SOCIAL BEHAVIOUR, DIETARY PREFERENCES AND BODY TEMPERATURES IN A CAPTIVE COLONY OF GREEN IGUANAS *(IGUANA IGUANA)* IN A NATURALISTIC ENVIRONMENT

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INTRODUCTION

Studies of wild populations of the Green Iguana *(Iguana iguana)* have indicated that whilst males are highly territorial, females are remarkably non-aggressive with other females (Swanson, 1950) except when nest sites are scarce (Rand, 1968). Social behaviour is particularly important in the applied husbandry of captive *Iguana iguana,* since injuries through conflict can increase mortality levels. Continuous direct observation of animal behaviour in captive environments may not relate in detail to the animals' natural behaviour, but it can be a useful guide for captive husbandry programs in relation to (for example) stocking densities and population structure. The results presented in this paper were part of a second year BTEC National Diploma Animal Behaviour Assignment at Huddersfield Technical College, carried out at the college's herpetological unit from 1997 - 1998. The objectives of the assignment were to investigate social hierarchies in Green Iguanas – particularly in females, dietary preferences, activity patterns and thermoregulation.

METHODS

Observations were made on six Green Iguanas. A male and three females were released into the enclosure as juveniles in the autumn of 1996. A juvenile male was released during January 1997 and a ten year old female (which had been a family pet) during February 1997. The observations were carried out in a tropical enclosure subject to natural sunlight, measuring 6 by 5.5 metres at ground level and 4 metres high.

A series of naturally growing plants were present (Table 1) with the main shade species *Cyperus alternifolius, Ficus, Dracaena & Monstera sp.* The inclusion of tree branches, a small pond with waterfall in addition to the abundant shade plants, give a light – shade mosaic effect similar to their natural habitat. Two spot lamps of 275w, one above a tree branch and one directed at ground level, gave the lizards the opportunity to bask on cloudy days.

Behaviour patterns. A total of 59.25 hours of continuous observation were made on the lizards' behaviour. Behaviour was defined as:- **active,** walking around the enclosure for more than a few brief seconds, **shade,** inactive in an area where there was no sunlight, **feeding,** this could either be from a bowl of food supplied or on any of the plants growing in the enclosure. There were two types of **basking,** a) under the spotlamps or b) in the sun's rays. When the weather was overcast an animal was scored as basking if it was lying in an area without cover.

Social behaviour. The behaviour of the lizards when they came into contact with one another was recorded. A successful encounter was scored when a lizard drove the other animal away. A retreat was scored if the animal moved away at the approach of another lizard and a friendly encounter scored when there was no aggression during a contact. Dominance was estimated by observing the lizards with the highest number of successful encounters and lowest numbers of retreats.

Thermoregulation. Body temperatures (n = 40) were measured using an infra-red detector (Digitron 232-3305 Pyrometer). This is a non-invasive instrument that measures skin surface temperatures by detecting the infra-red energy emitted by reptiles (Tracy, 1982). A method of estimating the core temperature from skin surface temperature has been given by Alberts and Grant (1997), which showed differences of up to 3°C between skin surface from core temperature in lizards of the size range used in the study. Simultaneous measurements were also made of air temperatures.

RESULTS

Behaviour patterns. Figure 1 shows lizard behaviour patterns with the results expressed as percentage time spent in each behaviour. Figure 1a shows behaviour during intermittent sunshine and Figure 1b behaviour when the weather was overcast. Basking either in sunshine (intermittent sunshine = 44.3%) or under a heat lamp (cloudy = 71.9%; intermittent sunshine 25.9%) was the principal activity whatever the weather conditions. Basking whilst gaping was observed under very hot sunshine or under heat lamps when the weather was overcast. Rather more time was spent in the shade during intermittent sunshine (12.6%) than when the weather was cloudy (5.02%). There was little difference between the amounts of time the lizards spent feeding (intermittent sunshine 6.6%; cloudy 5.8%) or in a locomotory activity (intermittent sunshine 10.8%; cloudy 9.6%) under different weather conditions. As can be seen these latter activities formed only a small part of total behaviour.

Thermoregulation. Figure 2 shows daytime body temperature levels of the six Green Iguanas with the data grouped at 2°C intervals. The results show a peak level between 36-38°C although a maximum body temperature of 41.1°C and minimum body temperature of 26.2°C were recorded. The interquartile range was 32.1-38.3°C (median = 36.8°C). Air temperatures in the enclosure ranged from 17.2-36.0°C (mean = 27.07°C). Body temperatures were significantly higher than corresponding air temperatures ($F_{(1, 78)}$ = 57.1, p <0.0001). Regression analysis of body temperatures with air temperatures (Huey & Slatkin, 1976) with body temperatures treated as the dependent variable and air temperatures the independent variable, gave a regression coefficient of 0.20 (R^2 = 0.08), which was not significantly different from 0 (*t* 1.72, p > 0.05, 38 d.f.), the value required for a hypothetical perfect thermoregulator (Huey, 1982).

Social behaviour. Figure 3 shows a series of bar charts which give the results of social encounters between the lizards. Areas of conflict were most frequently observed around the feeding bowl or during overcast weather under basking lamps. The most successful lizard in these encounters was a large female (F1) which was never observed to retreat from any other lizard including the males. The males, which were both physically smaller than the females, would often be driven from under the basking lamps by all the females with the exception of F4, a 10 year old lizard who was introduced around 6 months after the others into the enclosure. This lizard would often close its eyes when approached by certain lizards (particularly M1) and when touched by humans. Eye closing has been described as a possible mechanism for, among others things, reducing aggression in *Iguana iguana* (Distal & Veazy, 1982).

The results in Figure 3 indicate a female hierarchy of, in order of dominance, F1, F2, F3 & F4. Size did not necessarily guarantee high social position since F3 was heavier than F2 by almost 400g. The apparently dominant F1 and lower ranked F3 were the largest lizards with weights of nearly 3Kg at the end of the study period.

The two males continually fought when they came into contact, with the smaller animal persistently retreating. This lizard was eventually removed from the enclosure as the fighting intensified. However, despite his low ranking, M2 was seen mating with two of the larger females (F2 & F3) before his eventual removal. The male M1 was seen mating with all the females despite usually being greeted by the threat of biting. This was involved in more social encounters than any of the other lizards.

Food preferences. Table 1 shows the plant species consumed by the iguanas. A total of 20 plant species were consumed more than once and a further 4 species were grazed on at least one occasion. Particular favourites were passion flower *(Passiflora),* spider plant *(Chlorophytum)* and dragon trees *(Dracaena).* None. of the bromeliad species were used as food despite several species being present in the enclosure. Iguana foraging tended to follow cycles and heavy grazing on particular species following by periods of non interest.

Table 1

Plant species present in the enclosure and the number of times (N) they were observed being consumed by Green Iguanas. Also shown are the plant species observed being eaten on one occasion only, in addition to species present but seen consumed.

Plant species consumed	N	One observation	Plant species present but not consumed
Dracaena sp	15	*Aloe barbadensis*	*Schlumbergera bridgesii*
Dracaena tricolor	12	*Aeonium sp*	*Maranta leuconeura*
Crassula argentea	3	*Iresine herbsei*	*Stramanthe sanguinea*
Zingeraceae sp	3	*Tradescantia sp*	*Sedum spathulifolium*
Chlorophytum commosum	51		*Mandevillia laxa*
Cymbopogon citratus	6		*Ficus benjamina*
Zantedeschia aethiopica	4		*Ficus pumila*
Aloe ciliaris	2		*Agave americanum*
Cymbidium hybridis	4		*Begonia sp*
Cyperus alternifolius	14		*Sedium spathifolium*
Kohleria bogotensis	2		*Cerapegia woodii*
Rhoeo disclor	5		*Calathea sp*
Sanseveria trifaciata nana	3		*Nerium oleander*
Asparagus asparagoides	6		BROMELIADS
Ixora sp	7		*Aechmea fasciata*
Monstera delicosa	3		*Guzmania lingulata*
Passiflora caerulea	32		*Billbergia sp*
Ociumum basilicum	26		*Neoregelia carolina*
Iresine herbesei	4		*Tillandsia argentea*

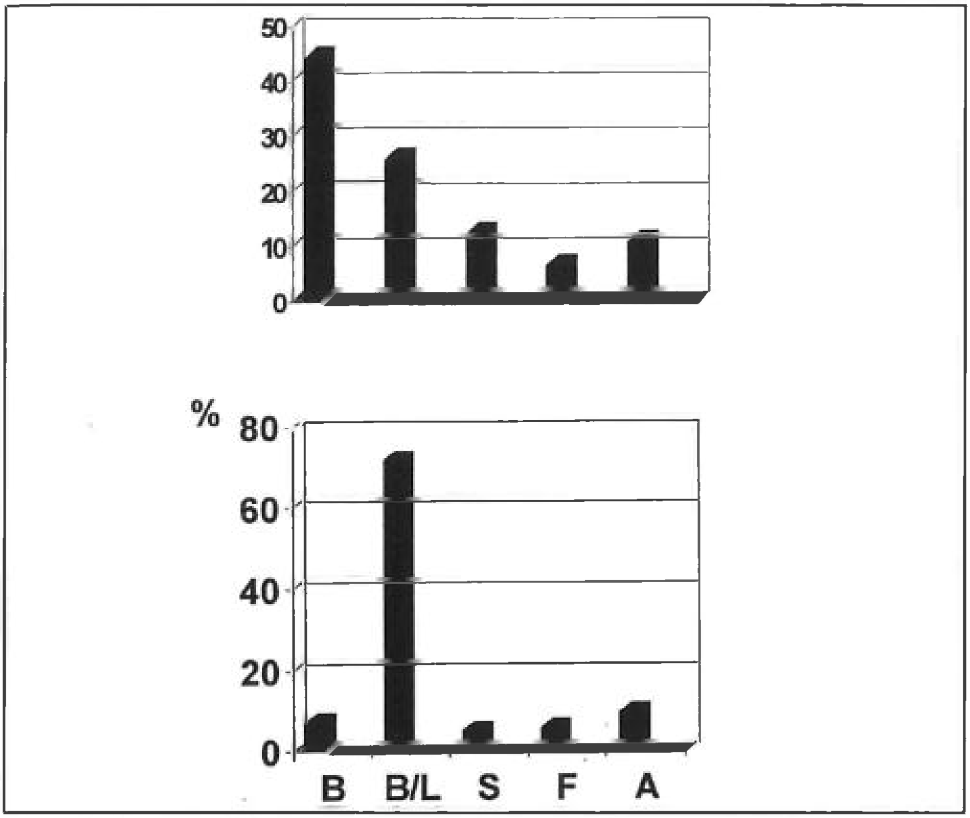

Fig. 1: Behaviour of Green Iguanas *(Iguana iguana)* under different weather conditions. Chart A shows behaviour when the weather had some sunshine, chart B when the weather was overcast. The charts show how much time, as a percent frequency of total observations, the lizards spent basking B, basking under a heat lamp BL, in the shade S, feeding F and active A.

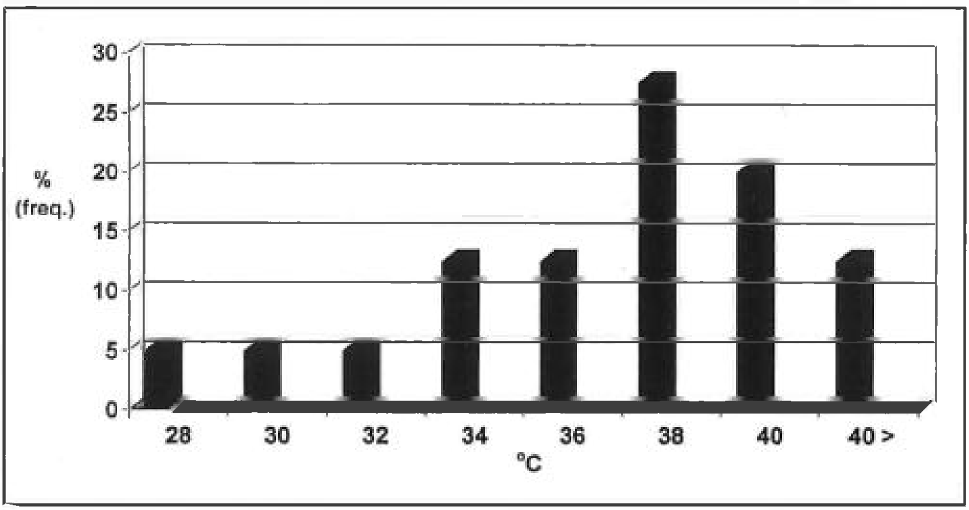

Fig. 2: Frequency distributions (%) of iguana body temperature at 2°C intervals. See text for other details

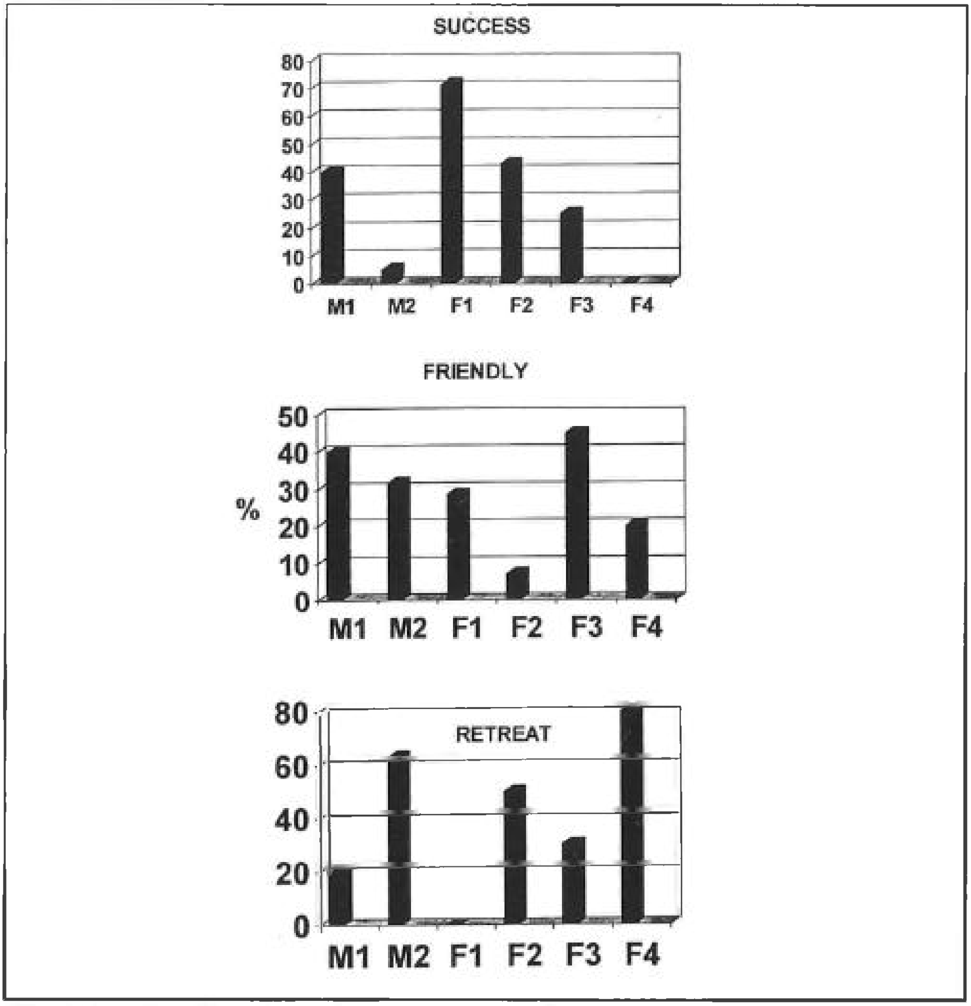

Fig. 3: A series of bar charts showing outcomes of encounters between iguanas. The top chart shows the number of successful encounters of each lizard, the middle chart the number of friendly or non-aggressive encounters and the bottom chart the number of retreats. The y - axis shows the frequency of observations as percentages and the x-axis the code names of the lizards as mentioned in the text.

DISCUSSION

The results of this study have shown that the female iguanas formed social hierarchies in which no injuries were inflicted during the study period. This contrasted with the behaviour of the two males where fighting could be intense and result in injuries. Two types of dominance hierarchies in lizards have been recognized, the 'peck-right' where aggression is one sided and the subordinates almost never attack higher ranking animals, and 'peck-dominance' where subordinates may attack higher ranking animals. The lizards in this study apparently operated the peck-right system in common with most species of iguanids (Stamps, 1977).

Much of the lizards' time in the enclosure was spent in an inactive state. The ectothermic nature of their physiology in addition to the fact that they are hind gut fermenters

(Iverson, 1982; McBee & McBee, 1982) imposes a daily routine that largely involves basking and temperature control. Efficient temperature regulation is an important aspect of behaviour in a hind gut fermenter since progressive departures from optimal body temperatures renders digestion increasingly more difficult. Troyer (1987) reported good digestive efficiency in *Iguana iguana* at body temperatures of 36.5-37.5°C which is in approximate agreement with the body temperatures selected by the lizards in this study. Natural populations of *Iguana iguana* apparently alternate between days of foraging for plant material and basking (van Marken Lichtenbelt *et al*, 1997), which in general was the routine that this captive colony followed. Moberly (1968) estimated that *Iguana iguana* spends 90% of its time resting and other field workers as much as 96% inactive and 1% feeding (ref. in Iverson, 1982). Foraging activity in the captive colony was slightly higher than reported for these wild populations. Activity in the males during the summer and autumn appeared to be driven by sexual behaviour, particularly the dominant of the two (M1).

The dietary habits of the lizards indicate that they were not highly selective feeders although certain species of plant were more frequently consumed. In addition to direct observation there was evidence of evening grazing on certain species, for example on *Rhoeo discolor*. Supplementary food was also given to the lizards daily. This consisted mainly of kale, coriander, bananas, tomato, alfalfa pellets, grapes, apple and commercial iguana pellets. Occasionally low grade cereal based dog food was also given (mixed with alfalfa pellets) and the animals would also consume any giant mealworms they came across. Reports, however, of iguanas consuming insects in their natural habitat apparently stem from a single observation of a juvenile eating a grasshopper (Hirth, 1963).

Field studies indicate that a wide diversity of plant species – primarily the leaf material, form the natural diet of *Iguana iguana* (Van Devender, 1982, van Marken Lichtenbelt, 1993, Rand *et al*, 1990). The leaves of some plants have been found to be indigestible to herbivorous lizards e.g. *Cyclura carinata* and *Cyclura cornuta* and may be passed intact (Iverson, 1982), but there was no evidence of this in this study, although the observation suggests that many herbivorous reptiles are opportunistic foragers. Indeed feeding behaviour may be learned in iguanas. As an example, when the first of two *Dracaena* species were planted in the enclosure, the lizards initially showed little interest, but after several weeks the male (M1) climbed the tree and began feeding on the leaves. Within the following hour all the lizards had climbed the tree and virtually decimated its leaves. However the time lag between the introduction of a plant and the lizards' interest was not always so prolonged; passion flower *(Passiflora caerula)* leaves were consumed within an hour of the plants' introduction to the enclosure. There was, additionally, evidence of the lizards attempting to feed on *Allamanda carthartica,* a species with toxic compounds. Several species of reptilian herbivores have been observed in their natural habitats feeding on plants with distasteful or toxic substances, for example *Testudo hermanni* (Meek, 1985), *Cyclura cornuta* and *Cyclura carinata* (ref. in Inverson, 1982).

SUMMARY

Captive female *Iguana iguana* formed a hierarchy which was more tolerant than those of two males living in the colony. The most intense period of female conflict was during the initial introduction of the group into the enclosure. Once the pecking order was established, the number of incidents began to decrease and were usually centred around the feeding bowl and basking lamps. In males, on the other hand, fighting appeared to increase with increasing size. Thermoregulation to body temperatures similar to those recorded from free-living iguanas was achieved by the use of basking lamps when the

weather was overcast and during hot sunshine by shuttling between the mosaic of sunlit and shaded areas provided by vegetation. Social structure and environmental complexity (Avery, 1985), including providing an appropriate thermal environment and the cultivation of a broad selection of plant species as potential food, are important considerations to be taken into account when establishing captive colonies of iguanas.

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