaviors in blue-winged teal will be presented in further detail. These data were collected as part of the time-activity study of Section I.

SECTION II:

Seasonal changes in the form, frequency and intensity of aggressive interactions in blue-winged teal (Anas discors) breeding in captivity

ABSTRACT

Aggressive behavior in captive blue-winged teal (Anas discors) was studied in a flight pen consisting of two separate enclosures located in the Macdonald College Wildlife Area, Ste. Anne de Bellevue, Quebec. Data were collected from mid-April to mid-October in 1983 and 1984, and grouped into five seasonal periods in order to discern seasonal changes in the form, frequency and intensity of aggressive interactions through the study period.

Prior to laying, both paired and unpaired male birds engaged in a greater number of aggressive interactions, and did so more frequently than females. Paired birds were more aggressive than unpaired birds. Hostile Pumping was the most common form of aggression. During the laying period, the duration of aggressive encounters increased, as did the frequency of interactions. Frequency and duration of encounters decreased while females were incubating, although more Chases and Pursuit Flights were seen at this time in unpaired males. Only females with broods were aggressive in the post-hatch period: these birds usually engaged in "active" agonistic behaviors. No aggression was observed in the post-fledge period.

Aggressive interactions were more common in the more populated enclosure. Altogether, interspecific encounters were rare, and those which did occur were "passive".

Interactions at feeders were mainly "passive", consisting

of Threats by paired males and Hostile Pumping by unpaired males.

Results are discussed in terms of the importance of male territorial behavior in ensuring his reproductive success and that of his mate by deterral of conspecifics.

INTRODUCTION

Competition for ecological requisites in short supply leads to inter- and intraspecific aggressive and territorial behaviors. These behaviors in turn result in resource partitioning in mobile animals. Birds of similar size should compete more than those of dissimilar sizes with increased aggression resulting from this increase in competition (Burger et al., 1979). In addition, as the number of individuals competing for a particular resource increases, the number of aggressive encounters between these individuals will increase (Kalinoski, 1975).

Territorial behavior in blue-winged teal (Anas discors) was first described by Bennett (1938), and later intensively studied by Stewart and Titman (1980). Aggressive components of territorial behavior in these birds have been examined by Connelly (1977).

Male blue-winged teal are territorial from the time of nest site selection until the third week of incubation (McKinney, 1965, Stewart and Titman, 1980). The manner in which a male blue-winged teal defends a territory, as well as the intensity of this defence changes through the breeding season (Stewart and Titman, 1980), as has been observed in gadwall (A. strepera) (Gates, 1962, Dwyer, 1974, 1975), shovelers (A. clypeata) (McKinney, 1967, Afton, 1979, Seymour, 1974a), black ducks (A. rubripes) (Seymour and Titman, 1978), and mallards (A. platyrhynchos) (Titman,

1983). Unmated males are tolerated by paired territorial birds early in the breeding season (Dwyer, 1974, Seymour and Titman, 1979), although these birds may later attempt to court and mate with paired females (McKinney and Stolen, 1982).

Because dabbling ducks defend both food and mates, any increase in the number of individuals in a given area will result in increased aggression through the defence of these resources, as noted by McKinney and Stolen (1982), Titman (1983), and Lokemoen et al. (1984). Blue-winged teal are among the most territorial of duck species, (McKinney, 1965, Titman and Seymour, 1981).

Predictions arising from the hypothesis that the form, frequency and intensity of aggressive behavior changes through the period of summer residency were tested:

(i) seasonal changes in frequencies of agonistic behavior are influenced by the sex and reproductive status of the bird

(ii) seasonal changes in the form of aggression displayed are influenced by the sex and reproductive status ofthe bird

A further aim of this study was to compare and contrast aggressive behavior patterns characteristic of intra- versus interspecific interactions. Considering that competitive effects between species were expected to be less pronounced than intraspecific effects, it was predicted that the

intensity of intraspecific aggression would be greater than that of interspecific aggression.

MATERIALS AND METHODS

This study was conducted in 1983 and 1984 in a flight pen similar to McKinney's (1967) design. The pen was located in the Macdonald College Wildlife Area, Ste. Anne de Bellevue, Quebec (45°24' N, 73°57' W). A wall divided the pen into two 30 X 30 X 4 m visually isolated halves, each containing a pond lined with bentonite. Ponds were shaped like a four-leafed clover in an attempt to provide four discrete bays, each offering some visual isolation from those adjacent. Water was pumped in as necessary from a nearby well, and depth varied from about one meter in early spring to about 15 cm in mid-summer. Natural vegetation, consisting mainly of horsetails (Equisetum spp.), smartweed (Polygonum spp.), water plantain (Littorella spp.) and tall grasses was allowed to grow in the pen and regularly trimmed to a height of 15 cm after ducklings had hatched. Each side of the pen was provided with a small wooden feeder box (30 X 10 X 10 cm) containing cracked corn and pigeon grit available ad lib.. Four pairs each of wild stock mallard and blue-winged teal were obtained from the Delta Waterfowl and Wetlands

Research Station, Delta, Manitoba in early April, 1983. Three pairs each of mallards and blue-winged teal were released into the east side of the pen, and one pair of each species, along with a pair of wild black ducks, was placed in the west side. The same numbers of mallards and blue-winged teal were allocated in the same way in 1984. However, in 1984 all of the mallards were new stock from Delta. On the west side of the pen were an adult male and female blue-winged teal from 1983, and on the east side were two adult females from 1983, a first year male hatched in the pen in 1983, and two first year males and a first year female. Birds used in both years had overwintered in a barn in a single flock.

In 1983, all birds were marked for individual identification with leg bands and/or nasal saddles modelled after those of Bartonek and Dane (1964). Identification on birds with only leg bands became very difficult once the birds had moulted and became indistinguishable from each other. Therefore, patagial tags made from different colors of Saflag, similar to those used by Anderson (1963), were put on all of the blue-winged teal. This marking method was again used for the blue-winged teal in 1984.

Observations were carried out from mid-April to mid-October in 1983 and 1984 from a permanent blind attached to the pen. Data on aggressive behavior were collected as part of a time-activity study of blue-winged teal. Two, 2 hour

observation periods were done daily, seven days a week, with starting times staggered to cover all daylight hours in a week. Each pair of birds was observed directly or with binoculars for two continuous 15 m sessions during a two hour period. A Sony TCM5 tape recorder and stop watch were used to record start and stop times of each behavior to the nearest second. Aggressive behaviors quantified, other than biting, were as described by Connelly (1977). Movements of pairs under observation were traced on scale maps of the pen.

Tapes were transcribed after each observation session, and the number of minutes and number of minutes per hour spent in agonistic behavior calculated for each bird. Numbers of aggressive interactions participated in were also totalled for each bird. Hostile Pumping, Threats and Inciting were all considered to be "passive" forms of aggressive behavior, while the other categories, that is, Rush, Bite, Chase, Circular Fight and Pursuit Flight were considered "active" (Connelly, 1977). Being ritualized displays, "passive" aggressive behaviors act to warn other birds. "Active" behaviors, on the other hand, involve direct attacks of one bird upon another, and so are energetically more costly than "passive" displays (Connelly, 1977). Data for each blue-winged teal on the west side of the pen were totalled for 1983 and 1984. Similarly, data for the three paired males, five paired females, two unpaired males, and

one unpaired female on the east side of the pen were grouped together.

Behavioral frequencies for males and females were divided into five seasonal periods: pre-laying, laying, incubation, post-hatch and post-fledge (Table 1). The pre-laying period was considered to begin when the birds were introduced to the pen and ended when each female began to lay. Laying included the time from deposition of the first egg to the day the clutch was completed, and incubation the day after completion of the clutch to the day prior to hatch. Observations on laying and incubating females were only made for time spent off the nest. The post-hatch period lasted from the day of hatch until fledging of ducklings in 1983, and, as no ducklings survived to fledge, until the last duckling of a brood died in 1984. The last seasonal period, post-fledge, began with fledging (1983) or death of ducklings (1984), and finished with the termination of observations in October. Although the last two seasonal divisions relate to the female reproductive cycle, they correspond to pre- and post-moult periods for paired males, and so the same time divisions were used for both sexes. Seasonal divisions used for unpaired birds (Table 2) were chosen to allow for maximum interactions with paired birds. That is, the pre-laying period was considered to last until the final paired female had laid, and laying the time from deposition of the last egg until the last female began to

incubate. Incubation terminated with the hatch of the first egg.

In 1983, the male on the west side of the pen found its way into the east side midway through incubation (16 June); thus, observations on this bird were discontinued at this time. The female on the west side escaped with her ducklings 6 July, 1984; no aggression data were collected on the remaining male after this date.

Although the small sample size did not permit statistical analysis, the data indicated trends supporting the predictions postulated.

RESULTS

I Seasonal changes in the frequency and number of aggressive interactions

During the pre-laying period, male blue-winged teal spent more time (paired: 0.0099 min/h, unpaired: 0.0060 min/h) in aggressive behavior and engaged in a larger number of aggressive interactions per bird (paired: n=132, unpaired: n=115) than females (Figs. 1 & 2). Paired male and female birds were aggressive more often and involved in more interactions than unpaired individuals of the same sex (Figs. 1 & 2).

Time spent in agonistic interactions increased for all birds when females were laying (Fig. 1). Number of interactions per bird per hour also increased in males (Fig. 2). During laying, mated blue-winged teal were more aggressive than those without mates (Figs. 1 & 2).

As females began to incubate, both the duration and frequency of aggressive interactions decreased for all birds (Figs. 1 & 2). Unmated males, though, devoted more time to agonistic behaviors (0.0101 min/h), and engaged in a greater number of encounters than paired males did in the pre-laying period (Fig. 1).

Only females with ducklings behaved aggressively in the post-hatch period (Figs. 1 & 2). After broods had fledged, the adult birds formed a mixed-sex group: very few agonistic encounters were observed at this time (Figs. 1 & 2).

II Seasonal changes in the form of aggressive behaviors

In the pre-laying period, Hostile Pumping was the most common form of aggressive behavior performed by all birds observed (Tables 2 & 3). Both paired and unpaired males performed a greater percentage of "active" aggressive behaviors than females in this time period (Figs. 3-6).

Laying females did not Hostile Pump to the same extent as unpaired males (Tables 2 & 3), and again performed more "passive" behaviors than any males (Fig. 5). Paired males

were more aggressive than unpaired males at this time (Figs. 3 & 4). Unpaired females were only seen to Hostile Pump once during the laying period.

During incubation, the predominant form of aggressive behavior in unpaired males was again Hostile Pumping; these birds engaged in Pursuit Flights more often while females were incubating (Tables 3). While off the nest, incubating females mainly Threatened, while little aggression was seen to be performed by the unpaired female (Tables 2 & 3).

Male aggression levels were low after broods hatched, with paired males exhibiting no aggressive behavior (Fig. 3), and unpaired males mainly Hostile Pumping (Tables 2 & 3). Females with broods became actively aggressive for the first time, with 20% of all agonistic encounters at this time being Chases (Table 2).

After fledging of ducklings, little aggressive behavior was observed by any of the birds.

III Intra- and interspecific aggressive interactions

Although the pair of blue-winged teal on the west side of the pen only had the opportunity to interact with heterospecifics, both inter- and intraspecific encounters involved all birds on the east side. Most agonistic encounters seen were intraspecific (Tables 4 & 5).

Interspecific interactions were most common in all birds in the pre-laying period, and were less frequent than intraspecific interactions in all seasonal periods with the exception of incubation (Tables 4 & 5). No "active" interspecific aggression was observed.

Table 6 indicates that the mean number of aggressive interactions per bird was greater on the more populated east side, particularly among paired individuals, with the exception of females with broods. Birds on the east side of the pen also engaged in more aggressive encounters per hour than those on the west side in all seasonal periods but post-hatch (Table 7).

Precise locations of agonistic interactions could only be determined from 1984 data. Additionally, location maps for bird movements in both years indicated that only one male had defended a well-defined territory, that being on the east side of the pen in 1983. Feeder boxes were used by all birds. Thus the 1984 data were examined to determine the extent to which aggressive behaviors occurred at feeders. On the east side of the pen, the majority of aggressive encounters observed at feeders were "passive" (Tables 8 & 9). A large percentage of the total number of Threats observed in paired birds occurred at the feeders (Table 8). Unpaired birds, however, Hostile Pumped (Table 9). Aggressive interactions in paired birds near feeders on the west side of the pen were virtually nonexistent (Table 10).

DISCUSSION

I Seasonal and sexual differences in the form, frequency and intensity of aggressive interactions

Breeding dabbling ducks respond in several different ways to the presence of other ducks: displays, attack, escape, avoidance, sexual pursuit or sociability (McKinney, 1965). The particular response exhibited depends upon the species, sex and reproductive status of the individuals involved. Aggressive behaviors in breeding ducks are associated with strong pair bonds (McKinney, 1965), and many authors agree that male hostility at this time allows the female the opportunity to obtain adequate food and provides protection from predators (Dwyer, 1974, Seymour 1974 a,b, Afton, 1979, Seymour and Titman, 1978, Stewart and Titman, 1980).

Male blue-winged teal exhibit territorial behavior from the time of nest site selection until the third week of incubation. However, most pairs share their home ranges with conspecifics to some extent (McKinney, 1965) resulting in agonistic interactions when the birds encounter one another. In this study, paired males were aggressive more frequently and participated in more agonistic encounters than any of the other blue-winged teal prior to the laying period.

Paired male gadwall (Gates, 1962, Dwyer, 1974, 1975), shovelers (McKinney, 1967, Seymour, 1974, a,b, Afton, 1979), green-winged teal (A. crecca carolinensis) (McKinney and Stolen, 1982), black ducks (Seymour and Titman, 1978), mallards (Titman, 1983) , and wild blue-winged teal (Stewart and Titman, 1980), have been observed to behave similarly.

The majority of agonistic interactions seen were those classified by Connelly (1977), as "passive". Such behaviors are energetically less demanding than those classed "active". Pursuit Flights, which require a large energy expenditure, were rarely seen in this study, although they are an important means of territorial defence in wild blue-winged teal (Stewart and Titman, 1980). McKinney and Stolen (1982) saw few such flights in captive green-winged teal, and also observed few "active" aggressive encounters. The small number of "active" encounters seen in this study may be a reflection of the fact that all of the birds knew each other well, having been exposed to almost constant sight of one another, and thus had no chance to react to strange individuals. This familiarity resulted in "passive" displays sufficing to deter other birds. Seymour and Titman (1978) and Titman (1983) noted similar responses to known individuals in wild black ducks and mallards, respectively.

During laying, male birds participated in aggressive encounters more frequently and devoted more time to each encounter. Thus, interactions were more intense , as in wild

blue-winged teal (Stewart and Titman, 1980). Laying females are most susceptible to forced copulation attempts (Cheng et al, 1982), hence, males must protect their mates, and therefore their genetic investment most assiduously at this time.

Like captive shovelers (McKinney, 1967), the birds were observed to engage in aggressive interactions immediately after introduction into the pen. Only one territory was established, that by a male on the east side of the pen in 1983; a similar occurrence was recorded in captive green-winged teal by McKinney and Stolen (1982). Although only one of five paired males in this study had a well-defined territory, all males exhibited behaviors characteristic of territorial defence, as they defended the areas around their mates. Gates (1962) and Seymour (1974a) observed similar "mobile" territorial defence in wild gadwall and shovelers, respectively. This suggests that males are not only allowing a female access to food and protection from predators, but also are protecting their mates from forced copulation attempts by paired and unpaired males (McKinney and Stolen, 1982).

Unpaired males were observed in fewer aggressive interactions, and exhibited agonistic behaviors less frequently than paired males, but more than any females, prior to and during laying. Both of the unmated birds in 1984 were first year individuals in incomplete alternate

plumage. McKinney (1965) and Wishart (1983) suggest that juveniles and birds with less colorful plumage are less successful in competing for mates. In addition, the unpaired males formed a "pseudo-pair" (Lebret, 1961), and were seen pre-copulatory Head Pumping toward each other on several occasions.

Although no forced copulation attempts were observed in unpaired male black ducks (Seymour and Titman, 1979), or in blue-winged teal in this study, an increase in both the duration and frequency of agonistic encounters by unpaired males was observed during the laying and incubation periods. Paired males exhibited considerably more "active" aggressive displays during laying, as was seen by McKinney (1965) in shovelers. Once females began to incubate, however, their mates became less aggressive due to weakening pair bonds. The unpaired males remained highly aggressive at this time. The behavior of both unpaired birds suggests that they may have been trying to form pair bonds with already paired females, as suggested by Bailey et al. (1978) and McKinney and Stolen (1982). "Active" aggressive behaviors by paired males were therefore used when other passive threats failed to deter persistent intruders.

All males became gregarious by the third week of incubation. The only aggressive interactions observed after this time were the result of a male bird defending himself from attack by a female with ducklings.

Because the female requires a great deal of energy and nutrients to produce and incubate a clutch of eggs, it is necessary that she be allowed to feed undisturbed. Male territorial behavior usually permits this. If approached too closely by other birds, however, a female would react aggressively. Female gadwall behave similarly (Dwyer, 1974). Birds accompanied by broods were highly aggressive, attacking other adult birds and ducklings which approached too closely. Many of the aggressive interactions initiated by females at this time were "active", as observed in shovelers (McKinney, 1967), Barrow's goldeneye (Bucephala islandica) (Sugden, 1960, Robertson and Stelfox, 1969, Savard, 1982), and bufflehead (B. albeola) (Savard, 1982). Such aggressive behavior by a female serves to protect her genetic investment, her ducklings, from potential predators, and to allow them to feed undisturbed.

The lone unpaired female blue-winged teal in this study was less aggressive than any of the other birds in all seasonal periods. As with the unpaired males, this bird was a juvenile, and was not actively courted by any male. It is unlikely that this female was lacking the nutrient reserves necessary for reproduction, as it had overwintered indoors and weighed nearly 400 g when put into the pen. Thus, it is not known why this bird did not breed.

II Intra- and interspecific aggressive interactions

Mallards and blue-winged teal are both dabbling ducks: while similar, their feeding niches do not overlap entirely, blue-winged teal being more specialized (DuBowy, 1985). The feeders in this study created identical feeding "niches" for the two species, thus the opportunity for interspecific aggression arose. Interspecific aggressive encounters were rare on both sides of the pen. Thus, the two species probably had differing activity patterns, which resulted in the avoidance of interactions, particularly at the feeders.

Observed interspecific encounters were all "passive". Although blue-winged teal are extremely territorial, mallards were probably dominant, being larger birds (Wishart, 1983). Mallards do not compete directly with male blue-winged teal for mates, nor do they make forced copulation attempts upon the females. Thus, it appears that energetically more costly "active" aggressive behaviors are only used by male blue-winged teal to deter persistent conspecifics. Additionally, cuckoldry is probably more biologically costly to a male than a small amount of food, and therefore worthy of more intense defence.

The feeders on the east side of the pen were the site of many low-level aggressive encounters, as was observed in captive green-winged teal by McKinney and Stolen (1982). Paired birds used Threats to warn intruders away from feeders, while unpaired birds more frequently Hostile

Pumped. Because more brightly colored adult birds are dominant to juveniles (Wishart, 1983), paired birds may have been able to stop the approach of others to the feeder with only a threat. Subordinate juvenile males, however, may have had to resort to more energetically costly Hostile Pumping in order to maintain their positions at the feeder. Interactions at feeders represented a greater proportion of the total number of observed agonistic encounters in unpaired males than in paired males. Because the juvenile males may have been subordinate, and because all birds in the pen were familiar with each other, the presence of a paired male at a feeder may have caused an avoidance reaction, and therefore no subsequent encounter when an unpaired male approached. Paired males, however, would readily approach feeding unpaired birds. Mated females were more likely to be aggressive at feeders than their mates. This indicates that food is a vital resource for the breeding female.

Sample sizes in this study were small, and the conditions in the pen certainly resulted in increased aggressive behavior. Thus, the results presented here must be viewed with some caution. However, this is the first study to record quantitative data on the changes in aggressive behavior of a population of known, marked individuals through the period of summer residency. The results have verified previous hypotheses on changes in the form,

frequency and intensity of aggressive behaviors through the breeding season in blue-winged teal.

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TABLE 1: Seasonal divisions used in data analysis for captive blue-winged teal, 1983 and 1984. Odd numbers represent male birds, even numbers represent females. Birds 1 and 2 are from the west side of the pen, all others from the east side. Numbers in brackets designate mates for each bird, dash inside bracket for unmated birds. More than one number in brackets indicates pairing with more than one mate.

	PRE-LAYING	LAYING	INCUBATION	POST-HATCH	POST-FLEDGE
1983					
1(2)	04/05-23/05	24/05-03/06	04/06-25/06	26/06-13/08	25/08-19/10
3(4)	04/05-24/05	25/05-07/06	08/06-03/07	04/07-13/08	25/08-19/10
5(6,8)	04/05-04/06	05/06-18/06	19/06-08/07	09/07-13/08	25/08-19/10
2(1)	04/05-23/05	24/05-03/06	04/06-25/06	26/06-13/08	25/08-19/10
4(3)	04/05-24/05	25/05-07/06	08/06-03/07	04/07-05/07	05/07-13/08, 25/08-19/10
6(5)	04/05-04/06	05/06-18/06	19/06-08/07	09/07-15/07	16/07-13/08, 25/08-19/10
8(5)	04/05-19/05	20/05-31/05	01/06-24/06	25/06-13/08	25/08-19/10
1984					
1(2)	19/04-31/05	01/06-11/06	12/06-02/07	03/07-06/07	(escaped 06/07)
3(4,8)	19/04-22/06	23/06-01/07	02/07-27/07	28/07-14/08	15/08-01/10
5(-)	19/04-22/06	23/06-01/07	02/07-19/07	20/07-14/08	15/08-01/10
7(-)	19/04-22/06	23/06-01/07	02/07-19/07	20/07-14/08	15/08-01/10
2(1)	19/04-31/05	01/06-11/06	12/06-02/07	03/07-06/07	
4(3)	19/04-10/06	11/06-27/06	28/06-19/07	20/07-14/08	15/08-01/10
6(-)	19/04-22/06	23/06-01/07	02/07-19/07	20/07-14/08	15/08-01/10
8(3)	19/04-22/06	23/06-01/07	02/07-27/07	28/07-02/08	03/08-01/10

TABLE 2: Percentage composition of forms of intraspecific aggressive behaviors by captive paired blue-winged teal, 1984. Numbers in brackets represent number of interactions of each type.

	PRE-LAYING		LAYING		INCUBATION		POST-HATCH		POST-FLEDGE	
	male	female	male	female	male	female	male	female	male	female
DISPLAY										
"PASSIVE"										
HOSTILE PUMP	71.9 (149)	84.5 (104)	28.6 (2)	100.0 (16)	0 (0)	0 (0)	0 (0)	0 (0)	100.0 (1)	50.0 (1)
THREAT	14.1 (39)	5.2 (6)	14.3 (1)	0 (0)	75.0 (3)	33.3 (3)	0 (0)	80.0 (8)	0 (0)	0 (1)
INCITE		3.4 (4)		0 (0)		0 (0)		0 (0)		0 (0)
SUBTOTALS	86.3 (188)	93.1 (114)	42.9 (3)	100.0 (16)	75.0 (3)	33.3 (3)	0 (0)	80.0 (8)	100.0 (1)	50.0 (2)
"ACTIVE"										
RUSH	1.5 (3)	0.9 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BITE	1.0 (2)	0.9 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CHASE	1.0 (2)	0 (0)	0 (0)	0 (0)	25.0 (1)	0 (0)	0 (0)	20.0 (2)	0 (0)	0 (0)
CIRC. FIGHT	0 (0)		0 (0)		0 (0)		0 (0)		0 (0)	
PUR. FLIGHT	1.5 (3)		57.1 (4)		0 (0)		0 (0)		0 (0)	
SUBTOTALS	5.0 (10)	1.7 (2)	57.1 (4)	0 (0)	25.0 (1)	0 (0)	0 (0)	20.0 (2)	0 (0)	0 (0)
TOTALS	90.3 (198)	94.8 (116)	100.0 (7)	100.0 (16)	100.0 (4)	33 3 (3)	0 (0)	100 0 (10)	100 0 (1)	50 0 (2)

TABLE 3: Percentage composition of forms of intraspecific aggressive behaviors by captive unpaired blue-winged teal, 1984. Numbers in brackets represent number of interactions of each type.

	PRE-LAYING		LAYING		INCUBATION		POST-HATCH		POST-FLEDGE	
	male	female	male	female	male	female	male	female	male	female
DISPLAY										
"PASSIVE"										
HOSTILE PUMP	80.1 (196)	76.0 (19)	41.5 (61)	100.0 (1)	40.1 (98)	40.0 (2)	80.0 (4)	0 (0)	0 (0)	0 (0)
THREAT	6.2 (17)	16.0 (5)	3.5 (5)	0 (0)	5.3 (13)	40.0 (2)	20.0 (1)	66.7 (2)	0 (0)	0 (0)
INCITE		4.0 (1)		0 (0)		20.0 (1)		0 (0)		0 (0)
SUBTOTALS	86.3 (213)	96.0 (25)	45.0 (66)	100.0 (1)	45.4 (111)	100.0 (5)	100.0 (5)	66.7 (2)	0 (0)	0 (0)
"ACTIVE"										
RUSH	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BITE	0.9 (2)	0 (0)	0.7 (1)	0 (0)	0.4 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CHASE	1.0 (7)	0 (0)	1.4 (2)	0 (0)	5.7 (14)	0 (0)	0 (0)	33.3 (1)	0 (0)	0 (0)
CIRC. FIGHT	1.0 (6)		0.7 (1)		0 (0)		0 (0)		0 (0)	
PUR. FLIGHT	1.0 (3)		4.2 (6)		2.8 (7)		0 (0)		0 (0)	
SUBTOTALS	3.9 (18)	0 (0)	7.0 (10)	0 (0)	9.0 (22)	0 (0)	0 (0)	33.3 (1)	0 (0)	0 (0)
TOTALS	89.2 (231)	96.0 (25)	52.0 (76)	100.0 (1)	54.4 (133)	0.0 (5)	100.0 (5)	100.0 (3)	0 (0)	0 (0)

TABLE 4: Percentages of interspecific aggressive encounters in captive paired blue-winged teal, 1984. Numbers in brackets represent total number of encounters.

	PRE-LAYING		LAYING		INCUBATION		POST-HATCH		POST-FLEDGE	
	male	female	male	female	male	female	male	female	male	female
DISPLAY										
"PASSIVE"										
HOSTILE PUMP	5.4 (149)	10.7 (56)	0 (2)	0 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)	0 (1)
THREAT	28.2 (39)	0 (6)	0 (1)	0 (0)	0 (3)	67.0 (3)	0 (0)	0 (8)	0 (0)	0 (1)
INCITE		0 (4)		0 (0)		0 (0)		0 (0)		0 (0)
"ACTIVE"										
RUSH	0 (3)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BITE	0 (2)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CHASE	0 (2)	0 (0)	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)	0 (2)	0 (0)	0 (0)
CIRC. FIGHT	0 (0)		0 (0)		0 (0)		0 (0)		0 (0)	
PUR. FLIGHT	0 (3)		0 (4)		0 (0)		0 (0)		0 (0)	

TABLE 5: Percentages of interspecific aggressive encounters in captive unpaired blue-winged teal, 1984, east side of pen. Numbers in brackets represent total number of encounters.

	PRE-LAYING		LAYING		INCUBATION		POST-HATCH		POST-FLEDGE	
	male	female	male	female	male	female	male	female	male	female
DISPLAY										
"PASSIVE"										
HOSTILE PUMP	5.6 (196)	0 (19)	3.3 (61)	0 (1)	0 (98)	0 (2)	0 (4)	0 (0)	0 (0)	0 (0)
THREAT	29.4 (17)	25.0 (5)	0 (5)	0 (0)	0 (13)	0 (2)	0 (1)	0 (2)	0 (0)	0 (0)
INCITE		0 (1)		0 (0)		0 (1)		0 (0)		0 (0)
"ACTIVE"										
RUSH	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BITE	0 (2)	0 (0)	0 (1)	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CHASE	0 (7)	0 (0)	0 (2)	0 (0)	0 (14)	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)
CIRC. FIGHT	0 (6)		0 (1)		0 (0)		0 (0)		0 (0)	
PUR. FLIGHT	0 (3)		0 (6)		0 (7)		0 (0)		0 (0)	

TABLE 6: Mean numbers of aggressive interactions per bird for captive blue-winged teal through 6 seasonal periods, 1983 and 1984.

SEASONAL PERIOD	PAIRED MALES (e. side) (n=3)	UNPAIRED MALES (e. side) (n=2)	PAIRED FEMALES (e. side) (n=5)	UNPAIRED FEMALES (e. side) (n=1)	PAIRED MALES (w. side) (n=2)	PAIRED FEMALES (w. side) (n=2)
PRE-LAYING	187	115	42	25	50	4
LAYING	55	38	14	1	32	1
INCUBATION	34	66	3	5	0	0
POST-HATCH	2	2	18	3	0	20
POST-FLEDGE	0	0	2	0	0	0

TABLE 7: Duration of aggressive interactions (min/h) for captive blue-winged teal through 5 seasonal periods, 1983 and 1984. Numbers in brackets represent total number of hours of observation.

	PAIRED MALES (e. side) (n=3)	UNPAIRED MALES (e. side) (n=2)	PAIRED FEMALES (e. side) (n=5)	UNPAIRED FEMALES (e. side) (n=1)	PAIRED MALES (w. side) (n=2)	PAIRED FEMALES (w. side) (n=2)
SEASONAL PERIOD						
PRE-LAYING	0.0133 (117)	0.0060 (128)	0.0028 (185.5)	0.0011 (64)	0.0034 (62.5)	0.0001 (62.5)
LAYING	0.0174 (36.5)	0.0154 (17)	0.0038 (64.5)	0.0016 (8.5)	0.0152 (22)	0.0007 (22)
INCUBATION	0.0052 (80.5)	0.0101 (33)	0.0005 (115.5)	0.0005 (16.5)	0.0019 (31.5)	0.0000 (41.5)
POST-HATCH	0.0002 (143.5)	0.0002 (50)	0.0028 (89)	0.0003 (25)	0.0000 (3)	0.0014 (52)
POST-FLEDGE	0.0000 (185.5)	0.0000 (83)	0.0001 (307)	0.0000 (41.5)	0.0000 (0)	0.0001 (48)

TABLE. 8: Percentage of aggressive encounters occurring at feeder platforms in captive paired blue-winged teal, 1984, east side of pen. Numbers in brackets represent total number of encounters.

	PRE-LAYING		LAYING		INCUBATION		POST-HATCH		POST-FLEDGE	
	male	female	male	female	male	female	male	female	male	female
DISPLAY										
"PASSIVE"										
HOSTILE PUMP	5.5 (26)	13.7 (24)	0 (0)	24.2 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
THREAT	36.6 (15)	42.9 (3)	0 (0)	0 (0)	33.3 (1)	66.7 (2)	50.0 (1)	5.3 (1)	0 (0)	0 (0)
INCITE		0 (0)		0 (0)		0 (0)		0 (0)		0 (0)
"ACTIVE"										
RUSH	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BITE	0 (0)	100.0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CHASE	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CIRC. FIGHT	0 (0)		0 (0)		0 (0)		0 (0)		0 (0)	
PUR. FLIGHT	0 (0)		0 (0)		0 (0)		0 (0)		0 (0)	

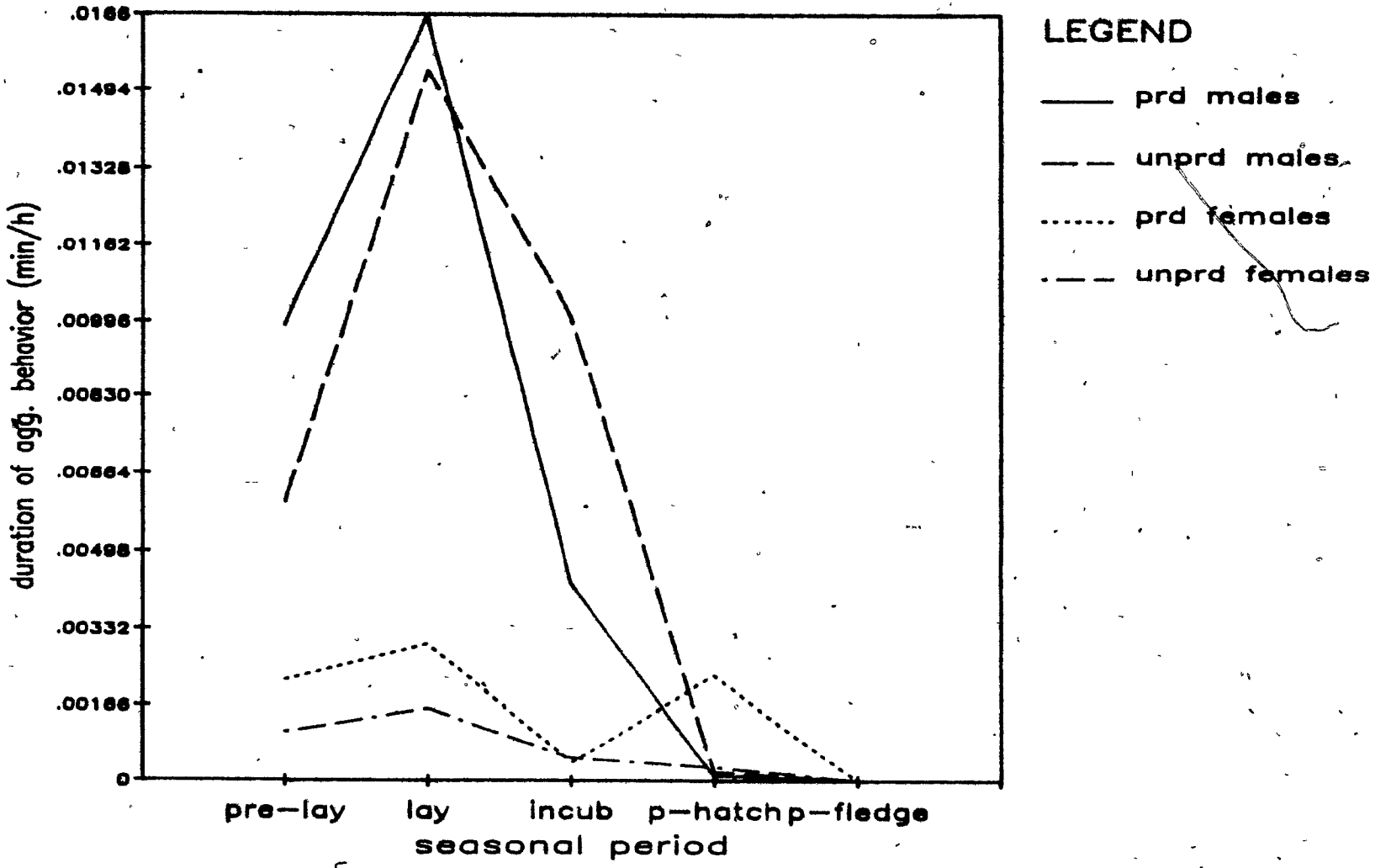
TABLE 9: Percentage of aggressive encounters occurring at feeder platforms in captive unpaired blue-winged teal, 1984, east side of pen. Numbers in brackets represent total number of encounters.

	PRE-LAYING		LAYING		INCUBATION		POST-HATCH		POST-FLEDGE	
	male	female	male	female	male	female	male	female	male	female
DISPLAY										
"PASSIVE"										
HOSTILE PUMP	20.4 (40)	42.1 (8)	28.5 (18)	0 (0)	24.5 (24)	0 (0)	25.0 (1)	0 (0)	0 (0)	0 (0)
THREAT	52.9 (9)	20.0 (1)	20.0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
INCITE		0 (0)		0 (0)		0 (0)		0 (0)		0 (0)
"ACTIVE"										
RUSH	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BITE	50.0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CHASE	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CIRC. FIGHT	16.7 (1)		16.7 (1)		0 (0)		0 (0)		0 (0)	
PUR. FLIGHT	0 (0)		0 (0)		0 (0)		0 (0)		0 (0)	

TABLE 10: Percentage of aggressive encounters occurring at feeder platforms in captive paired blue-winged teal, 1984, west side of pen. Numbers in brackets represent total number of encounters.

	PRE-LAYING		LAYING		INCUBATION		POST-HATCH		POST-FLEDGE	
	male	female	male	female	male	female	male	female	male	female
DISPLAY										
"PASSIVE"										
HOSTILE PUMP	1.3 (1)	0 (0)	1.6 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
THREAT	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
INCITE		0 (0)		0 (0)		0 (0)		0 (0)		0 (0)
"ACTIVE"										
RUSH	0 (0)	0 (0)	50.0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BITE	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CHASE	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CIRC. FIGHT	0 (0)		0 (0)		0 (0)		0 (0)		0 (0)	
PUR. FLIGHT	0 (0)		0 (0)		0 (0)		0 (0)		0 (0)	

FIG. 1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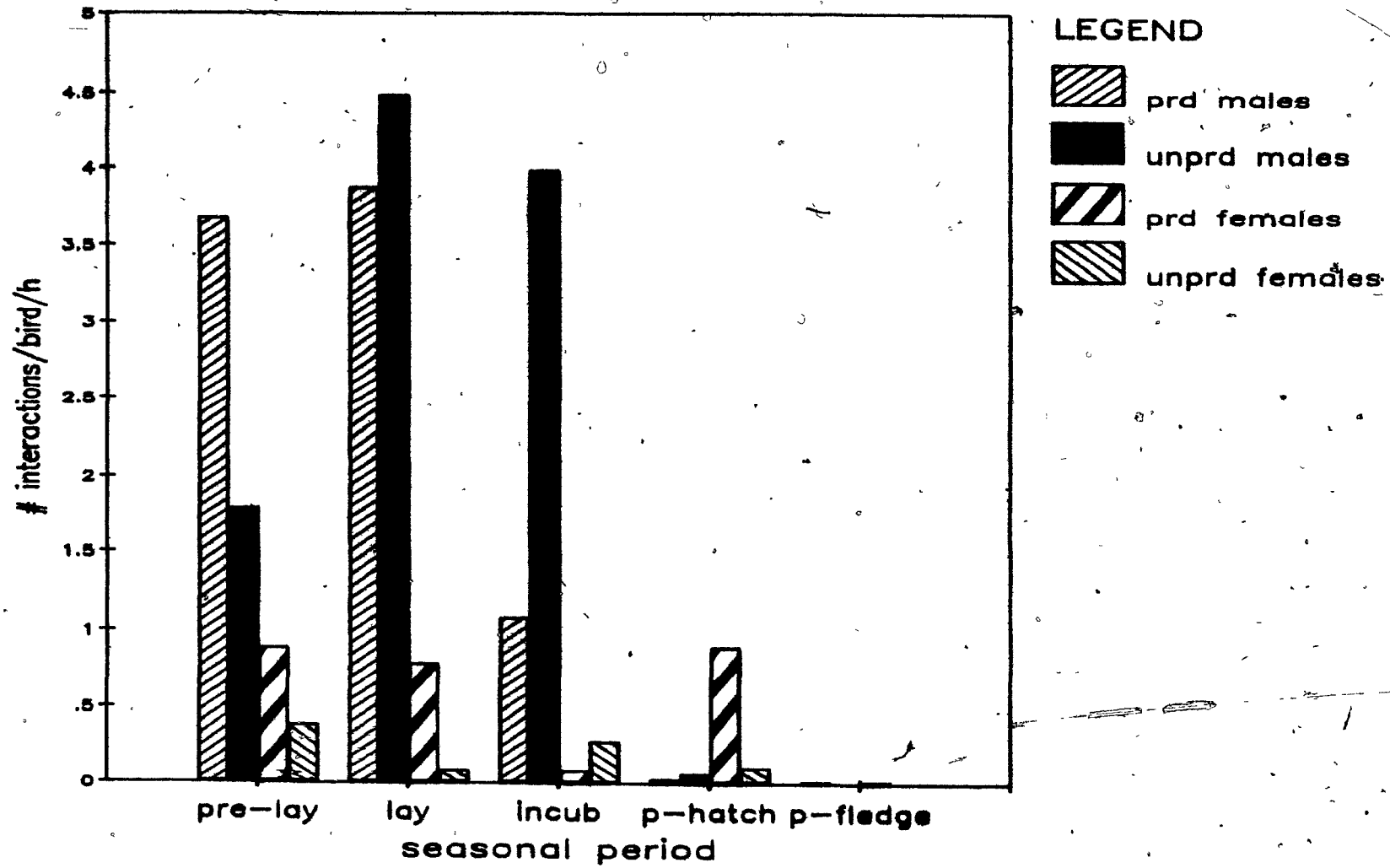
.00166
0
duration of agg. behavior (min/h)
pre-lay
lay
incub
p-hatch
p-fledge
seasonal period
LEGEND
prd males
unprd males
prd females
unprd females

FIG. 2


LEGEND
prd males
unprd males
prd females
unprd females
interactions/bird/h
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.5
1
1.5
2
2.5
3
3.5
4
4.5
5
pre-lay
lay
incub
p-hatch
p-fledge
seasonal period

FIG. 3

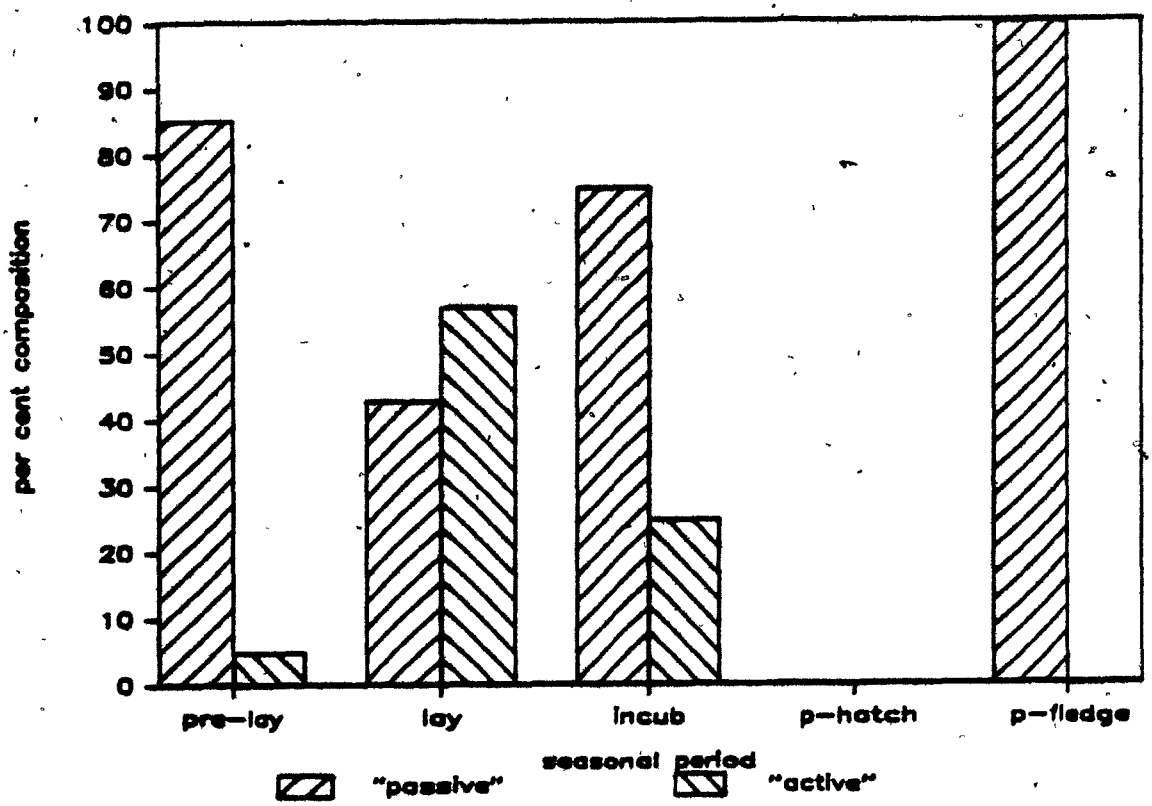
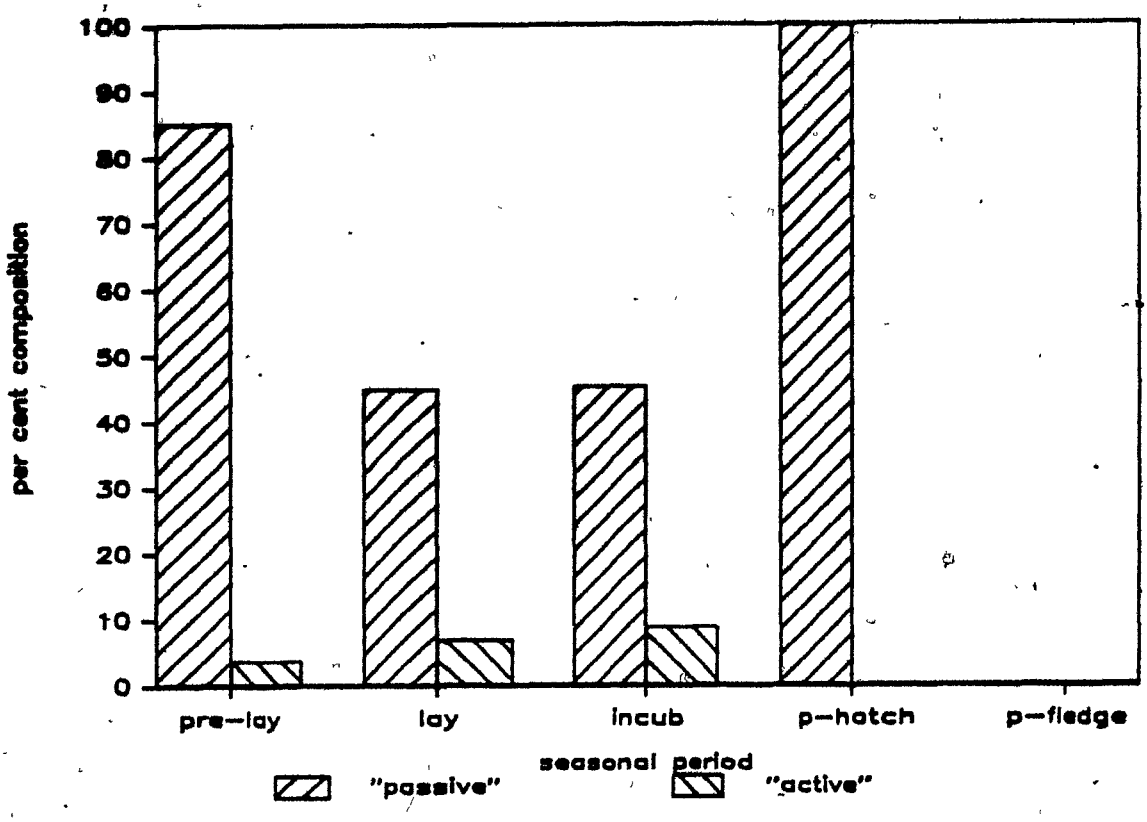

100
90
80
70
60
50
40
30
20
10
0
per cent composition
pre-lay
lay
incub
p-hatch
p-fledge
seasonal period
"passive"
"active"

FIG. 4


100
90
80
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60
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20
10
0
per cent composition
pre-lay
lay
incub
p-hatch
p-fledge
seasonal period
"passive"
"active"

FIG. 5

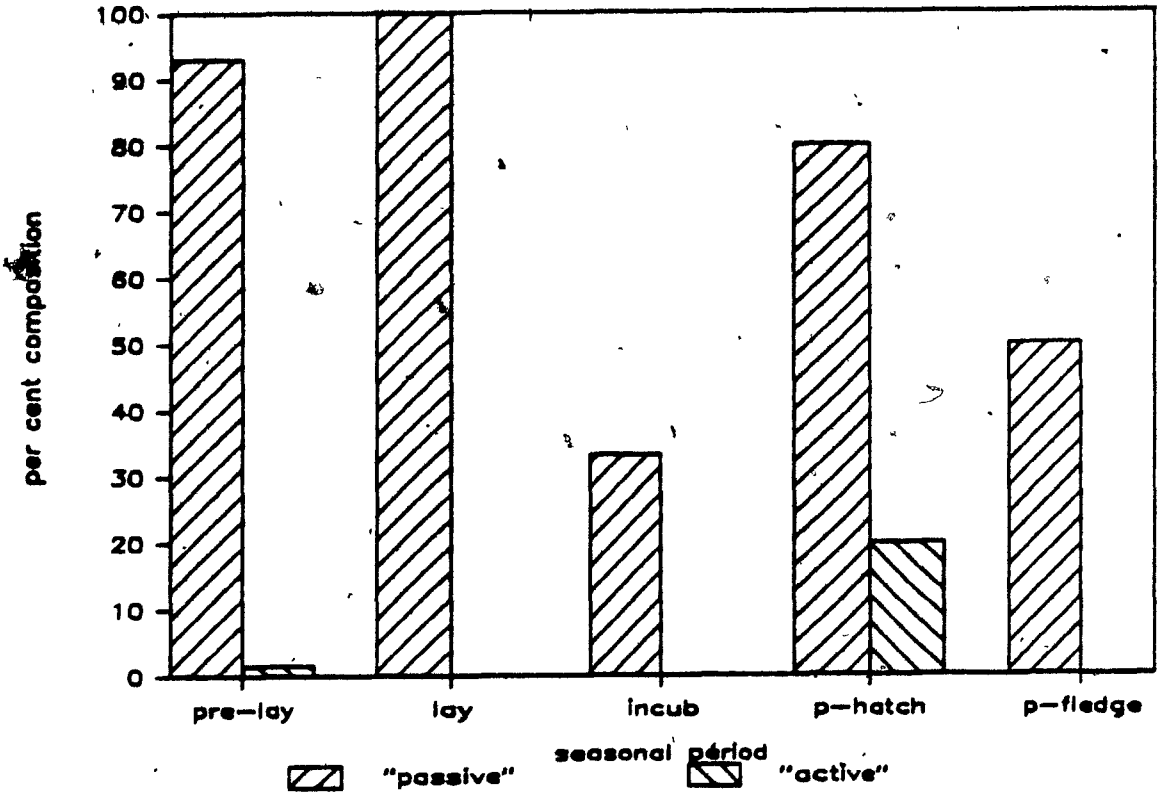
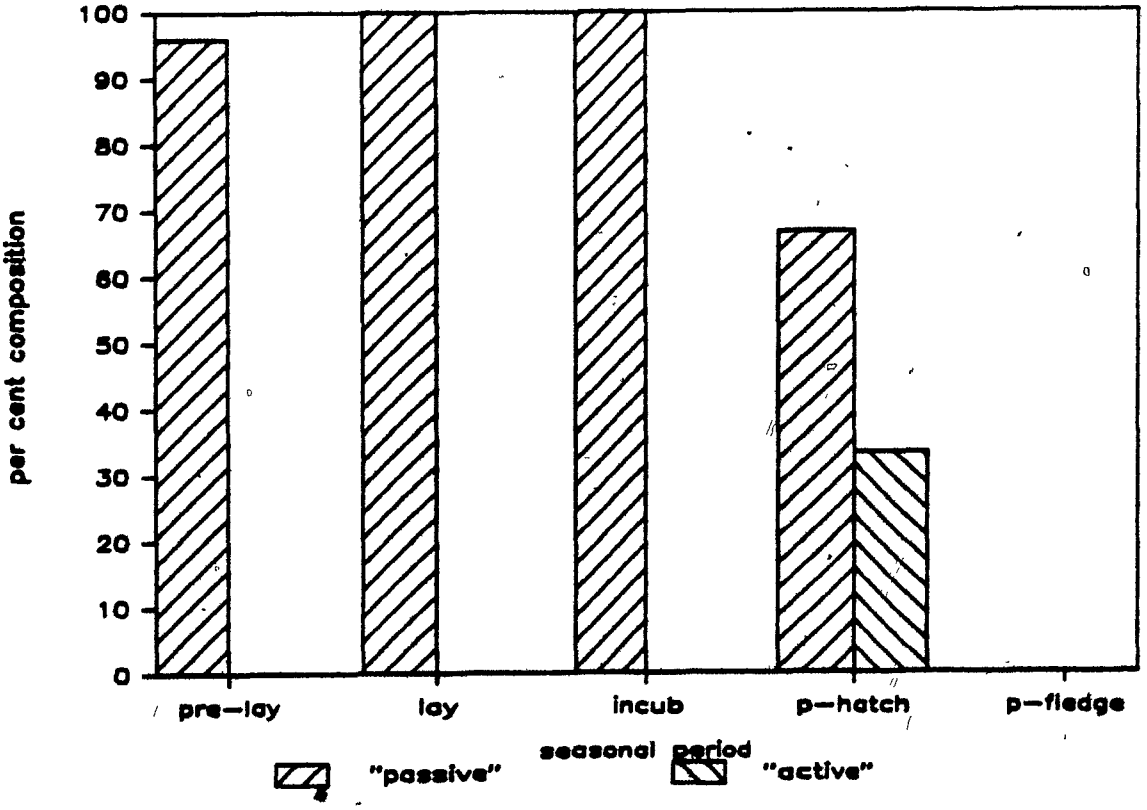

100
90
80
70
60
50
40
30
20
10
0
per cent composition
pre-lay
lay
incub
p-hatch
p-fledge
seasonal period
"passive"
"active"

FIG. 6


100
90
80
70
60
50
40
30
20
10
0
per cent composition
pre-lay
lay
incub
p-hatch
p-fledge
seasonal period
"passive"
"active"

GENERAL CONCLUSIONS

In summary, the results of the time-activity study show that time spent in various activities by captive, paired blue-winged teal changes with time of day, sex, and reproductive status of the bird. Daily activity trends within a sex were related to the availability of natural foods in the morning and evening, as well as the need to thermoregulate at mid-day.

Aggressive behaviors in blue-winged teal changed in form, frequency and intensity through the study period, with intraspecific aggression being more common than interspecific.

Seasonal changes in agonistic behaviors and sexual dissimilarities in both daily and seasonal behaviors were the result of differences in the energetic costs of reproduction to male and female blue-winged teal. Male birds defend their genetic investment by means of territorial behavior, which allows a female to feed undisturbed and protects her from forced copulation attempts by other males. Females fed intensively in early spring to build up energy reserves necessary for laying and incubation, and were most aggressive when protecting young ducklings.

This study represents the first quantification of the activities of a group of captive individually marked blue-winged teal of known age and breeding status from the time of spring arrival to that of fall migration. Although sample

sizes were small, and the occurrence of some behaviors, particularly flights and aggression, affected by the captive situation, general behavior patterns were very similar to those previously documented in the wild. The data presented here will provide a baseline for comparison with future studies of this type in wild populations of dabbling ducks and can be utilized to determine a complete energy budget for blue-winged teal.