

SEED SIZE PREFERENCE IN FINCHES

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SEED preferences of several finch species have been explored in the laboratory (Willson, 1971; Willson and Harmeson, in press) using both wild and commercial seeds. Choice among a variety of seed types necessarily involves many variables such as color, flavor, size, nutritional value and so forth. In an effort to eliminate some of these variables, I conducted series of choice experiments using different sizes of the same species of seed (from the same commercial shipment or gathered from the same areas locally). Most of these trials used Cardinals (*Richmondena cardinalis*) but a few observations are available for other species. Hespenheide (1966) earlier made similar observations on a few individuals of two species.

METHODS

Birds were captured locally, kept in fairly large, individual cages in the laboratory (see Willson, 1971), and fed on a diet of mixed seed plus supplements. Equal numbers of different size classes of seed, placed in small dishes, were presented to the birds. Since the position of the dishes relative to the perches in the cage influenced choices, the relative position of each seed size was changed between trials. Four sizes of sunflower seed (*Helianthus annuus*) were tested: long and fat (LF), long and thin (LT), short and fat (SF), and short and thin (ST). Seeds were divided into length categories of 12 mm or less and 13 mm or more, and thickness categories of 4.7 mm or less and 5.2 mm or more; width in all categories was similar. Wild hemp (*Cannabis sativa*), sorted into the two size classes by sieving, was also used. Seed dishes were placed in the cages and left for a short period, depending on how fast the seeds were eaten: the dishes were removed before any one of them was completely empty. Ten trials for each bird were run on both sunflower and hemp.

The significance of differences in seed choice were tested by chi square, $P \leq 0.05$.

RESULTS

Five male and five female Cardinals were tested; there was no significant difference between male and female choices. Nine birds showed no preference, individually, and one avoided class LT. Taken as a group, however, the ten manifested a significant preference for class ST and against class LT (Table 1A). Cardinal preferences for certain sizes of sunflower, when shown, were not based solely on thickness or length for either males or females: when all seeds of the same thickness or length classes were pooled, no difference between classes were evident.

In a set of earlier tests, four Cardinal females and two males were given ten trials each. This group preferred thin seeds to fat, regardless of length.

Nine birds were tested on hemp. Two males and the four females had no

TABLE 1
A. SUNFLOWER SEED SIZE PREFERENCES

	ST	SF	LT	LF	<i>n</i>
Cardinal*					
1. 5 ♂♂, 5 ♀♀	29	25	20	26	1,391
2. 4 ♀♀, 2 ♂♂	30	18	29	22	1,568
Tree Sparrow* (4)	55	9	4	32	22
Song Sparrow* (4)	57	28	11	4	54
Slate-colored Junco* (4)	71	21	4	4	24
Purple Finch* (3)	39	7	39	14	635
Rose-breasted Grosbeak* (2)		57		43	212

B. HEMP SEED SIZE PREFERENCES

	Large	Small	<i>n</i>
Cardinal (5 ♂♂, 4 ♀♀)	52	48	2,675

* Indicates significant differences among the choices by χ^2 , $p \leq 0.05$. The percentage of all seeds eaten that were of each size class is given, with the total number of seeds eaten in all trials.

preference for either large or small hemp seeds, two other males preferred small and one preferred large seeds. Males as a group, however, showed no significant preferences (Table 1B).

Both male and female Cardinals husked and ate large and small hemp at the same rate, but females husked large hemp faster than males (Table 2). Males husked all sizes of sunflower at the same rate; for females, husking rates were also similar except that seeds of class ST were husked significantly faster than those of LT (*t*-test, $df = 50$). Males husked large sunflower seeds, both LF and LT, somewhat faster than did females.

Several other finch species were tested in fewer numbers and with fewer trials (summarized in Table 1). Tree Sparrows (*Spizella arborea*), four birds in four trials each, ate mostly class ST, but class LF was second choice, which seems peculiar, and is probably a result of the small sample size. Song Sparrows (*Melospiza melodia*) and Slate-colored Juncos (*Junco hyemalis*) (four birds of each species, eight trials per bird) preferred class ST, with class SF in second place, so that in general both species preferred short to long seeds. The small number of seeds eaten by all the small birds reflects the difficulty with which they handled even the smallest sunflower seeds. Of two Rose-breasted Grosbeak (*Pheucticus ludovicianus*) males in ten trials between long and short sunflower seeds, one bird preferred long, the other short ones.

TABLE 2
CARDINAL: SEED HUSKING-AND-EATING TIMES, IN SECONDS

	♂ ♂			♀ ♀		
	\bar{x}	SE	N	\bar{x}	SE	N
Sunflower						
ST	28.8	2.3	25	32.2*	3.1	24
LF	29.1	2.8	25	39.2	5.0	26
SF	35.0	3.1	25	43.3	4.9	25
LT	33.9	2.4	26	39.0	2.3	28
Hemp						
Large	6.9	0.87	15	4.1*	0.32	15
Small	6.2	0.60	15	6.0*	0.98	15

** Indicates a significant difference between males and females.

* Indicates a significant difference between seed sizes.

Three Purple Finches (*Carpodacus purpureus*), probably females, 10 trials, preferred thin seeds to fat ones; length preferences varied among the individuals. Husking times for Purple Finches were similar for all sizes of seeds (Mann-Whitney U, $P \geq 0.05$; $\bar{x} = 83.1$ sec., $n = 10$ seeds of each size category), but fat seeds were obviously more difficult to handle since over 50 per cent of those picked up slipped out of the bill before cracking.

DISCUSSION

In the main, the results for Cardinals indicate a highly variable choice of sunflower seed sizes. Many individuals showed no particular preference, but the collection as a whole was inclined to favor short-thin seeds, and sometimes long-thin. Correspondingly few differences were found in husking times, except that females could handle class ST more quickly than class LT. Also, no strong preference was seen for size of hemp seed, and there was no difference in husking time of different sizes. This suggests that all the sizes used may have been well within the average capacities of the Cardinals to handle. Any individual preferences could be the result of individual differences in morphology, learning, physiology, etc. J. R. Jehl (pers. comm.) has recently emphasized the importance of such individual variability among the experimental birds.

Song and Tree Sparrows and juncos chose class ST especially, in keeping with their smaller bills (see Willson, 1971 for average dimensions). Purple Finches are intermediate between Cardinals and the smaller birds in bill size (length 10.0 mm, depth 8.3 mm, width 6.9 mm, $n = 12$). They selected seed primarily on the basis of thickness rather than length. Purple Finches have

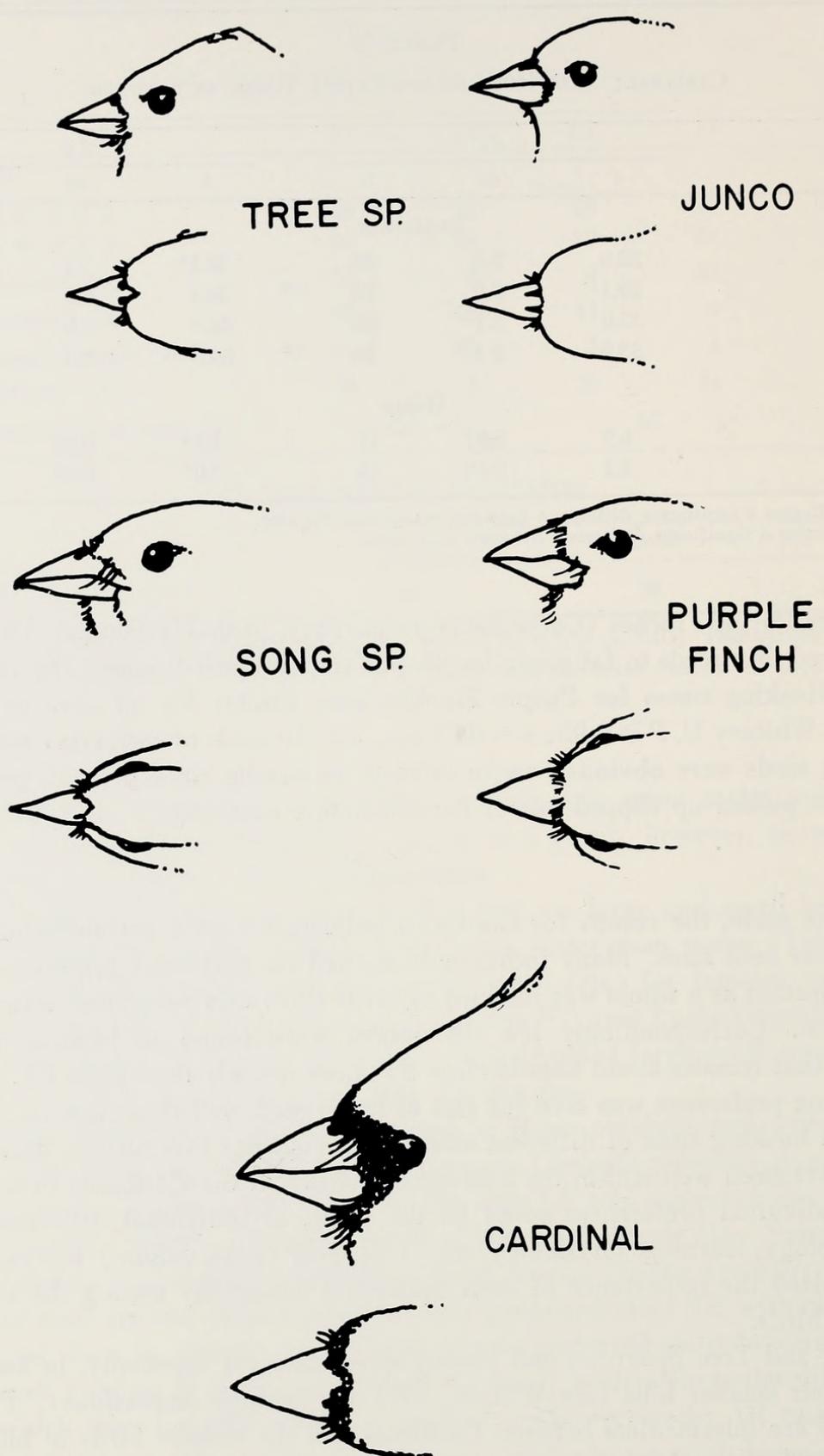


FIG. 1. Top and side views of the bills of the primary experimental species, to scale.

an average bill length equal to that of juncos, intermediate between Tree and Song Sparrows, but much shorter than Cardinals (see Fig. 1). The ability of Cardinals to handle experimental seeds of all sizes with almost equivalent facility is probably a function of their larger bill size. The shorter bills of Purple Finches and the small-billed species may make difficult the handling of thicker seeds by providing a smaller "pocket" for the holding of thick seeds, so that they slip out more readily. The greater bill depth and width of Purple Finches (and Cardinals) may facilitate handling of long seeds by providing a broader base for holding the seeds while they are rotated during cracking and by permitting greater forces to be applied to the seed so that even if long seeds can't be balanced as well as short ones, the greater forces permits them to be cracked before they slip away. Bill characteristics and related morphological characteristics concerned with food handling are discussed in some detail by Bowman (1961, 1963) and Ziswiler (1965).

Measurements of the force delivered by the bill in cracking seeds would be most useful. At present, the only information available came from a Gilson polygraph "physiograph," which transforms physical pressure into electrical impulses to be recorded on a moving graph. The birds were held in such a manner that either the upper or the lower beak pressed against the transducer as the bird "bit." The largest response so generated was used as an index of maximum pressure generated, and converted to force/unit area. These estimates of force refer to the middle of the bill, not the tip where the pressure would be greater. Although in absolute terms the estimates of force applied may not be accurate, they are probably adequate *relative* indices.

Six species were so measured: Cardinal, Purple Finch, Song Sparrow, White-throated Sparrow (*Zonotrichia albicollis*), Fox Sparrow (*Passerella iliaca*), and junco. At least two individuals of each, sometimes four, were measured. Invariably the lower jaws exerted a somewhat greater pressure than the upper, but for purposes of Figure 2, all measurements were averaged. All bill dimensions are significantly correlated with the average force applied (Spearman rank correlation, $p \leq 0.05$), but Figure 2 suggests that force exerted by the bill is more closely associated with depth or width than with length. Width and depth are more closely correlated with each other than with bill length and it seems reasonable to suppose that depth is more important in determining the force applied than is width (Bowman, 1961). Obviously the presence of palatal bosses or keels or other special structures could confound this tendency.

Average kernel weights of the different sunflower seed sizes varied significantly (Mann-Whitney U, $p \leq 0.05$): LF > LT = SF > ST. The mean weights of 10 kernels of each size class were as follows: LF, 0.084 g; LT, 0.065 g; SF, 0.063 g; ST, 0.053 g. Making the reasonable assumption that

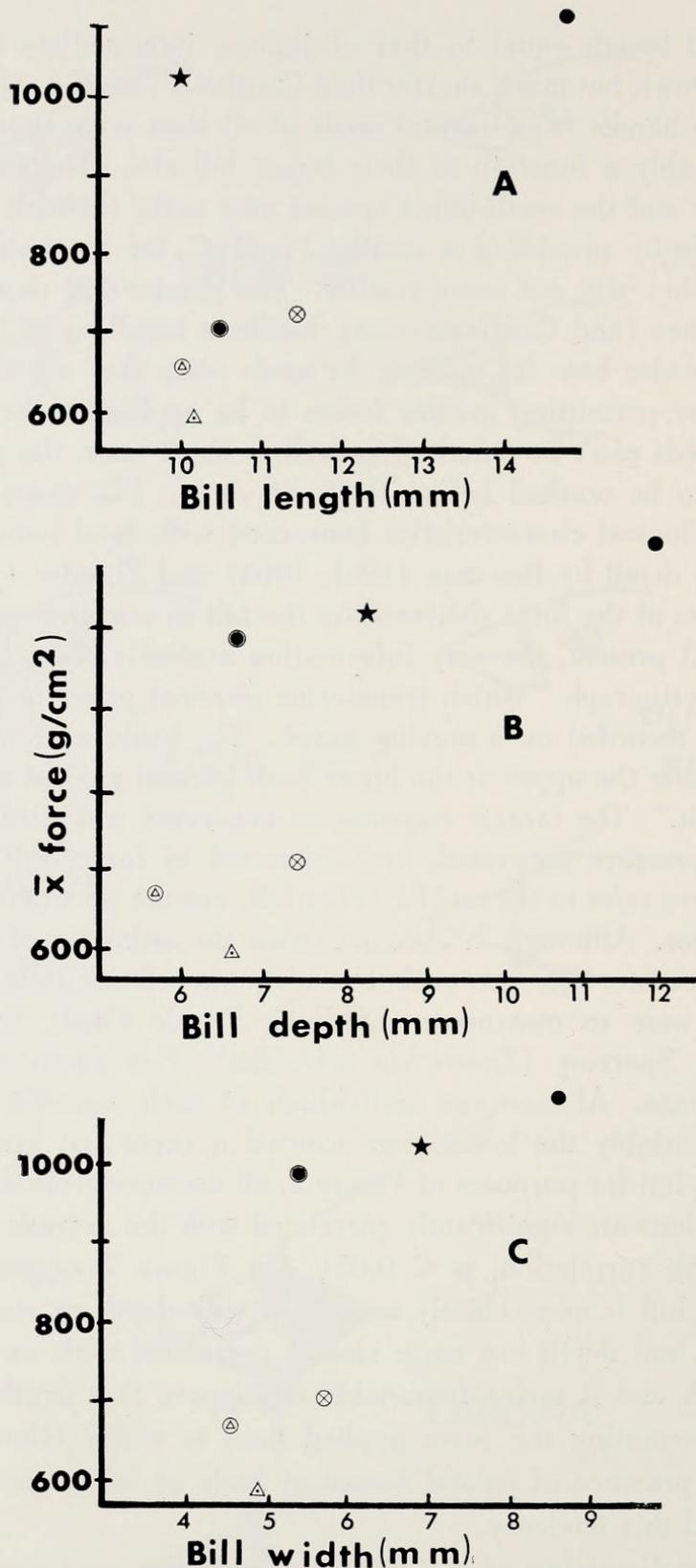


FIG. 2. Association of each bill dimension with the average force exerted by the bill: all correlations are significant, but there is less scatter for width and depth, which are themselves closely correlated. Cardinal, ●; Purple Finch, ★; Fox Sparrow, ○; Song Sparrow, ◉; White-throated Sparrow, △; Slate-colored Junco, ⊖.

the per-gram caloric content of different-sized kernels is similar, the small-billed species were limited in their food intake by their apparent inability to handle large seeds. In the wild they seldom tackle such large seeds. However, Cardinals, which could handle all sizes offered, certainly did not exercise their ability to maximize caloric intake.

SUMMARY

Cardinals showed few preferences for seed (sunflower or hemp) size and little difference in ability to handle different seed sizes. A slight tendency to prefer short and thin sunflower seeds may be associated with the ability of females to husk this size more rapidly.

Other species tested usually preferred small (short and thin) sunflower seeds corresponding to their small bills and general inability to handle larger seeds. Purple Finches preferred thin sunflower seeds to thick ones, regardless of length. Thick seeds were apparently difficult to hold in relatively short bills, long ones difficult for more slender bills.

Relative forces applied by the main portion of the bill may be correlated more closely with bill depth, and perhaps width, than with length.

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