

survived. Moreover, these transplants appeared to be very healthy.

DISCUSSION

The data seem to indicate that *Borrchia* might be limited by one or more of the following factors: 1) the effect of ion population (types of ions), and chlorinity; 2) the duration and depth of flooding; 3) the xeric conditions of the High high marsh; and 4) any or all of the above factors coupled with inter- and intraspecific competition.

Spartina patens might be limited in the lowest three zones for all of the aforementioned suggestions except statement 3. Personal observations of this species in salt marshes from Cape Hatteras, North Carolina, to northern Maine suggest the possibility of two varieties, one more flood and salt tolerant than the other.

Spartina alterniflora might be limited in the uppermost portion of the High high marsh for all of the four postulations listed, particularly statement 3.

Salicornia virginica appears to thrive in areas of high soil solute concentration and long periods of flooding. Presumably the seaward extent of *Salicornia* is limited by difficulties in establishment.

Limonium may also be limited for the same reasons

as *Salicornia virginica* though the data suggest that the mature forms may not be as flood tolerant as *Salicornia*.

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WINTER DIET OF THE PERUVIAN DESERT FOX

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Abstract. The winter food habits of the native desert fox of northwestern Peru were examined by an analysis of fecal pellets collected in two areas. In the Sechura Desert, foxes eat mainly the seed pods of perennial shrubs. In a coastal area, the foxes supplement their largely herbivorous diet with carrion and crustaceans.

Among the most desolate, arid areas in the Western Hemisphere is the Sechura Desert of northwestern Peru, near latitude 6° S. The native terrestrial mammalian fauna is apparently limited to a mouse, *Phyllotis gerbillus*, and a small fox, *Dusicyon sechurae* (Koford 1968, personal observation). Near Bayovar, on the coast of the Department of Piura, I made scattered observations on fox tracks and droppings during the Peruvian winter of 1967. Tracks were common in the sand, and at night I saw from one to six foxes by eyeshine in vegetated areas.

To determine what role the diet plays in supporting populations of the fox in an area with few apparent prey, I returned to Bayovar and collected fox scats in two areas during July and August of 1968. Area I, about 20 km into the desert from Bayovar, is characteristic of the Sechura Desert proper with shifting barchanes¹ and large hummock dunes stabilized by *Capparis scabrida*, the dominant plant (Fig. 1). Plant cover is low.

Area II at Bayovar encompasses the abutment of the Sechura Desert on an isolated coastal hill, Cerro Illescas, and the adjacent Pacific beaches. The terrain is flat. Hummocks and barchanes are absent. In this

¹Editor's note: Barchanes, sometimes spelled "barcanes," are shifting, crescent-shaped sand dunes.

area the crowns of the three major shrubs cover about 11% of the surface area, as measured by quadrat sampling, with *Capparis avicennifolia* the dominant plant. The shore has few plants but many intertidal invertebrates. Bodies of birds, fish, and other flotsam were observed on the beaches.

I collected all whole fox scats encountered and later identified the food remains insofar as practicable. The percentage of droppings that contained a particular food item is presented for both areas in Table 1.

C. scabrida seeds were found in all scats examined from Area I, and most scats (77%) consisted entirely of seeds. Tenebrionid beetles were found in 23% of the droppings, but no more than one per scat. I observed few vertebrates, either alive or as carrion, in Area I; only one scat contained the remains of a vertebrate, *Dicrodon guttulatum*, a large teiid lizard.

Seeds were found in 98% of the scats from Area II, and seeds were the only items in 63%. *Prosopis* seeds were found in 85% of the scats. Although 21% of the scats contained invertebrates and 20% contained vertebrates, none of the former scats and only 2% of the latter scats consisted solely of either group. The principal vertebrate items identified were gulls (*Larus* spp.), finches (*Piezorhina cinerea*), mice (*Phyllotis gerbillus*), lizards (*Phyllodactylus* spp. and *Tropidurus occi-*



FIG. 1. View of Area I, 20 km SE of Bayovar, Peru. Not the hummock dunes and interspersed barchanes typical of the Sechura Desert.

TABLE 1. Percentage of whole scats containing various prey taxa^a

Food taxa	Area I (inland)	Area II (coastal)
Seeds		
<i>Capparis avicennifolia</i>	43	67
<i>C. scabrida</i>	100	6
<i>Prosopis juliflora</i>	3	85
Invertebrata		
Crustacea.....		17
Insecta.....	23	11
Scorpionida.....		1
Vertebrata		
Aves.....		10
Reptilia.....	3	3
Pisces.....		2
Mammalia.....		2
Unidentified.....		4
Total seeds.....	100	98
Total invertebrates.....	23	21
Total vertebrates.....	3	20

^aThirty-five scats from Area I and 100 scats from Area II were examined.

pitalis), and a small snake. The principal invertebrate items were crabs and tenebrionid beetles.

Foxes ate mainly *C. scabrida* seeds in Area I and mainly *Prosopis* seeds in Area II. These differences largely reflect the relative abundances of plants and the proportions of plants bearing seed pods in the two areas.

The foxes usually chew open the seed pods of *Pro-*

sopis and *C. avicennifolia*, but do not masticate them. The pods of *C. scabrida* are comparatively large and have a tough covering. Foxes consume the seeds and syrupy matrix, but apparently not the husks.

Dicrodon, *Piezorhina*, and *Phyllotis*, included in the diet of the fox, are also herbivorous. *Phyllodactylus* spp. and foxes commonly eat the same Tenebrionidae. Hence, the foxes may be directly affecting the populations of these competitors as well as obtaining vertebrate meals, assuming that these prey are captured alive.

Among North American foxes, the desert kit fox (*Vulpes macrotis*) is comparable in size and habitat to the Sechura fox, but eats primarily small rodents, lizards, and insects (Burns 1960, Grinnell, Dixon, and Linsdale 1937). Predaceous food habits may be related to the comparatively rich vertebrate faunas of North American deserts.

In the two study areas, *Dusicyon sechurae* is omnivorous. Foxes along the coast include crustaceans, fish, and birds in their diets, some of which is undoubtedly carrion. Scavenger habits have previously been noted (Koeppke and Koeppke 1952). In the more productive Andean foothills, this fox may prey on doves (Osgood 1914).

In the Sechura Desert itself, the Peruvian desert fox is an opportunistic feeder consuming mainly seed pods. By becoming a primary consumer, the fox ensures itself of a reliable supply of food and water at least during the winter. Small body size, about 2.2 kg (C. Koford pers. commun.), and thus reduced food requirements may also be of survival value.

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ON THE RELATIVE ABUNDANCE OF SPECIES

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Abstract. When data are collected so that they can be treated as coming from a variety of sample sizes, it is possible to use the same data to test the effect of altering sample size on the fit to any model. The method is applied to nonpredatory soil mites and their fit to the "broken-stick" model of MacArthur. It is found that by choosing a quadrat size of 4 in.² (25.8 cm²), a good fit is obtained. Smaller and larger quadrats involving the same data do not permit the data to fit the model. It is concluded that the model lacks ecological meaning.

One would suppose that after the originator of a theory had abandoned it publicly, it would be mentioned thereafter only in historical accounts, unless it could be revived by new and different evidence. Such seems not to be the case with MacArthur's "broken-stick" model (MacArthur 1957, 1960) which continues to be used (Kohn 1968, Inger 1969, MacDonald 1969) even after the original author has described it as "an obsolete approach to community ecology which should be allowed to die a natural death" (MacArthur 1966). It is the purpose of this note to demonstrate that conformity to the model is a function of sample size, rather than of any ecological properties of the system being sampled. It will further be demonstrated that deviations from the model may be in either direction, a finding which precludes the use of the model as a limiting case.

METHODS

A block of turf 20.32 by 20.32 by 2.54 cm deep (8 by 8 by 1 in.) was taken from an old field and subdivided into 64 units of equal size. Soil arthropods were extracted by means of a set of 64 Tullgren funnels. The location of each of the 64 units in the original block was known, and thus the whole collection could be treated as a set of 64 small samples, or as a set of fewer samples of larger size. For present purposes, the data were treated as 64 samples 2.54 by 2.54 cm, as 16 samples 5.08 by 5.08 cm, and as 4 samples 10.16 by 10.16 cm. After extraction, the specimens were sorted into morphologically distinct kinds and counted. The imperfect classification that resulted did not appear to detract from conclusions based on an analysis of the data (see Hairston and Byers 1954; Hairston 1959).

In the present analysis, only the nonpredatory mites are considered, this being a group which more or less

corresponds to the model's assumptions. This part of the fauna was dominated by oribatids, the 17 species of which included the 8 most abundant. Other taxonomic groups were tarsonemids with three species, tyroglyphids with three species, and eupodids with two species.

Several methods have been devised to compare data with the model (King 1964), but all were intended to compare one sample at a time. The present data, consisting of 4-64 replicate samples, present a somewhat different kind of problem. The data also give the opportunity to examine the variation in how well samples of any size agree with expectations based on the model, in addition to expressing the average situation. The calculation of the average sample requires some explanation, because it is not the same for present purposes as adding together all of the data and dividing by the number of samples. The latter would give the same result for all sample sizes, and would be the equivalent of the total collection. The average sample was calculated from several separate properties of the individual samples. These were the average number of species per sample, the average number of individuals per sample, and the average relative abundances of the species present. Thus, the smallest samples, covering 6.45 cm², had an average of 6.7 species and 14.11 individuals; the second most abundant species in each sample had an average of 0.64 as many specimens as the most abundant, the third most abundant had 0.49 as many as the most abundant, etc.

The distributions around these means are approximately symmetrical, as is reflected in the median values: 7 species, 14 individuals, the second most abundant species 0.667 as abundant as the commonest, the third most abundant 0.444 as abundant as the commonest. The average values therefore seem appropriate for representing a synthesis of the relationship between observed and expected curves. The latter require integer numbers of