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Spring aspect of feeding ecology in *Podarcis peloponnesiaca* (BIBRON & BORY, 1833) (Squamata: Sauria: Lacertidae)

Zum Frühjahrsaspekt
der Nahrungsökologie von *Podarcis peloponnesiaca* (BIBRON & BORY, 1833)
(Squamata: Sauria: Lacertidae)

P. MARAGOU & E. D. VALAKOS & Z. GIANNOPOULOS
& A. STAVROPOULOU & B. CHONDROPOULOS

ABSTRACT

The stomach contents of 108 specimens of *Podarcis peloponnesiaca* (BIBRON & BORY, 1833) were examined and the results of the analysis are discussed together with prey availability data. The animals were sampled during the spring months March to May when the activity of the lizards and their prey is at its peak.

According to the results of the present study, *P. peloponnesiaca* feeds mainly on arthropods. Imaginal Coleoptera, Diptera, insect larvae, and spiders were the most frequently encountered prey in the lizard's environment. The same taxa were found to be numerically predominant in the stomachs of *P. peloponnesiaca*.

KURZFASSUNG

In der vorliegenden Arbeit werden Daten über die Mageninhalte von 108 Individuen von *Podarcis peloponnesiaca* (BIBRON & BORY, 1833) sowie über die in ihrem Lebensraum für sie verfügbare Nahrung diskutiert. Die Eidechsen wurden während der Frühlingmonate März bis Mai gefangen, wo die Aktivität dieser Tiere und ihrer Beute den Höhepunkt erreicht.

Danach ernährt sich *P. peloponnesiaca* überwiegend von Arthropoden. Imagines von Coleoptera, Diptera, Insektenlarven und Spinnen sind die häufigsten Beutetiere im Lebensraum der Eidechse; dieselben Taxa dominieren zahlenmäßig auch in ihrem Magen.

KEY WORDS

Podarcis peloponnesiaca; feeding ecology, diet in spring, prey availability, behaviour; Greece

INTRODUCTION

Basic ecological data are as critical to the development of conservation and management strategies for a species as they are to the development of hypotheses that may finally contribute to our understanding of more general ecological phenomena (VITT & ZANNI 1996). This is especially true in cases such as that of *Podarcis peloponnesiaca* (BIBRON & BORY, 1833), where basic ecological data are fragmentary and almost missing.

Even though some greek reptile species have been studied in this respect (CHONDROPOULOS 1984; VALAKOS 1990) and extraterritorial data from other Greek species are available, on the whole, information on their ecology is scarce. For the endemic species data refer mainly to their systematics and distribution. However, the up to now ecological studies on *P. peloponnesiaca* report spiders, Coleoptera and Diptera as being the most favourite prey groups (BRINGSOE 1986; MARAGOU & al. in press).

In this paper we present basic data on diet composition and prey selection of *P. peloponnesiaca*, a lizard species endemic to Peloponnisos, Greece. We comment on data from the spring since the activity of both lizards and prey taxa is at its peak during this period (PARASHI 1973).

MATERIALS AND METHODS

P. peloponnesiaca, a robust lacertid with a snout-vent length of up to 8.5 cm and a tail that can be twice as long, is very common in its distribution area where it is found from sea-level up to 1,500 m in a variety of habitats, basically dry, often broken and stony ones (BRINGSOE 1985; BUTTLE 1987). The species is a mainly ground-dwelling lizard though it can be observed on low rocks, stone walls and other raised surfaces. Occasionally it climbs extensively yet rather clumsily.

For the present study, the stomach contents of 108 *P. peloponnesiaca* specimens sampled between March and May were analyzed. The examined animals were either collected by the authors or belong to the Herpetological Collection of the Alexander Koenig Zoological Research Institute and Museum, Bonn and the Zoological Museum of Patra University.

The stomach contents of each specimen were examined under a dissecting microscope provided with a micrometer scale in the objective lens. We identified prey items and recognizable body parts to order level, except Coleoptera which were identified to family level. The lizard's sex was likewise recorded.

Taxonomic diet composition is summarized in two ways:

(1) numerical proportion of the taxonomic categories calculated from the total number of prey items in the stomachs (%n) and

(2) proportion of lizards that had preyed on a given prey category (F).

The proportion-by-number analysis is biased towards small social insects consumed in large quantities. On the other hand, frequency of occurrence indicates the proportion of the lizard population that is consuming a prey category and assists in correcting the bias outlined above (JAMES 1991).

In order to estimate prey availability and temporal variation of overall food abundance, pitfall traps proportionately placed in the different microhabitats of *P. peloponnesiaca* and filled with ethylenoglycole were used.

The overlap in the diet between sexes and among the months March, April, and May was estimated by the symmetric index of PIANKA (1973):

$$Q_{jk} = \Sigma(p_{ij}.p_{ik}) / \sqrt{\Sigma (p_{ij})^2.(p_{ik})^2}$$

where p_{ij} and p_{ik} are the proportions of prey category i in the diet of two sexes or months (j, k), respectively.

Electivity for a food category was calculated with IVLEV's (1961) index:

$$J = (r_i - p_i) / (r_i + p_i)$$

based on the proportions of prey category i in the diet (r_i) and in the habitat (p_i).

Niche breadth was calculated by the SHANNON-WIENER index:

$$H' = - \Sigma p_j \cdot \log p_j$$

where p_j is the proportion of individuals found in or using resource (prey category) j.

Evenness was calculated by

$$J = H' / H_{max}$$

where H' is the observed SHANNON measure of niche breadth, and H_{max} is the maximum possible SHANNON measure of niche breadth.

Differences between males and females were also estimated by chi-square tests.

RESULTS

Our data indicate that the diet of *P. peloponnesiaca* is of animal origin and consists mainly of arthropods with the exception of a small amount of terrestrial gastropods and insect eggs. The consumed vegetable matter (mainly seeds) and the tiny pieces of stone found in the stomachs were probably randomly taken together with the food.

Comparing the overlap in the diet of adult males and females, we found a high value ($Q_{jk} > 0.8$) that permitted the pooling of the data for further analyses.

In spring, the diet available for *P. peloponnesiaca* consisted of 24 taxonomic prey categories and was dominated by imaginal Coleoptera, Diptera, Hymenoptera, insect larvae, and Araneae (fig. 1). At the same time, these very prey categories were the most frequently encountered ones in the stomachs. About 20 % of the specimens had also consumed vegetable matter. There is a significant correlation between the results of the two ways of estimating the diet composition (SPEARMAN test, rs = 8.63, P > 0.05). The values of niche breadth and evenness suggest that *P. peloponnesiaca* uses a wide variety of prey (March: H' = 3.072, J = 0.83, April: H' = 3.222, J = 0.723, May: H' = 3.462, J = 0.865).

According to the proportion-by-number analysis (%n), the overlap between the months is high, Q_{jk} > 0.88. Regarding the frequency of occurrence (F) the estimated overlap between March and the other spring months is quite high (Q_{jk} > 0.67) but lower than the one between April and May (Q_{jk} = 0.94).

Among the Coleoptera consumed, species of the family Tenebrionidae were numerically most important constituting 45.71 % of the total number of Coleoptera. Five other beetle families were detected (Carabidae, Chrysomelidae, Coccinelidae, Scarabeidae, Curculionidae) with percentages of appearance below 10. However, 24% of the consumed Coleoptera could not be identified to family level.

Regarding frequency of the main prey categories in the environment and electivity, the results are shown in figure 2. Taxa like Collembola and Acarina, although common in the pitfall traps were never found in the lizards' stomachs and, thus, are not shown in figure 2. The presence of Formicidae in the pitfall traps is impressive (46 %) but their negative electivity value (- 0.95) indicates avoidance. Diptera and Araneae are frequently found in the stomachs; nevertheless their electivity is slightly negative. Regarding prey selection, strong positive electivity was estimated for insect larvae, imaginal Hymenoptera, Coleoptera, Heteroptera, Trichoptera and Gastropoda. From these groups only the first three are actually important in the diet of *P. peloponnesiaca* during spring.

No method of collecting insects samples the environment exactly as a foraging lizard does. Since the various prey types differ in their mobility and capturability, it is clear that the data obtained from traps and stomach contents cannot be compared without a bias.

This should be the case with Gastropoda, Trichoptera and Isopoda, which do not contribute to the diet of *P. peloponnesiaca* corresponding to their high electivity values.

DISCUSSION

The members of the family Lacertidae are small to medium sized lizards that prey upon a wide variety of mainly arthropod prey without obvious dietary specializations (GREENE 1982). Lacertids are opportunistic predators and variations in their diet composition reflect largely body size constraints and differences in prey availability (ARNOLD 1987).

Like the rest of the Mediterranean lacertid species, *P. peloponnesiaca* feeds mainly on arthropods. The observed predominance of Coleoptera has also been reported for other lacertids as well (e. g., ESCARRE & VERICAD 1983; CHONDROPOULOS 1984; VALAKOS 1990; ARNOLD 1987; CASTILLA & al. 1991).

About 20% of the specimens examined had consumed plant matter like seeds, pieces of leafs and stems. Herbivory has been observed in the Lacertidae connected to poor animal food availability in islands (PEREZ-MELLADO & CORTI 1993), a fact that does not apply to our case. Moreover, this plant matter never represented a substantial fraction of the food volume in the stomachs. Therefore we consider that plant matter was accidentally consumed together with the prey and, thus, can be regarded as additional food sporadically eaten (CASTILLA & al. 1991).

The differences observed in prey composition between March and the other months can be partly attributed to small sample size but most probably to the fact that March is at the beginning of the activity period (MARAGOU & al. 1995) when the weather conditions are not always favourable.

The absence of ants from the diet of

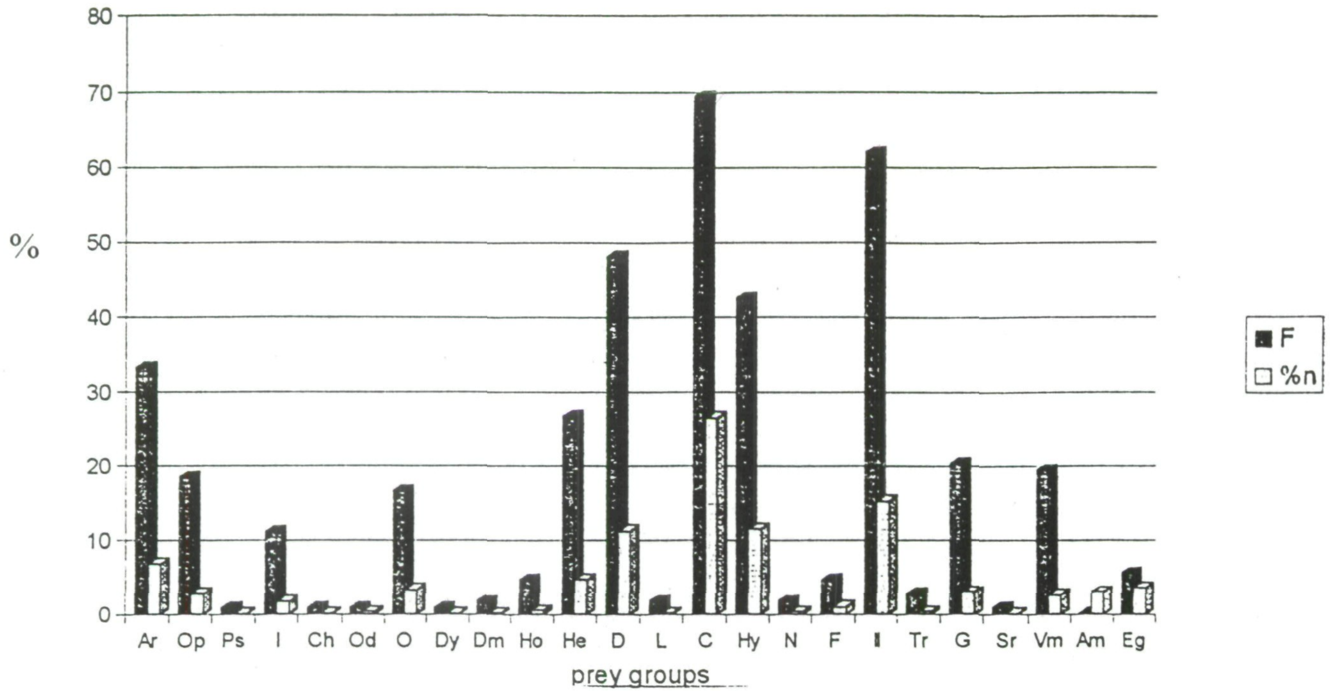

Fig 1: Stomach contents of 108 specimens of *Podarcis peloponnesiaca*; spring aspect.
%n - proportion-by-number of prey items, F - frequency of occurrence (proportion of lizards containing the prey category).
Ar - Araneae, Op - Opiliones, Ps - Pseudoscorpiones, I - Isopoda, Ch - Chilopoda, Od - Odonata, O - Orthoptera, Dy - Dictyoptera, Dm - Dermaptera, Ho - Homoptera, He - Heteroptera, D - Diptera, L - Lepidoptera, C - Coleoptera, Hy - Hymenoptera, N - Neuroptera, F - Formicidae, Il - Insect larvae, Tr - Trichoptera, G - Gastropoda, Sr - Skin residues, Vm - Vegetable matter, Am - Anorganic matter, Eg - Insect eggs.

Fig.1: Die Mageninhalte von 108 Exemplaren *Podarcis peloponnesiaca*; Frühjahrsaspekt.
%n - Zahlenmäßiger Anteil der Nahrungskategorie, F - Häufigkeit des Vorkommens (Anteil der Eidechsen mit dieser Nahrungskategorie im Magen).
Ar - Araneae, Op - Opiliones, Ps - Pseudoscorpiones, I - Isopoda, Ch - Chilopoda, Od - Odonata, O - Orthoptera, Dy - Dictyoptera, Dm - Dermaptera, Ho - Homoptera, He - Heteroptera, D - Diptera, L - Lepidoptera, C - Coleoptera, Hy - Hymenoptera, N - Neuroptera, F - Formicidae, Il - Insektenlarven, Tr - Trichoptera, G - Gastropoda, Sr - Hautreste, Vm - Pflanzenmaterial, An - Anorganisches Material, Eg - Insekteneier.

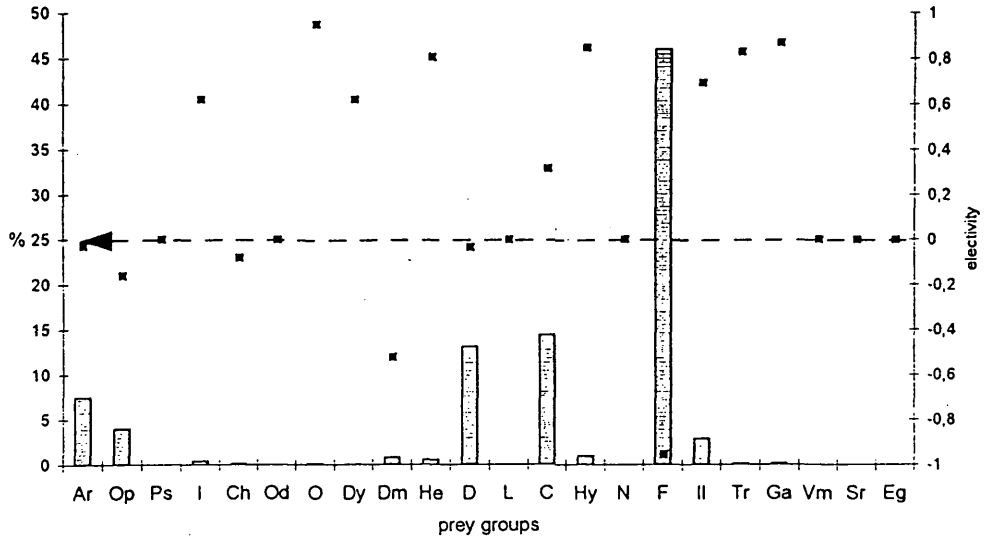

Fig. 2: Relative frequency (columns, %) of prey categories in the environment of *Podarcis peloponnesiaca* (results from pitfall traps) and electivity (black squares) values. Abbreviations as in figure1.

Abb. 2: Relative Häufigkeit (Säulen, %) der Beutetierkategorien im Lebensraum von *Podarcis peloponnesiaca* und Elektivitätswerte (schwarze Quadrate, electivity). Abkürzungen siehe Abbildung 1.

P. peloponnesiaca is an interesting fact since Formicidae are abundant and a quite common prey in other *Podarcis* species, especially in insular populations (VALAKOS 1990; PEREZ-MELLADO & CORTI 1993, CHONDTOPOULOS & al. 1993). It seems that myrmecophagy is associated with environments with poor trophic resources.

The values for niche breadth and eveness suggest that *P. peloponnesiaca* uses a wide variety of prey. In the diet we also observe a considerable number of sedentary and nocturnal animals like Gastropoda, insect larvae and Opiliones. This indicates that the species is a widely foraging predator (HUEY & PIANKA 1981) similar to the majority of the other lacertids.

Insect larvae, imaginal Heteroptera, Hymenoptera and Orthoptera are prey categories that are relatively common in the diet. However, their abundance in the field during the spring months is proportionately lower. We therefore believe that *P. peloponnesiaca* cannot be considered an opportunistic feeder. The above, as well as the strong positive electivity for insect larvae and the negative electivity for Diptera permit us to consider this lizard a fundamental food generalist with trophic limitations based on its behaviour (mainly a ground-dweller) and the fluctuations of food availability through the year.

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AUTHORS: Dr. PANAGIOTA MARAGOU [1,2] & Dr. EUSTRATIOS D. VALAKOS [2] & ZAFIRIS GIANNOPOULOS [2] & ANTONIA STAVROPOULOU [2] & Dr. BASIL P. CHONDROPOULOS [1]

[1] Section of Animal Biology, Department of Biology, University of Patra, 26001 Patra, Greece. [2] Section of Animal and Human Physiology, Department of Biology, University of Athens, 15771 Athens, Greece.