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Nutritional Aspects & Prey Preference Interplay
Observed in Four species of Horned Lizards

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ABSTRACT:

Amongst horned lizard experts it is commonly held that ants, primarily harvester ants (particularly, *Pogonomyrmex spp.*, and [*Vero]messor spp.*), make up the main food source of all known *Phrynosoma*. Field studies, observation of captives, and examination of horned lizard scat have all lent credence to this notion, but the percentages being suggested in most articles unaccompanied by sufficient observation data may be more conjecture than fact. The bottom line is that simply too little published data exits. To examine this problem one must consider that:

1) Different species of horned lizards vary in their numerical ant intake.

2) Each horned lizard species may have contrasting feeding habits when comparing feeding behavior in the morning to that at dusk.

3) Opportunism in foraging needs to be properly evaluated.

4) A comprehensive correlation is lacking which compares data for hatchling, juvenile, sub-adult, and mature specimens, and importantly, based on the prey that is in their natural habitats and under average temperature and moisture regimes in which they exist.

5) Variables such as periodic drought or excessive rainfall; latitude, longitude, and altitude; natural barriers like mountains and rivers which tend to isolate populations; need to be considered before arriving at definitive conclusions.

6) The consideration of usually broad geographic distributions for even a single species, and the multitude of micro habitats therein supporting genetically distinct populations, must temper generalized, sweeping statements about prey preferences.

The writer commenced re-examination of the "ant specialist issue" by charting the precise arthropod consumption of three hatchling *Phrynosoma platyrhinos* through to first year hibernation (1999-2000), intermittent winter emergence, and final spring emergence to develop a provocative hypothesis, i.e., "Horned Lizards Generally Are Opportunists". This tentative conclusion has been reinforced subsequently by observations of additional hatchlings indoors, and a number of adult captives (*P. cornutum, hernandesi, mcallii,* and *platyrhinos*), the latter in both indoor and outdoor terraria and in an outdoor enclosure simulating a typical habitat niche. Note: Albeit *P. hernandes*i studied were native to the mountains and consequently were forced to withstand a mid-desert backdrop, the impact of a potential humidity loss and risk of overheating were minimized by maintaining them within the aforesaid indoor, refrigerated air, microclimate.

Certainly horned lizards are myrmecophagus, but by no means exclusively so. Admittedly, the hypothesis needs to be tested further, but interestingly enough, all species were less anthropomorphic for ants than for other types of insects when are offered simultaneously.

Interpretation of the graphed data compiled thus far seems to suggest that quantities of certain food items ingested probably influences subsequent choices, both in the short run (a single feeding session), and what the horned lizard is hungry for at the commencement of the next day.

DISCUSSION:

Dr. Brown in her excellent dissertation and other recent works[1] has maintained the traditional line of thinking that horned lizards are not only myrmecophagus, but somewhat ant specialists. The fact that other insect remains are found in scat and within the dissected stomachs of preserved or sacrificed specimens has been normally used as evidence that besides ants, horned lizards require other insect forms to provide essential nutrients, or at least, water in greater quantities. Some have gone so far as to suggest that Phrynosoma have evolved a dependency upon the formic acid found to be prevalent in so many ant species. Others have said that horned lizards have merely developed a greater tolerance to it than most other lizards, much like the notion of their higher tolerance to the venom from the sting of ants. The former conjecture in retrospect would seem no more logical than stating that horned lizards have a dependency upon on ant venom and need to be stung every now and then to derive some sort of stimulus therefrom. In fact, formic acid is not a terribly complex substance and is readily assimilable by a variety of animals, other reptiles included[2].

What if the evidence were looked at in another way? Suppose horned lizards eat lots of ants because 1) ants are more numerous than other insects and have somewhat more defined patterns of activity and a permanent residence, and 2) are simply easier to catch by a waddly quadruped than flying or hopping insects?

ALTERNATIVE HYPOTHESIS:

Horned lizards are anthropomorphic for several genera of insects in preference to ants.

EXPERIMENT DESIGN:

Throughout the last two years the writer has charted what appears to be prey preferences of *Phrynosoma* temporarily housed in glass terraria (sealed in the case of flying insect prey). An outdoor enclosure was maintained from which candidates of more than one species could readily be obtained in the experimentation process. Individuals were placed in groups of twos and threes in the same cage to see further if different species might be more aggressive, or if even individual preferences within a single species might be observable as to a given prey item. Each reptile was distinctively marked, or certain were provided for distinctive ant species to better analyze what may be termed "**the Harvester Ant Myth**," infra. Tick marks were used for each insect consumed. These were later tabulated on a calendar basis and the resultant totals were incorporated in the graphs and charts which follow. Even various insects were weighed[3] to help correlate individual food mass to total consumption capability.

[1] "San Diego Coast Horned Lizards" (*Phrynosoma coronatum blainvillei*) pp. 6-8, Annual Report, 1999, ("CRES") Center for Reproduction of Endangered Species. San Diego Zoo/Sand Diego Wild Animal Park, and personal communications with writer.
[2] Wade Sherbrooke, personal communication.
[3] Exhibit II

BACKGROUND:

To better comprehend the ant question a certain foundation in Myrmecology is essential. And, when it comes to harvester ants, considerable knowledge of ant taxonomy is a prerequisite. According to Hölldobler and Wilson[4] there are 22 known species of *Pogonomyrmex* residing within the United States, but there are actually several genera of ants besides the Pogos with harvester representatives, e.g., *Aphaenogaster albisetosus*[5] and *cockerelli*; *Messor*[6] *spp.*, *Pheidole militicida, rhea, ridibula, xerophila* et al., and even *Solenopsis geminata* a "cousin" to the infamous fire ant said to be displacing other harvesters by the hundreds of millions in the southern regions. Several other genera outside the USA might also be considered[7].

There is still a good deal of disagreement about classification and the *Ephobomyrmex* group is an excellent example, held by some to be nothing but a subgrouping of *Pogonomyrmex*. As from the other examples evidenced herein concerning the application of nomenclature, a treatise is really needed to resolve conflicts like Nomina Insecta Neartica, ©1996, Entomological Information Services, Rockville, MD, ISBN 1-889002-00-3, but as thorough as it is, such a tome can become quickly outdated.

Recent work by Stephen Welton Taber[8] helps us to resolve the Pogo-Ephebo dichotomy. *Pogonomyrmex* ("bearded ants") are not always all that bearded, nor or all Ephobos necessarily completely devoid of psammaphore. A more important distinction, Taber argues, could be that all known worker Pogos have either 32[9] or 36 chromosomes per cell, whereas the Ephebo group displays 58-62[10]. Male representatives from both groups, of course, have fewer chromosomes, but the relative proportions are just as dramatic.

Why all the fuss about ants at this stage? Because ant mimicry and behavior may be the single biggest determinate to our explanations of horned lizard prey preference until we can adequately gauge taste and smell responses. Just as not all red Pogos are *californicus* it is equally important to know why certain genera of ants wind up in the bellies of particular species of horned lizards more often, as it is to know until now why it has appeared that more ants wind up there than other genera of insects. Deborah M. Gordon's brand new book[11] can give us some important clues based on her 17+ years of field studies on *P. barbatus* just a few miles from where this symposium is taking place.

[4] The Ants, © 1990, The Belnap Press of Harvard University Press, Cambridge, Massachusetts
[5] = *Novomessor albisetosus*
[6] E.g. *(Vero)messor pergandei*
[7] *Monomorium* amongst the foremost almost exclusive harvesters, and certain other like the leaf-cutting *Acromyrmex*, *Acanthomyrmex,* spp., or *Tetramorium spp.* , to name a few. Hölldobler and Wilson, The Ants, pp. 611-613.
[8] The World of Harvester Ants, © 1998, 1st edition, ISBN 0-89096-815-2
[9] All species of *Pogonomyrmex* except *P. huachucanus* which has 36.
[10] *Ephobomyrmex imberbiculus*.
[11] Ants at Work, © 1999, The Free Press (A division of Simon & Schuster, Inc.) New York, NY 10020 ISBN 0-684-85733-2

OBSERVATIONS:

1) All species were "fond of" many kinds of insects in preference to ants, generally.

2) If horned lizard hatchlings[12] were offered a choice of ants simultaneously they were usually consumed in quantity in the following descending order of preference: *Myrmecocystus spp*[13]*., Pogonomyrmex spp*[14]*., Solenopsis xyloni, Dorymyrmex insana,* provided the young lizards were big enough to even consider a Pogo.

3) If it were a struggle to overcome and swallow any *Pogonomyrmex*, then the little horned lizards would leave them alone entirely unless apparently very hungry.

4) As the hatchling *P. platyrhinos* studied grew a few millimeters their "interest" in the progressively larger ants increased. E.g., *P. salinus, occidentalis, maricopa, californicus, rugosus.* Noted exceptions, curiously were two of the smallest *P. platyrhinos* (last season) which "favored" the larger *P. rugosus* to all other Pogos.

5) Adult, female *P. cornutum* demonstrated a pronounced preference toward *P. rugosus* in the outdoor enclosure, but would also eat the various species of red Pogos.

6) When caged indoors, the large, female, Texas Horned Lizards would eat whichever ant was within range without any noticeable discrimination. "Rosa" was recorded to eat approximately 101 ants in one half hour on June 3[15], 2000 comprised of an ever-changing mixture of *P. rugosus* and *californicus* and the large, yellow *Myrmecocystus* "volcano ant" tossed into her terrarium in different proportions.

7) *P. platyrhinos* adults likewise would eat both *P. californicus* and *rugosus.* Sex of the horned lizard did not seem to matter; however, certain individuals concentrated more heavily on the rugosus and a lesser number on the californicus.

8) Two adult, male *P. cornutum* showed marked preferences. "Martinez" (the one with the gimp leg that was swallowed by the *Masticophis flagellum*) ate almost exclusively *P. maricopa* and *californicus*, while "Cortez", now hibernating would eat more or less an even number or red or black Pogos from one day to the next, with perhaps a slight tendency to consume more of the *rugosus.*

9) Hatchling *cornutum* would only eat tiny mealworms (*Tenebrio)* at first, have now discovered termites with "relish" and will occasionally take a *Myrmecocystus semirufus*, but have virtually nothing to do with the *Dorymyrmex* or *Solenopsis xyloni* which are of similar size and coloration. Any Pogo still appears to intimidate them even though they have doubled in size and weight since recovered from the outdoor enclosure.

10) Newborn *P. hernandesi* have consistently shown a marked interest in any *Myrmecocystus spp.*, and are even more inclined to pursue *Tenebrio* (beetles, pupa and larvae) and small cockroaches and crickets than any variety of ants.

[12] This has continued to hold true for *P. Platyrhinos* and *cornutum* and also newborn *hernandesi.*

[13] *M. semirufus, flaviceps*, and two varieties of "big , yellow, volcano ants" (which have majors and minors and in-betweens) yet to be properly classified.

[14] At least three other species of almost microscopic ants (not yet identified) were consumed eagerly, and again, way ahead of the Pogos.

[15] On the preceeding day she consumed 140 *Pogonmyrmex rugosus* in approximately 40 minutes (because that was all she was offered.)

THE MYTH ABOUT HARVESTER ANTS:

It would appear that my preliminary research provides some interesting evidence towards dispelling the notion that horned lizards need lots of harvester ants in their diet. Sherbrooke went so far as to attempt to raise some Regal Horned Lizards hatchlings without ever feeding them ants[16]. Although their less than impressive survival rate, and documented abscesses which some of them development should provide ample discouragement to repeat such an experiment, it is not clear whether the lack of ants or some other factor such as hibernation, outdoor air, natural sunshine or overlooked natural insect prey was the cause of the demise of such a high percentage, apparently prematurely.

Taber also reminds us that by and large, harvester ants do not have much, if any, formic acid[17] to begin with, so a second myth would seem to vanish from relevance as does the first fades from credibility.

CONCLUSIONS:

Again, more research needs to be conducted. While the evidence produced thus far is insufficient to be deemed to be conclusive, it does indicate that there may well be room for further consideration on the topic of prey preferences. Hand-in-hand should go the additional research in the area of nutrition. One should not assume that maximum numbers of different insects ingested clearly points the way as if *Phrynosoma* had some intuition about what proportions of different prey they should select. Each insect not only has a different mass, but its utilizable nutrients probably do not directly correlate with weight alone. Evidently, certain insects contain more chitin or more water than others, and probably due to their own feeding habits, some are likely to contain more kelated trace minerals and vitamins than others. Hence their food value needs to be better assessed. Brown conducted some interesting research in the area of energy and water, but it would be reasonable to see some more work done with simple calorie charts and the same kinds of things that healthy humans like to know about fats, carbohydrates, proteins, etc.

[16] "Captive *Phrynosoma solare* Raised Without Ants or Hibernation", Herp Review 18(1), 1988, pp. 11-13.

[17] Personal communication. Pogos, Ephobos, (Vero)messor et. al. belong to the subfamily *Myrmicinae*. It is another subfamily, *Formicinae* which does produce formic acid from which the broader Formicine family, perhaps over ambitiously, derives its name. Famous members of the family's namesake subfamily are the *Camponotus, Formica*, *Myrmecocystus,* and *Paratrechina* genera.