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Bill size, food size, and jaw forces of insectivorous birds.—In a recent paper Willson (1972) demonstrated that the relative forces applied by seed-eating birds' bills may be correlated with bill depth and width more than length, and that small birds are limited in diet by their inability to handle large seeds. I would like to add some data on insectivorous birds (Tyrannidae) to her information, and clarify the methods used.

The bird being measured was held stationary in a plastic tube with an opening diameter slightly smaller than the bird's widest diameter. The upper and lower mandibles were inserted into metal plates with curled edges forming a tapering trough. The upper plate had upturned edges and the lower plate downturned ones. The plates were fastened to the upper and lower portions of a force pressure transducer and the jaws of the bird adjusted so that the head was severely restricted. The angle formed by the jaws was the maximum angle to which the bird opened its jaws just prior to prey capture. This angle (30–35°) was determined by analyses of high speed motion pictures of aerial captures of flies (*Sarcophaga bullata*).

The force pressure transducer was connected to a Gilson physiograph. The movement of the lower plate (the upper plate being fixed), caused by the movement of the bird's mandible, was converted into electrical impulses recorded on the physiograph. The height of the mark made on the physiograph paper was proportional to the distance the lower plate moved upward. The transducer was calibrated, by interchangeable springs, to move a certain distance under a certain force. Thus the height of the physiograph line could be easily converted into the force exerted by the bird's lower bill. The area of the bill contacting the plate was measured and the force per area (pressure) calculated. The lower jaw force only was measured as most of the muscles that function to close the bill work on the lower jaw. The upper jaw closes from the resiliency of the stretched nasofrontal hinge. I did not take into account the differences in force between the jaws, the effect of jaw kinesis, nor the strength of the nasofrontal hinge. Thus the force measured was a very general one (see Bock 1964, 1966 for detailed discussion), but was probably adequate for comparison between species.

To induce the birds to exert maximum force on the plates, both mechanical and electrical stimulation of the skin of the neck were tried. No discernable difference in results were detected. Whenever the bird tried to close its jaws, the force applied was at least fairly consistent, if not maximum.

Six species of flycatchers (Tyrannidae) were measured. Table 1 shows the average pressure exerted (g-wt per cm^2), bill measurements (mm), sample size, and standard deviation.

The correlation ($P < 0.05$) between all bill measurements is positive, and the force increases at about the same rate as bill width, somewhat slower than bill

TABLE 1

Species	Bill length	Bill width	Bill depth	Pressure	N	SD
Empidonax minimus	7.8	5.1	3.4	252	7	4.68
E. flaviventris	8.3	5.4	3.4	277	9	8.31
E. traillii	9.3	5.8	4.1	285	3	9.01
E. virescens	9.6	6.1	4.0	299	4	6.72
Contopus virens	10.6	6.3	4.1	320	11	2.99
Myiarchus crinitus	15.7	8.4	6.7	401	7	4.89

depth, and slower yet than bill length, which doubles when the force is increased by one and one-half.

Seed-eating birds must have bills and jaw musculature that are closely adapted to their food if they are to handle it effectively. Their food and bill characteristics may be closely related functionally (Hespenheide 1966), although recent evidence (Willson 1971, Pulliam and Enders 1971) casts some doubt on the closeness of the relationship. Insectivorous birds feed on a mobile and structurally more diverse diet, and their bills are adapted for capturing and holding prey, rather than preparing it for eating, although some manipulation may occur, especially beating the prey against a twig (Root 1967, Willis 1967, Williamson 1971, pers. obs.). Or the beak may be used to mandibulate or even shred insects (Willis 1968, Williamson 1971), but nothing indicates these actions require jaw forces above those needed to capture and hold prey. The trophic morphology of insectivorous birds is apparently selected more for prey capture than handling, while seed-eating birds have a bill morphology selected for food manipulation rather than procurement.

A direct relationship exists between bill length and the linear speed at which the mandibles can be moved (Beecher 1962). Long-billed birds should be able to capture fast moving prey more readily than short-billed birds. Thus the greater force exerted by longer-billed birds is a result of increased mandible speed (Bock 1964: 29) and may also indicate that a greater force is needed to handle larger prey. As larger birds feed on a wider range of food items than do smaller birds (Grant 1968), the increased force delivered by the longer-billed bird is not surprising. The difference in measured pressures exerted by different sized insectivorous birds is not so great as the difference in pressures exerted by different sized seed eaters (see Willson 1972) because: (1) the jaw pressures exerted by insectivorous birds need only be great enough to capture and hold prey, and (2) seed eaters must be able to exert enough pressure to be able to crack seed coats and need proportionately more force to open seeds as seeds increase in size.

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Mexican Crow invades south Texas.—The diminutive Mexican Crow (*Corvus imparatus*) is noticeably smaller than any of the U.S. members of its genus, and in habits and general appearance it seems quite different. All North American members of *Corvus* are rather gregarious, yet this small Mexican species appears even more so. Its softer, higher pitched, but unmusical voice is distinctive from all U.S. species.

The Mexican Crow should now be included in the A.O.U. Check-list as a species of the United States, as it has moved north across the Rio Grande into Cameron, Willacy, and southern Kenedy Counties, with a few somewhat doubtful records of observations in Hidalgo County. All of these are in the lower Rio Grande valley.

Earlier studies for various reasons have caused some workers to conclude that this species is closely related to our American Fish Crow (*C. ossifragus*). Hellmayr (1934: 5) classified the Mexican Crow as a subspecies of *C. ossifragus* and concluded that it "is clearly conspecific with the North American Fish Crow." Blake (1953: 376) concurred and followed Hellmayr's lead, identifying the bird as *C. o. imparatus*.

Miller et al. (1957) considered the Mexican Crow a separate species, *Corvus imparatus*. Ridgway (1904: 275) described the Mexican Crow as somewhat like *C. ossifragus* but decidedly smaller and plumage much more lustrous. Still he regarded it as a separate species and called it *C. mexicanus*.

More recently Johnston (1961) wrote after carefully reviewing previous studies, "the Mexican Crow and the American Fish Crow are quite unrelated in virtually all of their features." Peterson and Chalif (1973: 162) stated the Mexican Crow's curious voice and different habits make close relationship to the American Fish Crow quite unlikely. We concur with their conclusion.

Two specimens of the Mexican Crow collected by personnel at Laguna Atascosa National Wildlife Refuge are now housed at the National Museum of Natural History in Washington, D.C. where Richard C. Banks compared them with other