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Notes on alimentary habits and spatial-temporal distribution of eating behaviour patterns in a natural population of lizards (*Gallotia galloti*)

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RESUMEN: A partir de observaciones del comportamiento se describen los hábitos alimenticios de ejemplares de *Gallotia galloti* en una población natural. Se analizan también las distribuciones espacial y temporal de las conductas alimentarias en un área de 352 m^2 Los lagartos presentaron una dieta principalmente vegetal, incluyendo sobre todo frutos de *Opuntia* y flores de *Launaea arborescens*, aunque también se alimentaron de algunos insectos. Por otra parte, la distribución temporal de las diferentes conductas de alimentación fue afectada por el tiempo atmosférico, siendo más común en horas cercanas al mediodía. Se observó así mismo una distribución espacial solapada para las conductas de alimentación de los diferentes animales.
Palabras clave: Hábitos alimenticios, distribución espacial y temporal, conductas de alimentación, lagartos, Islas Canarias.

ABSTRACT: The alimentary habits of lizard specimens are described from behavioural observations of a natural population of the species *Gallotia galloti*. The spatial and temporal distribution of eating behaviours in the studied specimens were also analysed for a selected area of 352 m^2. The results showed that the cited population had a mainly vegetable diet, principally *Opuntia* fruits and *Launaea arborescens* flowers, although it also fed on some insects. On the other hand, the temporal distribution of different eating behaviours was influenced by the weather, being more common in hours near midday. Overlapping spatial distribution of eating behaviours for the different animals was observed.
Key words: Alimentary habits, spatial and temporal distribution, eating behaviours, lizards, Canary Islands

INTRODUCTION

The diets of many different species of lizards have been profusely studied, small iguanids having been shown to be mainly insectivorous (TANNER and HOPKIN, 1972;

PIANKA and PARKER, 1972, 1975; VITT and OHMART, 1974; SIMON, 1975; PARKER and PIANKA, 1975; TANNER and KROGH, 1975; LESCURE and FRETEY, 1977), the same occurring in most of the lacertids studied (ROLLINAT, 1934; AVERY, 1966, 1971, 1978; ITAMIES and KOSKELA, 1971; KABISCH, 1971). However, larger iguanids are mainly herbivorous (POUGH, 1973) and some lacertids, *Lacerta lepida* and *Lacerta dugessi*, have been cited as being omnivorous (SADEK, 1981). The diet of Canarian lizards, genus *Gallotia*, has not been studied in detail. However, some field notes, results of excrement analysis (BARQUÍN and WILDPRET, 1975) as well as observations of eating behaviour (MOLINA-BORJA, 1981) of Gallotia galloti from Tenerife have been published. For *G. stehlini* from Gran Canaria island, some feeding notes (STEINDACHNER, 1891), behaviour observations on eating behaviours (MOLINA-BORJA, 1986) and excrement analysis (BARQUÍN et al., 1986) have also been reported. LÓPEZ-JURADO (1981), in turn, studied the diet of G. atlantica from Lanzarote and Fuerteventura by means of gut content analysis and showed that this species is mainly insectivorous but also consumes vegetable matter, the latter having been confirmed by behaviour observations (MOLINA-BORJA and BARQUÍN, 1986). Moreover, MACHADO (1985) has reported on the omnivorous diet of the giant lizard G. aff. simonyi from El Hierro, as discovered from the analysis of excrement contents. However, there are only a few short reports on the study of spatial and/or temporal distribution of behaviour patterns in wild lizards, including eating behaviours (NAGY, 1973; SIMON and MIDDENDORF, 1976; HOUSE et al., 1980; SHAFFER and WHITFORD, 1981). Therefore, in the present paper, the behaviour during feeding, the animal and plant species that were seen to be eaten as well as the spatio-temporal distribution pattern of eating behaviours are described for a natural population of *G. galloti* in Tenerife.

MATERIAL AND METHODS

A natural population of lizards was studied in the locality of El Rayo, Buenavista (Northwest Tenerife). Although specimens identified as *G. galloti galloti* and *G. g. eisentrauti* (BISCHOFF, 1982) were both present in the zone, only individuals of the last subspecies are considered in the present work. The data were collected whilst carrying out a more general study on the distribution of lizard behaviour (MOLINA-BORJA, 1985). An area of 352 m^2 (22 x 16 m) was chosen in the specified locality and was marked with sticks situated every 2 m in order to have reference points with which to associate the behaviour of the animals. The lizard activity was observed by means of binoculars and from a hide situated on a platform 1.5 m above the ground. The hide was five metres away from the front border of the study area. Behaviour recordings were made two days per week mainly during the months of April, May and June. Before the study period up to 14 animals were captured and painted with a two-colour code on the parietal cephalic plates in order to identify them. This mark faded after two to three weeks, but particular anatomical and coloration characteristics of the lizards could be used to identify them and so up to 10 animals could be distinguished. Each behaviour pattern performed by any animal was verbally recorded on a microcassette, using a numerical code; the code for eating patterns is included here for reference throughout the rest of the paper: Licking jaws (5), Head-bending (13), Food licking (3), Chewing (23), Mouth food carrying while walking (45), Prey persecution (50) and Head towards prey (56). From these recordings the following data were transcribed

onto paper and analysed: time of occurrence of behaviour patterns, frequencies, place of performance, behaviour sequences and plant and animal species being consumed by every lizard.

RESULTS AND DISCUSSION

Vegetation of the zone

Based on the visual inspection of the chosen zone, a list of the main vegetable species, in order of decreasing presence, was made and is included here as a reference: *Opuntia dileni* (Fam. Cactaceae), *Launaea arborescens* (Fam. Asteraceae- Cichorieae), *Euphorbia balsamifera* (Fam. Euphorbiaceae), *Kleinia neriifolia* (Fam. Asteraceae), *Argyranthemum frutescens* (Fam. Compositae), *Licium intrincatum* (Fam. Solanaceae) and *Micromeria varia* cf. (Fam. Lamiaceae).

Eating behaviour

In general, lizards were seen to eat both on the ground and on plants. On the ground they mainly ate leaves or flowers of several small plants, but sometimes they were also seen eating ants. On larger plants (shrubs) they consumed flowers and/or fruits. Feeding on small plants at ground level usually occurred when the animals walked around in their exploratory activities. The sequence of behaviours in this case consisted of: the animal bending its head in the direction of the plant leaves, biting and chewing the leaves or flowers and licking jaws. For the description of these patterns see MOLINA-BORJA (1981). The small plant species that were mainly seen to be consumed were *Micromeria varia, Linus* sp., *Trifolium* sp. and *Calendula* sp. On five occasions witnessed, different lizards ate some specimens of the ant *Camponotus rufoglaucus* (Fam. Formicidae). In those cases the animals made rapid head movements on the substratum in order to capture the ant. This type of food has also been referred to for another Canarian lizard, *Gallotia aff. simonyi* (MACHADO, 1985) and different species of ants have already been reported to be eaten by other lizard species: *Hemydactilus brooki* (AVERY, 1981), *Phrynosoma modestum* (SHAFTER and WHITFORD, 1981), *Lacerta dugesii* (SADEK, 1981). A grasshopper as well as other undetermined insects were also seen to be chased by some specimens of *G. galloti*. On other occasions, lizards climbed plants in order to obtain their food. These plants were almost exclusively: *Launaea arborescens* (Fam. Asteraceae) ("ahulaga") and *Opuntia dileni* (Fam. Cactaceae) ("tunera"). When climbing the former, the lizards walked over its branches until they reached its yellow flowers which they ate in a single bite. Several times up to 5 or 6 flowers were consumed by the same lizard from the same individual plant. Lizards also frequently climbed plants of *Opuntia dileni* and on the top of the plant they ate both flowers and fruits. When eating petals, an individual would continually bite them until none remained intact; this contributed to a characteristic shape of the remains of the petals, which could later be recognized as a sign of having been bitten by a lizard. The fruits of this same plant were also consumed by the animals through a hole made in their skin. As the lizards' head were always smaller than the fruit, the anterior part of the head usually became stained with the characteristic red-purple colour of the fruit pulp. This colour remained on the lizard's head and could be used to tell that a particular animal had eaten an *Opuntia* fruit

without actually witnessing it. Sometimes, a lizard found the remains of an *Opuntia* fruit fallen on the ground and ate it there; as the animal tried to separate a piece of the fruit with its mouth, it steadied it with one of its front limbs.

Frequency of observations of different food items

Table 1 resulted from counting the times that observed lizards were seen eating different types of food during the months of April, May and June and calculating the corresponding percentages. Since the numbers of recording days and observed lizards were not the same in the three months, a strict comparison cannot be made. Considering the entire three month period, the foods most consumed were *Opuntia* fruits and Launaea flowers and buds. The twenty-eight percent of small plants corresponded to different species and is therefore not taken into account as the second preferred food.

Total Food items	April	May	June	percent.
Opuntia fruits	12	4	23	39%
Launaea flowers and buds	4	11	4	19%
Small plants (grasses herbs and small shrubs)	16	8	4	28%
Opuntia flower petals	-	1	4	5%
Argyranthemum buds	-	-	1	1%
Camponotus rufo-glaucus	2	2	1	5%
Undetermined insects	-	-	3	3%
n (total number of observations per month) ..	34	26	40	100%

Table 1.- Frequency and percentages of observations with which lizards were seen eating different food items.

The present data and others based on excrement analysis (BARQUÍN and WILDPRET, 1975) and on previous behaviour observations (MOLINA-BORJA, 1981) have shown that adult males consume both plants and insects. Therefore, this information does not agree with the generalization made by POUGH (1973) that lizards weighing between 50-100 g should be herbivorous, because adult males of *G. galloti* can weigh up to 68 g. The study of SADEK (1981) on *Lacerta dugesii* from the Madeiran Archipelago has also shown a partial disagreement with this generalization since it is omnivorous and has a mean weight smaller than that of the smallest omnivorous species listed by Pough. PIANKA (1973), in turn, has hypothesized that being herbivorous can be ecologically advantageous in reducing the foraging range and hence the probability of predatory action on lizards, and SADEK (1981) briefly suggested the possible correlation between reduced space on islands and lizards being herbivores.

Time distribution of eating behaviours

The distribution of eating behaviour patterns for all the observed lizards throughout morning hours of some selected days appears in Fig. 1. In general, these behaviours generally occurred between 10.00 and 12.00 h (8.00 - 10.00 h, solar time) but they could

also occur in the first or last morning hours, depending on the weather. Thus, their highest frequency and earliest occurrence were observed on sunny days (see examples "s" in Fig. 1), while the lowest frequency and latest occurrence were on cloudy days (see examples "c" in Fig. 1). Therefore, there is a clear influence of the environmental temperature on the manifestation of eating behaviours, probably in the sense that these patterns are complex and require that the lizard reaches a high activity level before being able to express them. A higher frequency of feeding activities has also been demonstrated during midmorning or at midday for the lacertids *Lacerta agilis* and *L. vivipara* (HOUSE et al., 1980) and at midday for the iguanid species Sceloporus jarrovi (SIMON, 1975).

Spatial distribution

Fig. 2a represents the places where all the lizards (individually recognized or not) were seen to eat any kind of food during the whole recording period. It can be seen that eating behaviours occurred in almost all the study area, except places in the bottom left and top right corners, possibly due to the poorer visibility of those areas or to a lack of available food items there. A second aspect is that the lizards did not appear to eat within a specific or restricted part of their whole home area. At least, when the feeding places for most of the recording period were represented for several recognized lizards, they were shown to be scattered and most of them appeared near the border of the home area calculated for each animal (see Fig. 2b). When considering all the observed individuals (recognized or not), several of them ate in the same places or very near-by, either on the same or successive days, for example on the same "ahulaga" shrub or on the same fallen fruit of *Opuntia*. A consequence of the overlapping spacing pattern, previously reported (MOLINA-BORJA, 1985), would be to permit a high density of lizards in the zone; in fact, more than twenty different animals could be detected in the study area. KREKORIAN (1976) found that the males of the iguanid *Dipsosaurus dorsalis* changed from having non-overlapped home areas to exhibit overlapped ones when the amount of available food decreased as the result of a wind-storm. This species together with *Sauromalus obesus* was cited to be mainly herbivorous and to deviate from the typical insectivorous diet of other iguanids. However, the overlapping pattern of home areas in *G. galloti* did not appear to be a consequence of a reduced amount of available food: at least vegetable food was present in a sufficient amount. As there are many different habitats within the island where *G. galloti* can live, the vegetation pattern thus being varied, the described feeding habits and spacing pattern do not neccessarily have to exist for all the lizard populations. In fact, other data on alimentary habits of this species in different parts of the island suggest a varied diet (MOLINA-BORJA, 1981, GARCÍA-CASANOVA, personal communication, MOLINA-BORJA, unpublished data).

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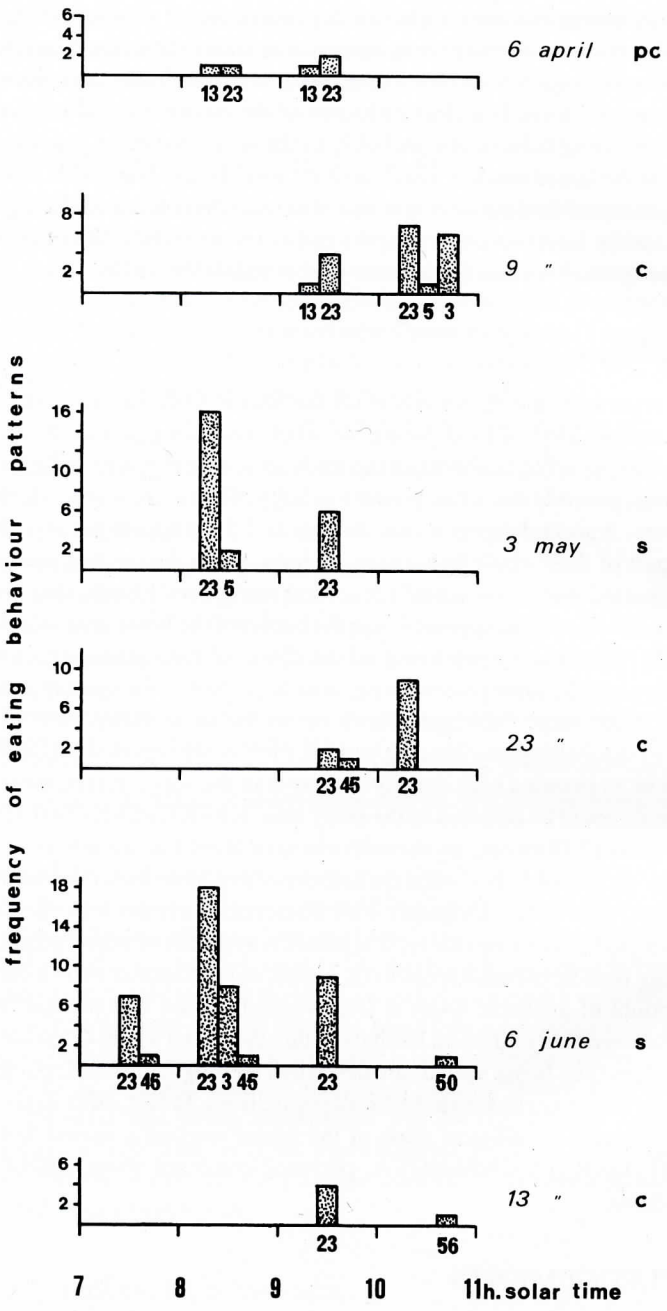

FIG. 1.- Examples of temporal distribution during morning hours of cumulated frequency of eating behaviour patterns for all the lizards; see Methods for the numerical code reference. pc= partially cloudy, c= cloudy, s= sunny.

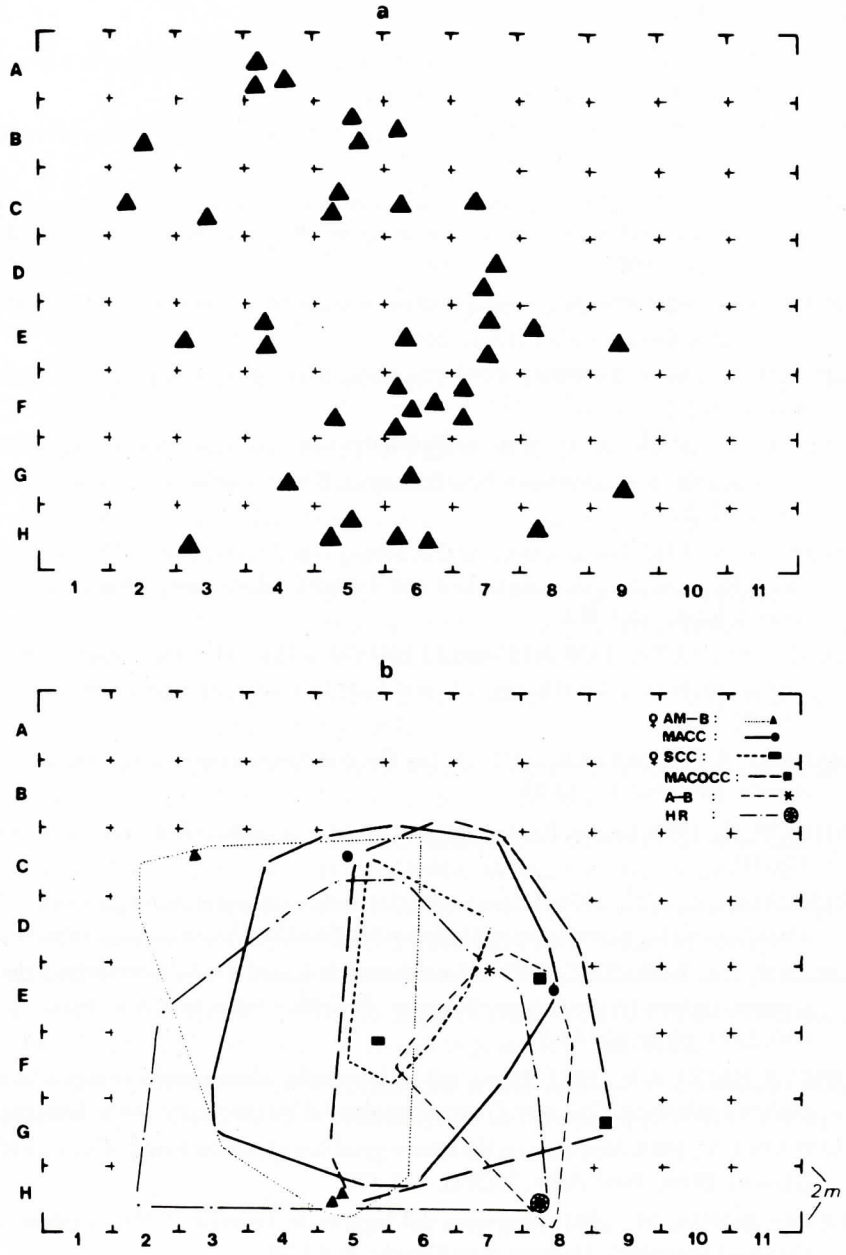

Fig. 2.- a) Locations where eating behaviour patterns were seen to be exhibited by all the observed lizards (from Bonn. Zool. Beitr., with permission). b) Places of eating behaviours (black symbols within the home ranges) for some recognized animals. The polygons shown with different line types correspond to the home ranges calculated for each recognized lizard. Capital letters in the top right corner are reference codes for each individual.

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