SHORT COMMUNICATIONS

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BROWN PELICAN FORAGING SUCCESS RELATED TO AGE AND HEIGHT OF DIVE[1]

GÖRAN ARNQVIST
Department of Animal Ecology, University of Umeå, S-901 87 Umeå, Sweden

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The Brown Pelican (*Pelecanus occidentalis*) is the only pelican species that dives for fish (Schreiber et al. 1975, Schreiber and McCoy 1983). Foraging Brown Pelicans fly slowly at varying distances above the water surface, searching for prey. When prey is sighted, the bird dives into the water. When the bill enters the water, the highly expandable gular pouch becomes enlarged and filled with water (see Schreiber et al. 1975). When the bill closes, the pouch may contain as much as 10 liters of water, as well as prey items (Schreiber et al. 1975). An unsuccessful bird pulls the head rapidly out of the water with the bill open, allowing the water in the pouch to drain out. In contrast, a successful bird raises its closed bill slowly, allowing the water to flow out of the pouch but leaving the fish inside. The prey is then swallowed with a tossing motion of the head. The post-diving behavior of Brown Pelicans makes them suitable for studies of foraging behavior, since successful and unsuccessful dives are easily distinguished (Orians 1969, Schreiber et al. 1975).

In this note, I present field data confirming previous observations of age-specific hunting success in the Brown Pelican (Orians 1969). Further, the diving height of foraging pelicans is shown to be related to both prey capture success and handling time, indicating a trade-off between these factors.

Observations of foraging Brown Pelicans were made at the southern part of Playa Naranjo, in Santa Rosa National Park on the northwest Pacific coast of Costa Rica (10°46′N, 85°40′W). A resident group of Brown Pelicans (n = 34–41), foraging in a limited area within 100 m from the shoreline, was followed on March 1–2, 1991. For individual dives, I recorded the prey capture success, and in successful dives the handling time was recorded. Handling time was defined as the time (in sec) that elapsed from the actual breaking of the water surface upon emergence until the prey was swallowed. Thus, handling time mainly includes the duration of the process of gular pouch drainage.

In a first series of observations, a number of dives of immatures (n = 108) and adults (n = 86) were observed. Age was determined by plumage (Orians 1969). Success rate and handling time were recorded. In a second series of observations, dives of adult birds only were subjectively classified as either low (approximately <4 m; n = 80) or high (approximately >6 m; n = 72). Dives that were judged to be made from intermediate heights were not included in the subsequent analysis.

In a similar series of observations, Orians (1969) observed a higher prey capture success of adult Brown Pelicans compared to immatures. While this result was mainly attributed to effects of improving hunting skill with age, Orians (1969) noted that differences in average diving height could have influenced the results. The results of the current study confirm previous findings; the capture success of adult birds was significantly higher than that of immatures (Fig. 1; $\chi^2_1 = 5.29$, $P < 0.05$), irrespective of diving height. Handling times of adult and immature birds did not differ (Fig. 1; t-test, $t = -0.29$, $P > 0.5$). In contrast to the study of Orians

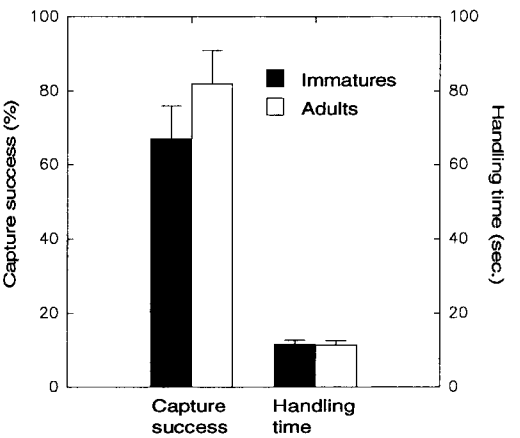

FIGURE 1. Capture success and handling time of immature and adult Brown Pelicans. Error bars represent 95% confidence intervals.

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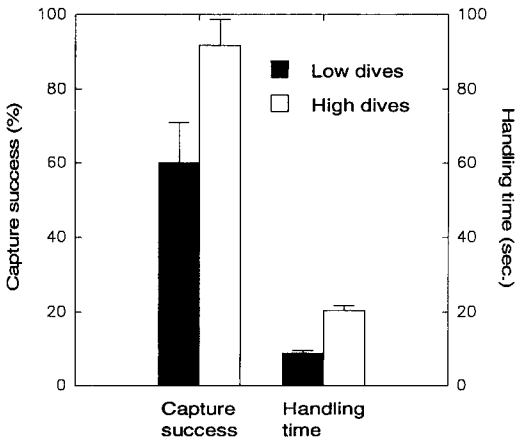

FIGURE 2. Capture success and handling time of adult Brown Pelicans in low and high dives. Error bars represent 95% confidence intervals.

(1969), the difference in capture success can thus be ascribed to age-specific differences in hunting skill rather than differences in diving height.

The effect of diving height on foraging success was compared in the second series of observations. Adult pelicans had a significantly higher capture success in high dives compared to low dives (Fig. 2; $\chi^2_1 = 20.27$, $P < 0.001$). The increase in capture success with diving height was accompanied by an increase in handling time (Fig. 2; t-test, $t = 15.79$, $P < 0.001$). Since the handling time mainly involves drainage of the gular pouch, the postdiving water volume of the gular pouch is apparently correlated to the diving height. The amount of gular pouch expansion and thus the volume of water in the pouch is probably related to the velocity with which a pelican hits the water surface.

The results of this study suggest that Brown Pelicans face a foraging dilemma. While increasing diving height increases the probability of prey capture in a specific dive, the cost in terms of handling time also increases as the expansion of the gular pouch increases. In addition, high dives may also involve higher time and energy costs in terms of flying. Thus, when choosing diving height, foraging Brown Pelicans seem to face a trade-off between the probability of capture and capture costs mainly in terms of handling time. It is unknown to what extent time and energy costs act as constraints for foraging pelicans. However, the pelicans observed in this study seemed to increase diving height during periods of low prey density and to dive from lower height when prey were abundant, suggesting that the trade-off is influenced by e.g., prey availability. Future studies of Brown Pelican foraging should attempt to elucidate the relation between diving height, capture success and other variables such as prey density, prey depth and prey size.

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