Facultative zygodactyly in the Black-shouldered Kite *Elanus axillaris*

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Summary. This note describes and illustrates facultative zygodactyly in the Black-shouldered Kite *Elanus axillaris*, whereby the Kite is able to swivel the outer toe from the anisodactyl position. Such an ability has been little studied or commented upon; in this respect, this genus of diurnal raptors resembles ospreys *Pandion* spp. and owls (Strigiformes).

Zygodactyly is characteristic of the parrots (Psittaciformes), cuckoos (Cuculiformes), and woodpeckers and relatives (Piciformes). It is a symmetrical toe positioning, with the inner (second) and central (third) positioned forward and the hind (first) and outer (fourth) toe backward. The recent discovery of zygodactyl tracks made by the fossil bird *Shandongornipes* dates to the early Cretaceous, which suggests that the emergence of zygodactyl foot morphology occurred much earlier than previously understood (Lockley *et al*. 2007). Facultative zygodactyly is a well-established trait commonly seen in the Strigiformes (owls), in which the fourth toe can be repositioned forward at will to assist when perching and capturing prey. Some groups of birds, however, are able to switch from the common anisodactyl toe arrangement (three forward, one backward)—as seen in songbirds (Passeriformes) and most diurnal birds of prey (Accipitriformes and Falconiformes)—to the zygodactyl arrangement.

This ability occurs in both diurnal and nocturnal raptor species. Ospreys *Pandion* spp. are well known for being able to rotate the outer toe, with one of the earliest known references made by Shufeldt (1909). A further brief discussion of ospreys using it to provide powerful symmetrical grip during dives to procure fish is made by Polson (1993). Owls (Strigiformes) also possesses the ability to rotate the outer toe forward when perching, hunting and striking prey, in order to ensure efficient capture of prey items (Polson 1993).

I have observed that the Black-shouldered Kite *Elanus axillaris* is also able to rotate the outer toe to a zygodactyl arrangement (photographs in Cupper & Cupper 1981 and Hollands 1984). These photographs show Kites when perched and alighting using a zygodactyl toe arrangement, but there is no discussion of this feature by those authors. Olsen (1995) made a small reference to the possibility of the *Elanus* group being able to rotate the outer toe, and a short comment on the *Elanus* group being zygodactylous is made by Negro *et al*. (2006). It is a trait that has gone largely unnoticed and appears to have remained unstudied.

In the tarsometatarsus of obligate zygodactyl birds such as parrots, the trochlea of the outer toe has a prominent accessory trochlea. Preliminary examination of the

Figure 1. Manipulation of both feet of the Black-shouldered Kite shows the ability to position toes in both anisodactyl (left foot) and zygodactyl (right foot) arrangements. Photo: Leah Tsang

tarsometatarsus of the Black-shouldered Kite shows that in this species the accessory trochlea is much less strongly developed than in obligate zygodactyl birds, anisodactyl species (other members of Accipitridae, Falconidae), or facultative zygodactyl species (*Pandion*, Strigidae) (W. Boles pers. comm. 2010).

Examination of a thawed specimen of a Black-shouldered Kite was made at the Australian Museum. In particular, the feet and toes were observed and manipulated to test for swivel ability of the toes and toe positioning. Figure 1 depicts the Black-shouldered Kite's feet in plantar view, and shows that the species can indeed reposition the outer toe from an anisodactyl arrangement (right) to a zygodactyl arrangement. Figure 2 is a close-up view of the Kite's zygodactyl toe position.

Another interesting external morphological feature that could assist the Kite's toe swivel ability is the lack of webbing between the central and outer toes. Dorsal views of the Kite's feet in the anisodactyl (Figure 3a) and zygodactyl (Figure 3b) arrangement show that the absence of significant toe webbing facilitates the range of movement of the outer toe, and seems to allow the toe to swivel back and forth. Absence of this webbing is also characteristic of the Pacific Baza *Aviceda subcristata*.

Facultative zygodactyly as seen in the Black-shouldered Kite invites several avenues of inquiry. How is it reflected in the osteology and soft tissue of the tarsus and phalanges? Has it been retained as a primitive character in more basal Accipitriformes such as *Pandion*, *Elanus* and *Aviceda*, or has it evolved as a consequence of the behavioural (hunting) ecology of the species (e.g. prey capture

Figure 2. Close-up plantar view of zygodactyl arrangement of Black-shouldered Kite. Photo: Leah Tsang

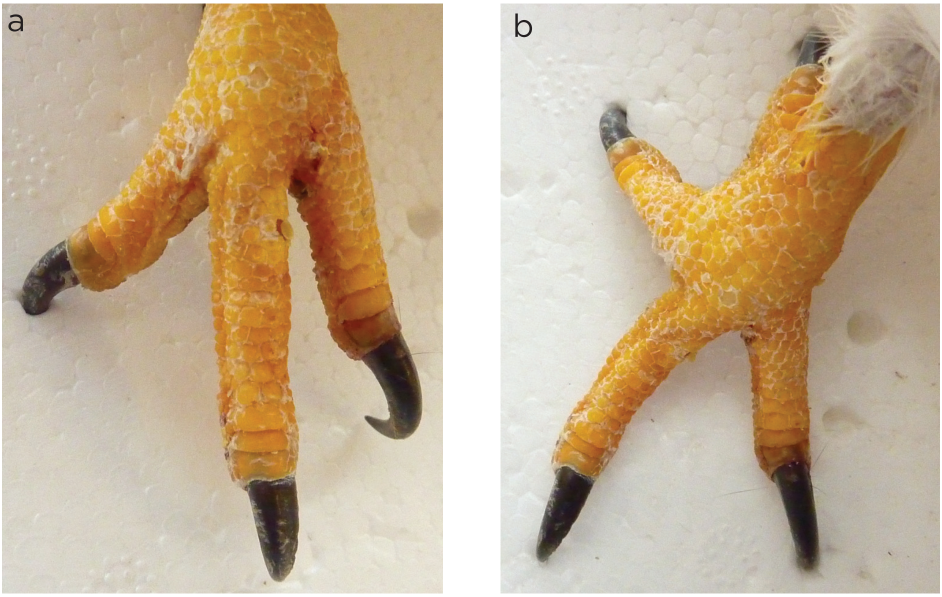

Figure 3. Close-up dorsal views of raptorial toe arrangement of Black-shouldered Kite: (a) anisodactyl, and (b) zygodactyl toe arrangement. Note absence of webbing between second and third toes. Photo: Leah Tsang

or prey restraint)? The Black-shouldered Kite is a small-mammal specialist (mainly small rodents) and often hunts crepuscularly (Marchant & Higgins 1993; Debus *et al.* 2006), so it is possible that a symmetrical toe arrangement increases capture success with small or obscured prey. What is the context surrounding its use? These questions are currently under investigation by the author.

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References

Cupper, J. & Cupper, L. (1981). *Hawks in Focus*. Jaclin Enterprises, Mildura, Vic.

Debus, S.J.S., Olde, G.S., Marshall, N., Meyer, J. & Rose, A.B. (2006). Foraging, breeding behaviour and diet of a family of Black-shouldered Kites *Elanus axillaris* near Tamworth, New South Wales. *Australian Field Ornithology* **23**, 130–143.

Hollands, D. (1984). *Eagles, Hawks and Falcons of Australia*. Nelson, Melbourne.

Lockley, M.G., Li, R., Harris, J.D., Matsukawa, M. & Mingwei, L. (2007). Early zygodactyl bird feet: Evidence from Early Cretaceous roadrunner-like track. *Naturwissenschaften* **94**, 657–665.

Marchant, S. & Higgins, P.J. (Eds) (1993). *Handbook of Australian, New Zealand & Antarctic Birds, Volume 2: Raptors to Lapwings*. Oxford University Press, Melbourne.

Negro, J.J., Pertoldi, C., Randi, E., Ferrero, J.J., Lopez-Caballero, J.M., Rivera, D. & Korpimaki, E. (2006). Convergent evolution of the *Elanus* kites and the owls. *Journal of Raptor Research* **40**, 222–225.

Olsen, P. (1995). *Australian Birds of Prey*. New South Wales University Press, Sydney.

Polson, J.R. (1993). Weapons to cradle: Birds put the toe to the task. *American Birds* **47**, 216–219.

Shufeldt, R.W. (1909). Osteology of birds. *New York State Museum Bulletin* **130**, 90–91.

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