these larvae are only getting prey once every three days or so, then the 45 minute cycles that we observed would be an insignificant time frame in the grand scheme of overall predation. Therefore, perhaps the amount of time a larvae takes to execute the predation cycle is not a selective force, and one should not expect larger larvae to execute the cycle any faster than smaller larvae. Thus, even though size influences predation efficiency in many animals, it does not seem to be a factor for ant lion larvae.

Literature Cited

Costa Rican Natural History. Janzen, Dan, ed. Chicago University Press, 1983.

FORAGING BEHAVIOR OF TYRANNUS MELANCHOLICUS, THE TROPICAL KINGBIRD

E. Gilmartin, T. Gorman, A. Mattoon, L. Taboada, and T. Young

Abstract (L.T.)

In our study on the feeding behavior of tropical kingbirds we could find little statistical support for either Fitzpatrick's theory of perch change (Janzen, 1983) or the optimal foraging theory. The following comparisons were found to be not significant:

1) inter-sally interval time and waiting time before perch change
2) inter-sally interval and prey size
3) time of sally and prey size

We concluded therefore, that the birds we studied were more influenced by such forces as territoriality and poor foraging conditions due to high winds.

Introduction (E.G.)

Tropical kingbirds (Tyrannus melancholicus) are flycatchers which select exposed perches from which they sally out to capture insect prey.

We wanted to see if the kingbirds foraging patterns follow those predicted by an optimal foraging model based on the following ideas. Birds would be better off changing perches when it is likely they will be able to increase their food consumption rate on a different perch. The amount of energy a kingbird would be willing to expend on capturing prey should decline as the nutritive value of the prey declines. It would also be advantageous for the kingbird to tolerate a greater time interval between sallies as the size of prey increases, because their energy consumption over time could still increase despite decreasing sally frequency.

We tested the following three hypotheses:

1) the waiting period just before a perch change will be greater than the average intersally time interval, as this greater time indicates that the perch quality has declined enough to make a perch change worthwhile (Fitzpatrick, in Janzen, 1983);
2) as the average prey size increases, kingbirds will tolerate longer inter-sally intervals without changing perches; and,
3) the average sally time, which is a measure of the energy expended on the prey, may increase as prey size increases.

Methods (L.T.)

Basic data collection for this experiment involved locating the kingbirds and then timing and recording their behavior. We searched for birds at the O.T.S. station (Palo Verde, Costa Rica) along the road from the field station to the park administration building, and also along the airstrip. Timing was attempted on any bird spotted so there was no other criteria of choosing subjects. The timed sequence began when the bird landed on a perch or, if it was already on a perch, from the time it was first spotted, they lasted until the bird was lost from view. A record was made of when each of the sallies made by the bird occurred and how long they lasted. A sally was defined as any flight made by the bird in which it returned to the same perch or in close proximity to the same perch. If the bird moved more than ten meters from original perch then the flight was labeled a perch change rather than a sally. With each sally, the size of prey caught, visible or invisible, was also recorded. Large prey(visible) was that which the bird was still eating when it returned to the perch. Small prey(invisible) was recorded when the bird returned to the perch with no sign of prey in evidence.

Results (A.M.)

There was no significant difference in the comparison between intersally interval time and waiting period before perch change for each bird (Us=86; $n_1 = 16$, $n_2 = 16$) (Table 1).

Intersally interval as related to ranked prey size also showed no significance when compared ($r_s = -0.017$; v) = 9; prey rank 0 = small, 1 = large) (Table 2).

The amount of time spent sallying for each prey compared to the size of the prey sallied for was also insignificant ($U_s = 221.5$; $n_1 = 24$, $n_2 = 15$, $p > 0.05$) (Table 3).

Discussion (T.G., T.Y.)

Our three hypotheses on the foraging patterns of the tropical kingbird were not supported by our data, a consequence which was primarily due to assumptions and controls within the study. We observed many factors which may have affected our test of the first hypothesis. These factors were often outside disturbances for which we could not control.

Territoriality: we observed many perch changes due to another bird invading the test bird's territory.

Disturbance by other animals: Horses and members of our group frightened test birds a few times and the birds changes perches.

Wind: There were high winds in many of our viewing areas and we could not determine if the bird was changing perches in order to be shielded from the wind, where the prey was not being blown away.

Also, we had no information on the distribution of prey. If we assume that all perches that the bird had access to are equal in their prey density, the bird might conceivably land on the next closest perch, rather than the original, after capturing its prey. The bird might also periodically change its perch to avoid vulnerability to predators by continually returning to the exact same spot. In addition to these factors, our original assumption that the bird was always foraging while on a perch may have been false. Perhaps it was resting or just sitting in the shade so that during many of our intersally interval times it wasn't actually looking for prey and these intervals would be exceptionally long. The bird may be changing perches for many reasons besides prey density in an area, and the waiting time before a perch change would therefore not be greater than the average intersally interval time.

Our second hypothesis was not supported by our data either, as the bird did not have a significantly longer intersally interval time when capturing larger prey. Perhaps these birds were opportunistic and would take either large or small prey, essentially, whatever came along. Therefore it might be just waiting for any prey, and the intersally interval time would just be the time to whenever the next available prey came into site. If the bird did not have access to some perches in the area, due to wind or more dominant birds, he would have to stay at a suboptimal perch and wait however long was necessary for any size prey.

Also, prey size was extremely difficult to assess. We had to wait until the bird returned to determine the size of its prey. To use any of our data, we assumed that the bird captured something on every sally, whether we saw the prey or not. Therefore there could have been several occasions where the bird took a long sally for large prey, missed it, and we interpreted this as a long sally for a small prey. This would obviously affect the validity of our results.

We did not find a significant difference between sally times for large and small prey. Again, there may have been an effect from the labeling of large vs. small prey. However, this hypothesis should not be dismissed. Our data did show a strong trend in which might be the result of a true difference. We had one datum for sally time that was extremely deviant from the others, and if this datum were disregarded, a significantly different sally time for large and small prey would have been observed (U-test, $p < .05$). It is possible that its variance was just ran down but we had no basis to eliminate it.

This deviant datum had in fact been a lengthy territorial conflict, a mating signal, flight, etc., but we could not identify this and still called it a sally. More research with a more strict definition of a sally could possibly clarify the legitimacy of the third hypothesis.

In conclusion, our hypotheses based on Fitzpatrick's theory and the optimal foraging theory were not supported. We observed few trends other than in the test of the third hypothesis. Optimal foraging is a relevant theory and is observed in other species. We still believe it should apply to the kingbird, but a more complex model is needed to observe it. Based on our possible sources of error, new techniques and different conditions for testing the optimal foraging theory could be used. These would include:

1) testing on a nonwindy day
2) knowing the exact territory of each bird
3) choosing a bird away from startling distractions
4) more closely following its capture with a video camera so as to identify large or small prey accurately
5) being able to identify when it is searching for prey when perched as opposed to when it is not searching (resting, etc.).

Table 1 Average intersally interval time vs. waiting period before perch change.

Bird #	Perch #	Avg. intersally interval time (sec.)	Time before perch (sec.)
1	1)	239.2	10
2	1)	232.5	656
	2)	---*	44
	3)	1234	525
	4)	----	237
3	1)	164	710
	2)	140.0	252
	3)	----	10
4	1)	302.2	244
5	1)	190.0	29
6	1)	47.0	165
7	1)	306.0	174
	2)	----	217
	3)	----	147
	4)	----	56
8	1)	43	305

*"-" means bird did not perform sallies from this perch; it waited, then changed perches again.
(U_s = 86; n_1 = 16, n_2 = 16)

Table 2: Average intersally interval time vs. average prey size (ranked)+

Avg. intersally interval time (sec.)	Avg. prey size (ranked)
302.2	0.5
204.4	0.75
95	0
156	0
273	0
567.8	0.57
146.9	0.81
109.5	1
217.6	0

r_2 = -0.017

+individual prey rank: small = 0, large = 1

Table 3: Sally times for small vs. large prey.

Time for small prey (sec.)	Time for large prey (sec.)
2	10
2	2
3	4
2	2
4	1
[20]H	2
2	3
3	2
1	4
3	2
3	9
3	3
3	6
6	4
3	4
	11
	4
	2
	4
	4
	5
	5
	3
	3

(U_s = 221.5; n_1 = 24, n_2 = 15)
H indicates deviant datum