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## Spatial and temporal behaviour of *Gallotia galloti* in a natural population of Tenerife

by

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### Introduction

Defended areas or territories have been established in males of the Iguanidae, Agamidae, Scincidae, Teiidae and Lacertidae (Fitch 1973, Mitchell 1973, Bustard 1970a, Parker 1972b, Boag 1973). However, in some cases the existence of reduced territoriality or, even, its absence has been reported (Lynn 1965, Whitford & Whitford 1975).

A great variety of spacing patterns has been found in different lacertid species. Thus, some specimens of certain species maintain areas that overlap with those of others and they do not exhibit, or at least in very few cases, a defense of the whole area (*Lacerta agilis*, Tertyshnikov 1970 and *L. viridis*, Spitz 1971). However, in other cases, the defense of certain specific places within the home area, such as those near shelters or in feeding locations, does exist (*L. agilis* and *Eremias arguta*, Tertyshnikov 1970). A third observation is that certain specific routes appear to be used during activity by male specimens, aggressive behaviour being observed when two males meet in route (*L. muralis*, Steward 1965).

Previous observations (Molina-Borja 1981 and unpublished data) have confirmed the existence of aggression phenomena between males of the Tenerife lizard (*Gallotia galloti*), both in the natural habitat and in captivity. However, little data has been gathered about the specific spacing pattern of this species and even less on the actual relationship between its observed behaviour and the space in which it is expressed.

Still less information is found in the literature about the temporal aspects of lizard behaviour. More commonly, data are about circadian activity rhythms in lacertids (Hoffmann 1957, 1959, Seva & Escarre 1980, Alvarez et al. 1983) and iguanids (Underwood 1970, 1973, 1975, 1977), but virtually nothing is found on the daily evolution of different behaviour patterns (Saint-Girons 1971). More recently, Regal & Connolly (1980) have published some new data on the existence of "temporal territories" in some captive *Tupinambis* specimens.

Therefore, a behavioural study of *G. galloti* was initiated in order to gain some insight into these and other aspects. The preliminary findings about the spatial and temporal behavioural patterns of this lizard are presented here.





Fig. 1. — General view of the study zone.

### Material and Methods

Lizard behaviour was studied in a natural population of El Rayo, a locality near the shore of the town of Buenavista (Northwest of Tenerife island) (Fig. 1). Specimens referable to *G. galloti galloti* and *G. galloti eisenrauti* (Bischoff 1982) were both present in the zone.

To study the animals, a rectangle of 22 x 16 m. (= 352 m<sup>2</sup>) was selected on the cited locality; a stick was anchored on the soil every two meters in order to have a grid of reference points to which the behaviour of the lizards could be associated.

The animals' activity was observed through binoculars from a hide situated on a platform which was at 1.5 m height from the soil. The hide and platform were five meters away from the front limit of the chosen rectangle.

The observation time was usually from 9.00 h to 13.00 h (local time; = 7.00 to 11.00 h solar time) and two days per week in the months of May and June; some preliminary observations were also done in April and others in July, but those of the latter are not presented here.

In April up to 14 animals were trap-captured and marked on the parietal cephalic plates with a two-colour code in order to be able to indentify them later. Unfortunately, this kind of marking only remained visible for two to three weeks and then faded. Therefore, a reference code based on particular morphological and coloration characteristics was used for the rest of the study.

The zone was observed by successively looking at every 4 m<sup>2</sup> square, some days beginning from left to right and from the back to the front of the squares and some other days in a contrary direction; and some days the observation was even initiated from central squares and followed in a random way. These varied observation protocols were done in order to avoid the bias which would result if the same squares were always observed at the same time.



The successive behaviour patterns of the animals were verbally recorded on a micro-cassette, as well as the time and place in which they occurred. Afterwards, these data were transcribed into graphics of behaviour pattern frequencies during each hour of the day, by summing the data of all the individual lizards. A numerical reference code was used for the different patterns of the lizard behavioural repertoire. Those patterns which were seen during the study are included here for reference: Scratching (1), Foot movement (2), Food-licking (3), Licking jaws (5), Tongue-flicking (8), Locomotion (9), Climbing (10), Descending from plant (10'), Digging (11), Running (12), Head-bending (13), Resting-front legs extended (14), Head-movements (16), Resting-head raised (17), Defecating (18), Head-movement on substratum (16'), Flight (20), Chewing (23), Resting-head down (25), Front-leg pattering (26), Alarm-posture (27), Tongue-flicking on excrement (28), Dewlap (29), Persecution (30), Squeak (32), Licking-chewing on feet (37), Male head toward female body (43), Courting dewlap (44), Mouth food carrying while walking (45), Male head bobbing (47), Projecting head on excrement (48), Prey persecution (50).

Every lizard's home area was established by connecting the outermost points of the locality in which each one was seen. That is to say, the convex polygon method was employed, a technique which has previously been used (Southwood 1966, Jennrich & Turner 1969) for capture points in trapping the animals. A convex polygon was obtained every day and for each of the recognizable lizards.

Although a direct observation method was used in the present study, an estimation of every home area was made using the formula:  $A_1 = 1/2 (X_i Y_{i+1} - X_{i+1} Y_i)$  which has been used previously for lizard capture points (Jennrich & Turner 1969).

The variation of temperatures and relative humidity was simultaneously obtained by periodically noting these factors (every 15 minutes), using a maximum—minimum thermometer and hygrometer, both situated at ground level.

## Results and Discussion

Morning temperatures ranged from 19°C to 28°C and midday ones between 34° and 38°C, while relative humidity varied between 55 to 95 % (morning) and 35 to 45 % (midday) (see Figs. 2 & 3). Temperature curves usually grew very quickly, except on some cloudy days (23-5-82: Fig. 2).

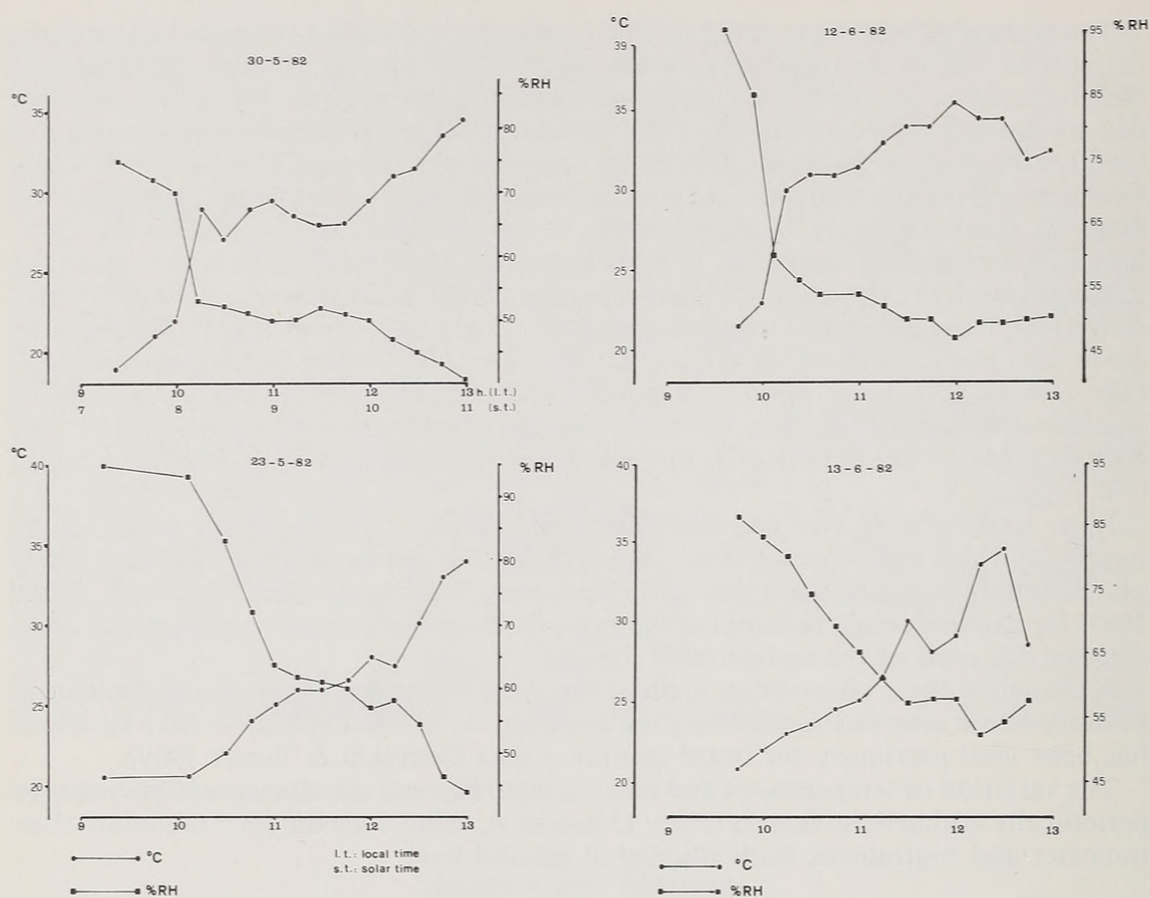
### Behaviour temporal distribution

Two examples of the graphics of daily distribution of behaviour pattern frequencies appear in Figs. 4 & 5. By comparing all the graphics, it was firstly noticed that the general activity of the animals appears to increase from April to June, except for some cloudy days in June. That is to say, a greater number of individuals and, hence, of different behaviour patterns was observed in June in comparison with April. The activity also began earlier during the observed days of June than in those of April.

During the every-day general activity, basking was seen to be performed mainly in the first observation hour (9.00 to 10.00 h., local time), being drastically reduced in the following hours, except when the day was partially cloudy and temperatures lower (Fig. 4).

Locomotor behaviour and, in general, exploration activities were more evident in the first two or three hours, being partially reduced towards midday (Figs. 4 & 5).





Figs 2 (left) & 3. — Temperature and relative humidity evolution during some recording days.

Feeding behaviour was mainly observed between 10.00 and 12.00 h. (local time) (Figs. 4 & 5), although sometimes such activity was also seen near the end of the observation period (13.00 h).

The same time distribution again occurred for aggression and courting activities although, on hot days, they were seen even from the first observation hour (Fig. 5).

A strict statistical comparison could not be done because of some discrepancies in the recording period during several days and in the number of observed active lizards per day. However, courting and aggressive behaviours seemed to be more frequent in the last study days (Fig. 5). A new behaviour pattern, tentatively assigned to a general behaviour category called "Egg-laying", was observed in the last day of recording. This pattern consisted of a movement in which the animal (a female with a folded skin) seemed to be engaged in a sort of ground digging and using the four legs, the result appearing to be a spreading and/or flattening of the soft soil. As this activity was seen to be repeatedly performed by this animal, it was thought that perhaps it could correspond to a step in the later stages of egg-laying. At the end of recording the author excavated in



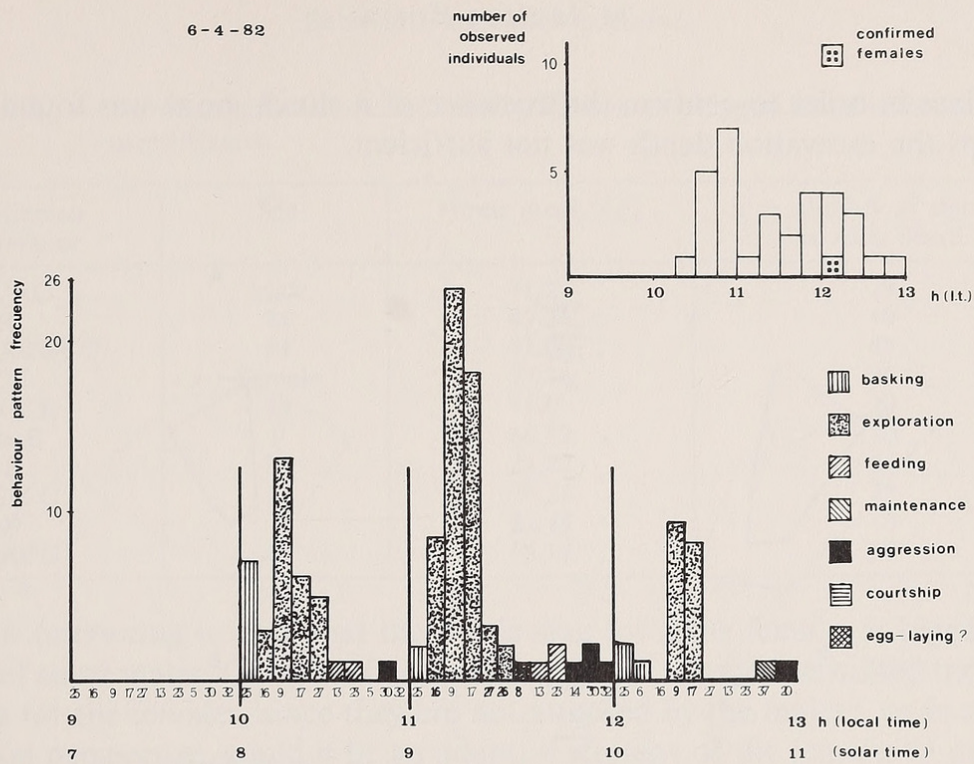
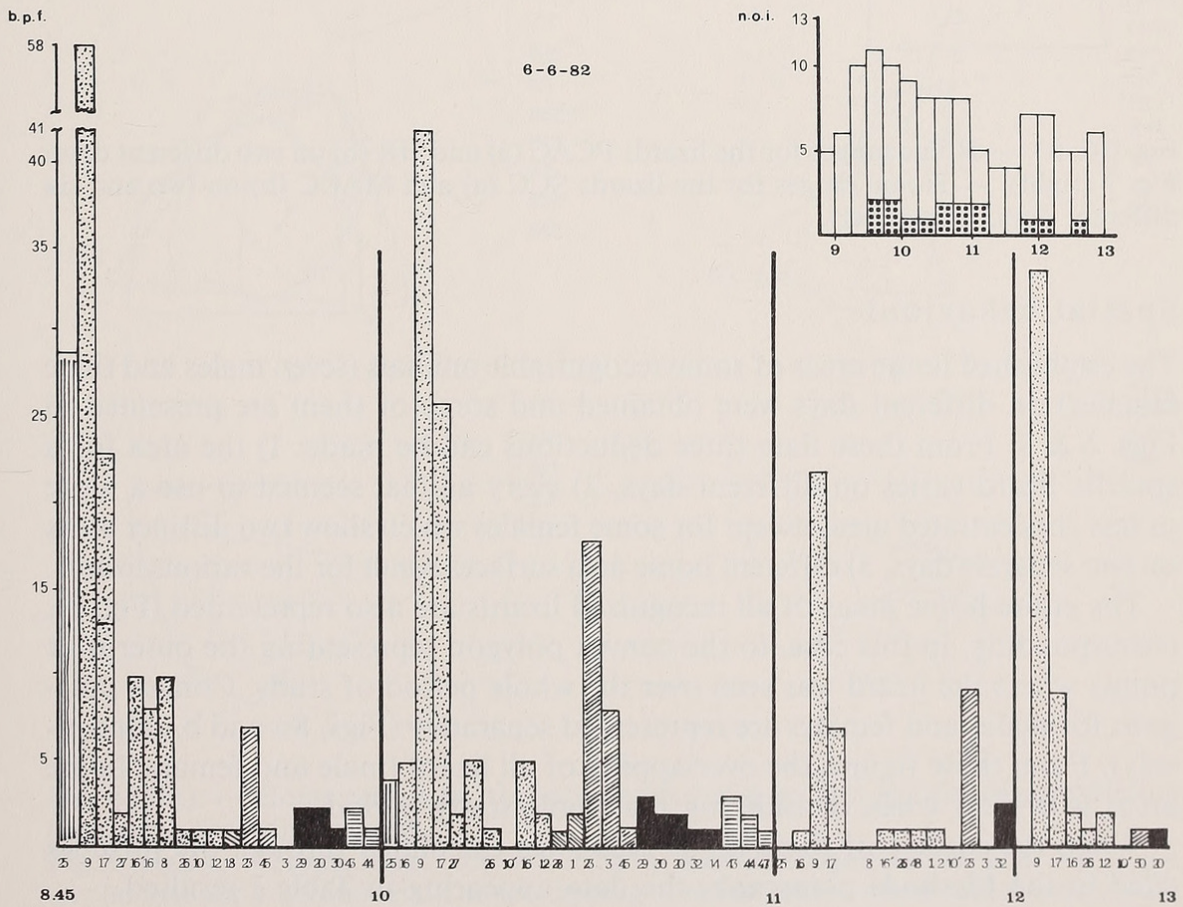


Fig. 4. — Behaviour pattern frequencies for all the recorded lizards on 6-april-82. Small numbers between hours give a reference code for the different behaviour patterns.

Fig. 5. — Idem for 6-june-82.





that place in order to confirm the existence of a clutch; none was found, but perhaps the excavation depth was not sufficient.

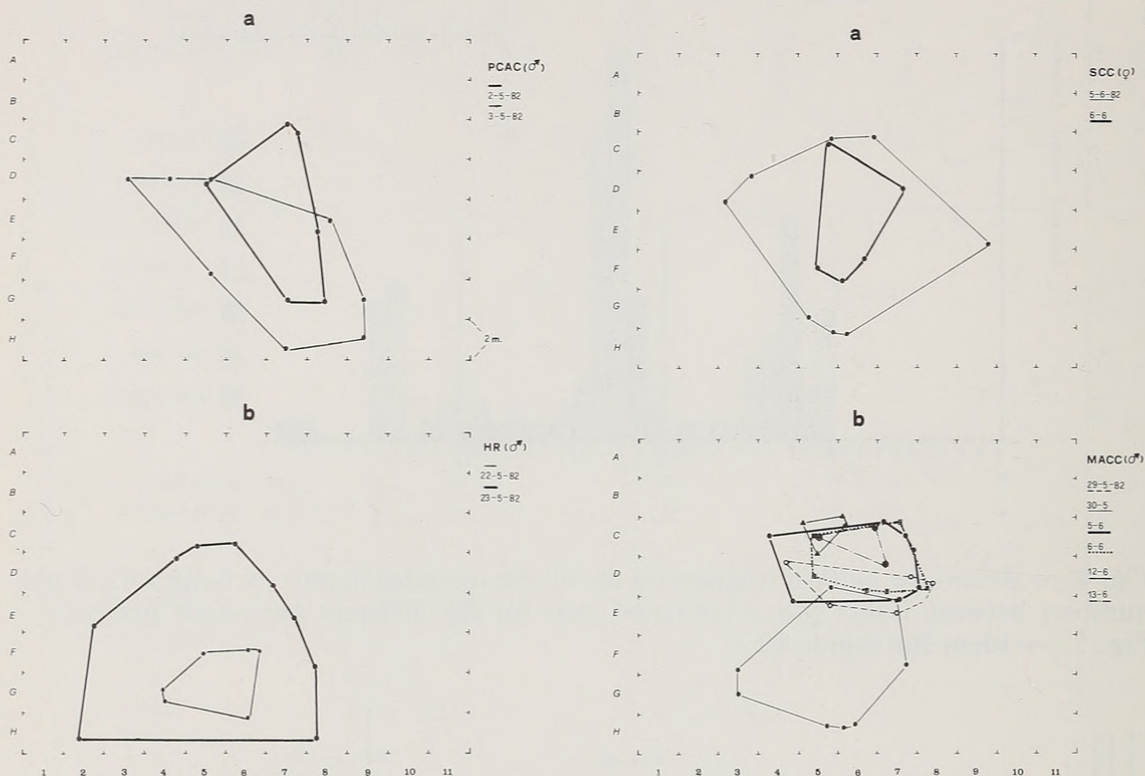


Fig. 6 (left). — Home ranges for the lizards PCAC (a) and HR (b) on two different days. Fig. 7 (right). — Home ranges for the lizards SCC (a) and MACC (b) on two and six different days, respectively.

### Spatial behaviour

The established home areas of some recognizable animals (seven males and three females) on different days were obtained and some of them are presented in Figs. 6 & 7. From these data three deductions can be made: 1) the area for a specific lizard varies on different days, 2) every animal seemed to use a more or less concentrated area, except for some females which show two distinct areas on two separate days, 3) different home area surfaces result for the various lizards.

The entire home areas of all recognized lizards are also represented (Fig. 8), corresponding, in this case, to the convex polygon representing the outermost points where the lizard was seen over the whole period of study. Convex polygons for males and females are represented separately (Figs. 8a and b, respectively). From these figures the overlapping of all lizard (male and female) home areas is evident when considering the whole study period.

When the surface of these home areas was calculated through the formula cited in the Methods paragraph, the data appearing in Table I resulted.



Table I. — Home area surfaces calculated by the convex polygon method for ten recognized lizards.

Specimen reference	Sex	Home areas (m <sup>2</sup> )	n = number of sightings of each lizard
PCAC	Male	71.27	29
HR	M	89.26	40
MACOCC	M	55.06	44
SCC	Female	77.74	26
MCCR	M	15.0	20
Am-B	F	66.13	20
A-B	M	23.82	26
MACC	M	79.21	73
R-B	F	22.46	8
MACO	M	78.17	39

It is interesting to note that the whole area for some females is bigger than that of some males. Could this be an indication of a larger permitted travelling space for the females, since they are not attacked by the males?, or in a more general perspective, could it be an adaptive strategy of the females in order to search for the optimal males?. These are questions that require further investigation to be answered.

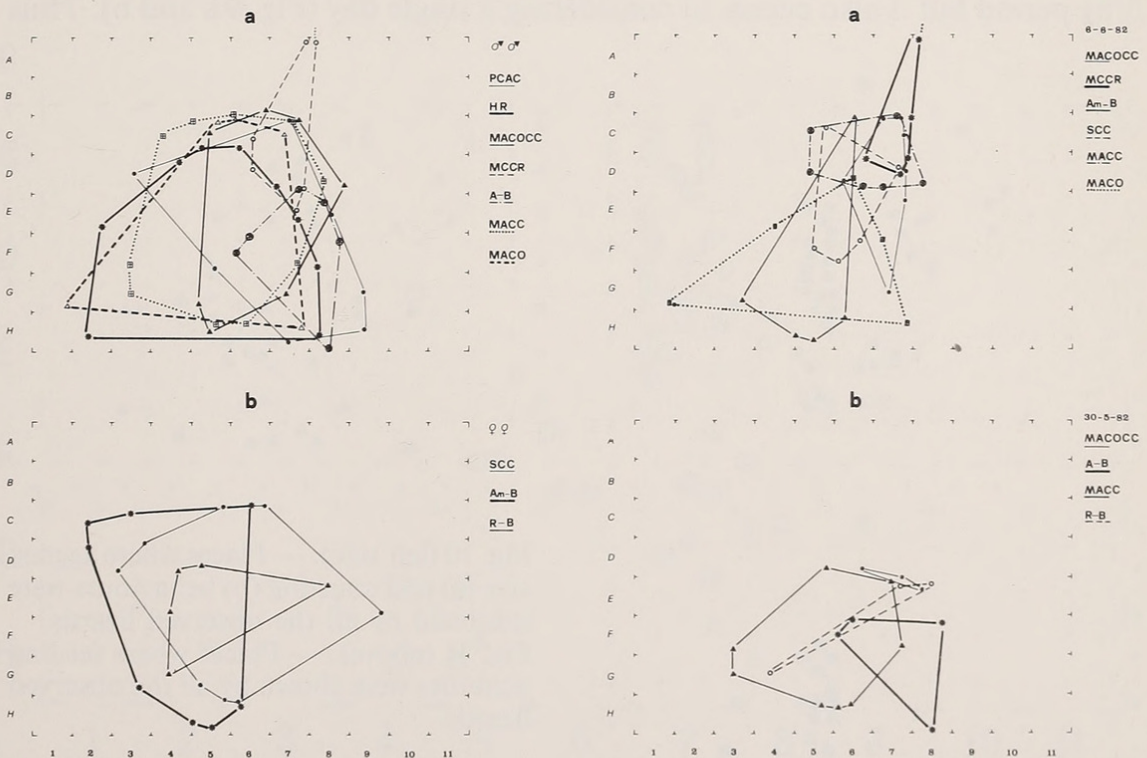


Fig. 8 (left). — Home ranges for the recognized males (a) and females (b) considering the overall recording period.

Fig. 9 (right). — Home ranges for two different sets of recognized lizards in one single day (a: first set; b: second set). The overlapping of the respective home ranges can be seen.



Jennrich & Turner (1969) gave a method to correct the polygon technique for sample size bias, that is to say, the influence of the number of captures or recordings on the estimated home range. However, this correction has not been done in our case because no observational studies of spatial behaviour were considered in their paper. The applicability of that method to cases of direct observational studies, such as ours, has not been treated in the literature. Thus, for example, the presence of a lizard may have been recorded up to a maximum of 73 different times (see Table I) during our study, and such figures are not very usual in capture techniques.

The direct observation method used in the present study gives more information about the every-day lizard movements than the classical one based on capture points, and there are other advantages which have already been mentioned (Mackay 1975). Therefore, apart from some possible error due to the lack of good visibility, in establishing some of the home range outermost points, the estimation of the whole home area appears to be more accurate in our case. However, the fact that the different lizard home areas were obtained from data over a different number of days must be taken into account; this varied day number being due to the variability of the visibility of the several representative lizards on different days.

The overlapping of lizard home ranges has been shown for the whole recording period but it also occurs in considering a single day (Fig. 9a and b). Thus

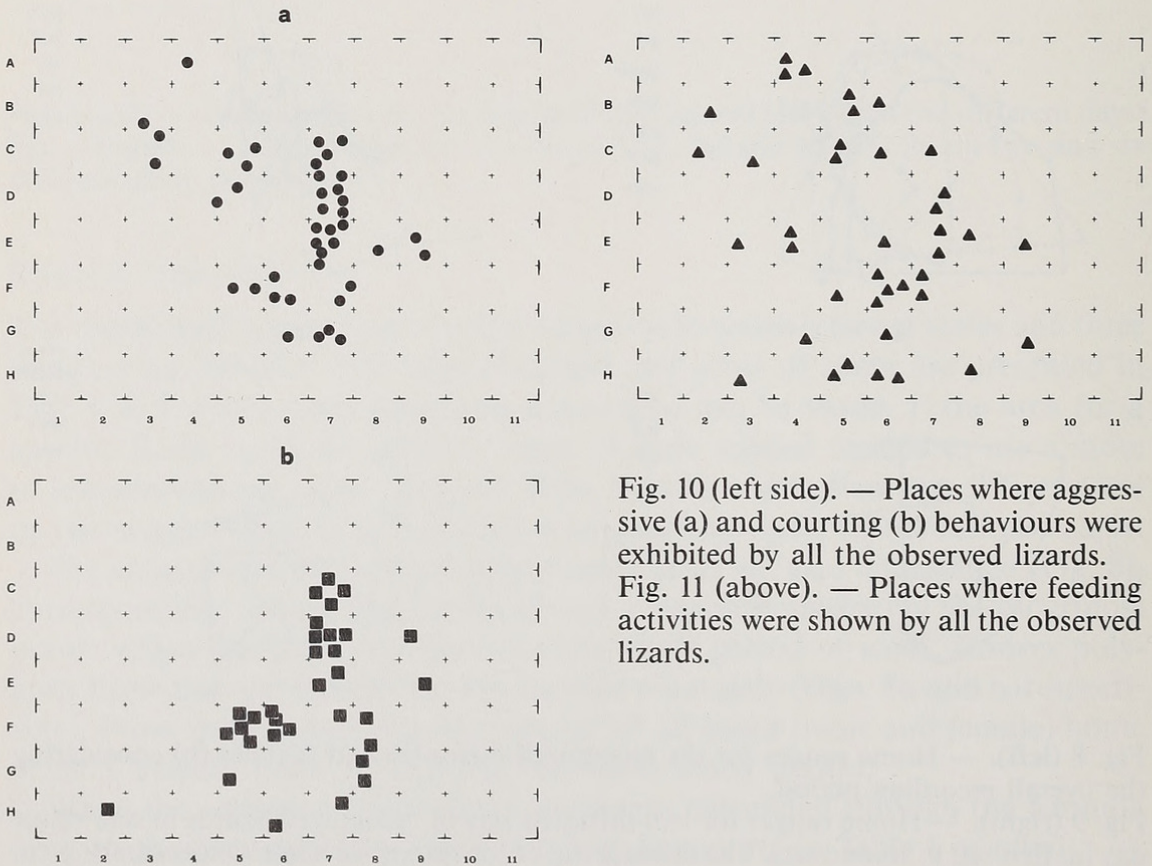


Fig. 10 (left side). — Places where aggressive (a) and courting (b) behaviours were exhibited by all the observed lizards.

Fig. 11 (above). — Places where feeding activities were shown by all the observed lizards.



the home range overlap seems to be a characteristic of the spacing pattern of these lizards. This overlapping, of course, does not imply all the animals being present at the same time in the same locality.

With respect to the possible existence of individual territories within the home area, it appears that they do not exist. At least when the places where aggression, courting and feeding activities were recorded for the observed lizards (individually recognized or not) (Figs. 10a and b, and 11) no strict area was found to be used for such behaviours by any individual lizard exclusively. That is to say, several lizards exhibited aggression, courting and feeding in the same or neighbouring places, even within a single 2 x 2 m square (for example in C-7 or D-7).

The same result emerged when the places of aggression, courting and feeding activities were represented for the entire recording period and for the ten representative lizards (Fig. 12). Here can be clearly seen that aggression (○), courting (□) and feeding (△) were manifested by at least five different lizards in a single square (D-7).

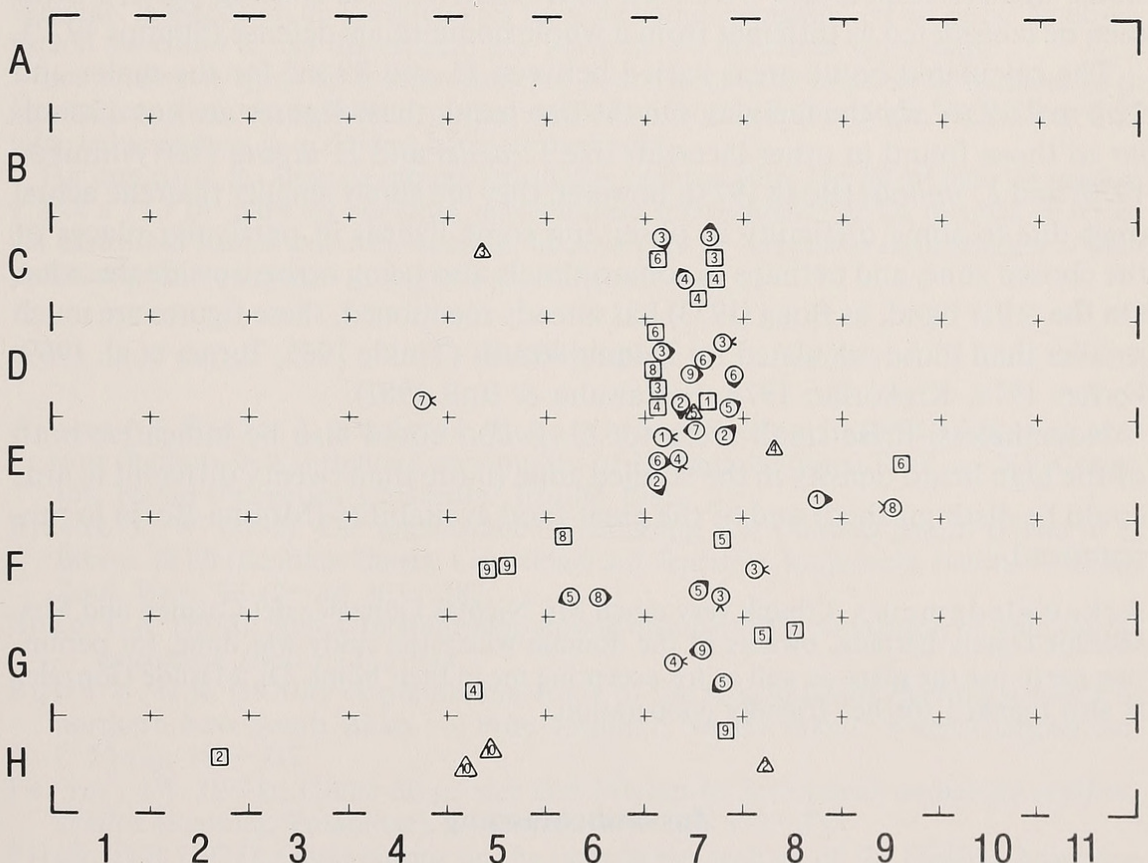


Fig. 12. — Places where aggressive (○), courting (□) and feeding (△) behaviours were shown by the recognized lizards (1, 2, 3 . . . 10). Reference code for every animal: 1 = PCAC; 2 = HR; 3 = MACC; 4 = MACOCC; 5 = A-B; 6 = MCCR; 7 = R-B; 8 = SCC, 9 = MACO; 10 = Am-B. ○>: emitted aggression; ○<: received aggression.



Thus, it appears that the only existing territories, if any, were of a temporal kind. That is to say, a lizard defends some specific places at defined times.

In summary, the spacing pattern of the lizard population studied seems to vary both in the amount of total travelled surface by each animal and in the places they run over. No strict territory seems to exist for any lizard, the whole home areas overlapping to a large extent. Consequently, the animals could travel through the same places at different times and when they meet, aggression, avoidance or courting could occur.

When two males meet in some place, several things could happen: 1) one of the males retires, 2) one of the males shows an aggressive dewlap posture and the other retires, 3) both males engage in aggressive dewlap postures and try to bite one another and, after this, one of them escapes being pursued by the other.

This particular spacing pattern in *G. galloti* is in accordance with that cited by Tertyshnikov (1970) for *L. agilis* and *E. arguta*, because there is no defense of the whole area but of specific sites. However, in our case no such association could be found with preferred feeding or basking places although, on some occasions, aggressive postures were seen near shelters. This spacing pattern must then be considered as different from a whole home-range defense (Stamps 1977).

The calculated home areas varied between 15 and 89 m<sup>2</sup> for the males and 22.4 to 77.7 m<sup>2</sup> for the females. On the one hand, these figures are not dissimilar to those found in other lacertids like *L. agilis* and *E. arguta* (Tertyshnikov 1970) and *L. muralis* (Boag 1973); however, they are surely smaller than the actual ones due to some difficulty in observing some lizards in particular places of the chosen zone, and perhaps to some animals also being active outside the zone. On the other hand, as Boag (1973) has already mentioned, these figures are much smaller than those calculated for iguanid lizards (Tinkle 1965, Turner et al. 1969, Ferner 1974, Krekorian 1976, Satrawaha & Bull 1981).

Nonetheless, these small areas for *G. galloti* could also be indicative both of the high lizard density in the studied zone (more than twenty different lizards could be distinguished) and of the great food availability (Molina-Borja in preparation).

**Acknowledgments.** I thank very much Mr. Nicolás González del Carmen and Mrs. Matilde García-Estrada, owners of the domain where the study was done, for permitting me to use the place as well as for accepting me in their home. Dr. Matilde González is also thanked for her friendly cooperation.

### Zusammenfassung

Es wurde das Verhalten einer Eidechsenpopulation in dem Gebiet von Buenavista (NO Teneriffa) untersucht, und zwar mit dem Ziele, raum — zeitliche Aspekte des Verhaltens zu klären. Ein Rechteck von 352 m<sup>2</sup> wurde dort abgesteckt und darauf ein Gitternetz aus Stäben in Abständen von 2 m gesetzt, um das Verhalten mit dem jeweiligen Standort in Verbindung bringen zu können.



Von einem Versteck aus wurde in den Monaten April, Mai, Juni jeweils an zwei Tagen jede Woche beobachtet, und der Wandel der Verhaltensweisen sowie die Benutzung des Raumes durch die Einzelexemplare registriert.

Die Aktivität begann in den Morgenstunden und trat in folgender chronologischer Reihenfolge auf: Sonnen- und Erkundungsverhalten, Aggression und Balz. Um die Mittagszeit ließ die Aktivität nach.

Die Einzugsgebiete hatten eine errechnete Ausdehnung von 15 bis 89 m<sup>2</sup> bei den ♂ und 22,4 bis 77,7 m<sup>2</sup> bei den ♀. In allen Fällen überlappten sich die Bereiche der einzelnen Individuen. Obgleich wahrscheinlich keine Individualreviere vorhanden sind, wurden doch einzelne Plätze gegen Eindringlinge verteidigt.

### Resumen

Se estudió el comportamiento de lagartos en una población natural de una zona de Buenavista (Noroeste de Tenerife) con vistas a obtener datos sobre los aspectos espacial y temporal de dicho comportamiento. Para ello se eligió un rectángulo de 352 m<sup>2</sup> en la citada localidad y se clavó una estaca en el suelo cada dos metros con vistas a disponer de una rejilla de puntos de referencia a los cuales pudiera asociarse, posteriormente, la conducta de los lagartos.

Mediante el registro continuado de la conducta observada desde un hide y durante dos días a la semana de los meses de abril, mayo y junio, pudieron establecerse, respectivamente, la evolución de los diferentes tipos de comportamiento en las horas de observación así como el uso del espacio por parte de los diferentes ejemplares.

Los diferentes tipos de comportamiento aparecieron a lo largo de la mañana y, en general, con el siguiente orden cronológico: Soleamiento y Exploración, Agresión y Correo, reduciéndose la actividad hacia el mediodía.

Por otra parte, las áreas de campeo calculadas variaron entre 15 y 89 m<sup>2</sup> para los machos y 22.4 a 77.7 m<sup>2</sup> para las hembras, detectándose solapamiento de las mismas en todos los casos. No parece evidente, además, la existencia de territorios individuales, si bien pudo observarse defensa de lugares específicos.

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