M. ILIOTIBIALIS MEDIALIS AND A REVIEW OF THE *M. ILIOTIBIALIS* COMPLEX IN FLAMINGOS

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IN a previous study of some aspects of morphologic variation in the appendicular musculature of several genera of Ciconiiformes (Vanden Berge 1970) I examined specimens of three of the six recognized forms of the flamingos. These included the two races of the New World Greater Flamingo, *Phoenicopterus r. ruber* and *r. chilensis*, and the James Flamingo, *Phoenicoparrus jamesi*. Some features of the myology of the Old World race of *ruber*, i.e., *r. roseus* (*antiquorum*), were described by Weldon (1883) and Gadow and Selenka (1891).

At that time, I described what appeared to be "an extra muscle in the thigh associated with the sartorius." Since then I have come to the conclusion that, only in the flamingos, the M. iliotibialis muscle complex is differentiated to form a separate medial component, namely M. iliotibialis medialis, in addition to the usual Mm. iliotibialis anterior and lateralis and M. iliofibularis.

The purpose of this paper is to review briefly the gross anatomical relationships of the M. iliotibialis muscle complex in flamingos and to describe and illustrate M. iliotibialis medialis. The latter is a separate medial derivative of this muscle complex and a unique morphologic variation that has been overlooked in previous anatomical studies or at least incorrectly described (by Weldon 1883) in this particular group of birds. The descriptions are based on a study of five individual specimens: the original three forms; a second specimen of *r. ruber*, and a partial dissection of *Phoeniconaias minor* (see Acknowledgments).

The nomenclature for the muscles represents, in part, a departure from my earlier paper (1970), but it is the nomenclature proposed by the Subcommittee on Myologia of the International Committee for Avian Anatomical Nomenclature as part of a projected Nomina Anatomica Avium. Synonyms have been included here on the basis that they have been used in the literature for some time; they were used in my earlier paper. Additional information relative to the NAA may be obtained from the author.

REVIEW OF THE M. ILIOTIBIALIS MUSCLE COMPLEX

Four muscles comprise this complex in flamingos. Three of these, namely M. iliotibialis anterior, M. iliotibialis lateralis, and M. iliofibularis, are common to most birds. The fourth, M. iliotibialis medialis, is

unique to flamingos. All arise from a nearly continuous aponeurosis of origin that extends from the spinous process of the last free thoracic vertebra posteriorly over most of the anterior and posterior iliac crests. Variations in the relative development of each muscle are as follows:

M. iliotibialis anterior ("*sartorius*").—The long, fleshy, parallel-fibered belly forms the anterior border of the thigh musculature. It is of rather uniform width throughout its length and inserts directly (fleshy) on the anteromedial aspect of the patellar tendon, passing deep to the Pars interna, M. gastrocnemius, which is reflected laterad over the entire anterior aspect of the knee.

M. iliotibialis lateralis.—The thin superficial sheet of muscle consists of an anterior or preacetabular and posterior or postacetabular part. A medius or acetabular portion, opposite the hip joint, is very weakly developed in flamingos and, as a result, the aponeurosis of origin is difficult to separate from the fascial sheath of the underlying muscles, specifically M. iliotrochantericus posterior and M. iliofemoralis externus ("gluteus medius et minimus"). Both preacetabular and postacetabular parts are well developed.

The fleshy fibers of both parts approach the patellar tendon at a similar angle from either side of the femoral axis, but they remain somewhat distinct far distally because the aponeurosis of insertion extends proximally to intersect the belly deeply. The aponeurosis blends with the fascial envelope surrounding Mm. femorotibialis medius and externus and is then continuous with the patellar tendon that is formed by all three muscles and M. iliotibialis anterior.

M. iliotibialis medialis (new name).—This is a deep, medial, preacetabular subdivision of the M. iliotibialis muscle complex, peculiar to flamingos. The very wide, relatively thin, parallel-fibered sheet of muscle arises from a common aponeurosis of origin with the preceding muscles from the anterior iliac crest (Fig. 1). The muscle is otherwise concealed by M. iliotibialis anterior and the preacetabular portion of M. iliotibialis lateralis, but is very clearly seen when the latter two muscles are transected and reflected.

The fleshy fibers extend distad for nearly the entire length of the thigh, converging on a narrow tendon that is formed opposite the distal fifth of the shaft of the femur. This tendon inserts on the medial aspect of the tibiotarsus at the base of the enlarged medial cnemial crest, not on the patellar tendon. In one leg of one specimen of *r. ruber*, a small fleshy slip is given off toward the insertion of M. iliotibialis anterior. In *r. ruber* and *r. chilensis*, the tendon passes beneath that of M. femorotibialis internus; in *minor* and *jamesi*, these two muscles unite to form a common tendon just proximal to the insertion on the tibiotarsus. In all

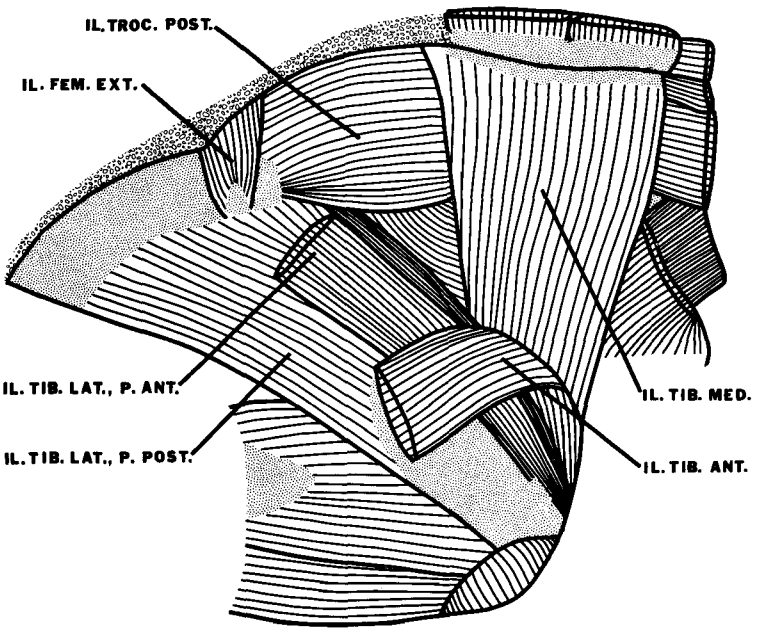

Fig. 1. M. iliotibialis complex in *Phoenicopterus r. ruber*. Abbreviations used: Il. tib. ant., M. iliotibialis anterior; Il. tib. lat., M. iliotibialis lateralis, pars anterior, pars posterior; Il. tib. med., M. iliotibialis medialis; Il. fem. ext., M. iliofemoralis externus; Il. troc. post., M. iliotrochantericus posterior.

specimens, the tendon(s) are concealed by the Pars interna, M. gastrocnemius on the medial aspect of the knee.

This newly redescribed muscle is innervated by a large nerve trunk that arises from the Plexus cruralis (Spinal nerves$_{25-28}$). As the nerve trunk crosses the lateral surface of the muscle it gives off N. cutaneus femoralis lateralis; the latter emerges between the bellies of M. iliotibialis anterior and M. iliotibialis lateralis to be distributed in the skin. Thereafter the trunk bifurcates to supply only M. iliotibialis anterior and M. iliotibialis medialis. (The preacetabular part of M. iliotibialis lateralis is innervated by a second nerve trunk that also innervates Mm. iliotrochanterici, M. iliofemoralis externus, M. ambiens, M. iliofemoralis internus ("iliacus"), and Mm. femorotibiales. The latter trunk represents N. femoralis according to many authors.)

M. iliofibularis (*"biceps femoris"*).—The well-developed belly arises in part by an aponeurosis from the posterior iliac crest in common with that of the postacetabular portion of M. iliotibialis lateralis. The latter conceals much of the belly except from the most posterior extent that

arises fleshy from the crest. The fleshy fibers converge on a tendon that passes through the usual fibrous loop (Ansa fibrosa) to insert on the posterolateral surface of the proximal portion of the fibula.

DISCUSSION

In the original description of the thigh muscles of the flamingos, Weldon (1883: 648–649) suggested that there were "three distinct portions [of M. iliotibialis anterior], separate in origin and insertion, but so situated that each has all the relations of the typical [muscle]. Of the [M. iliotibialis lateralis], only the postacetabular portion is left." The "three distinct portions" to which he refers are actually M. iliotibialis anterior, M. iliotibialis medialis, and the preacetabular part of M. iliotibialis lateralis. Gadow and Selenka (1891) also described three separate heads of the so-called "sartorius" (p. 150) and further state (p. 153) that the preacetabular part of M. iliotibialis lateralis "is absent in *Phoenicopterus*."

That the above represents an erroneous conclusion on the part of both authors is evident if one considers the known variation in the muscles that are derived from this complex in birds generally. For example, although there is considerable evidence for variation in the origin and/or insertion of M. iliotibialis anterior (Berger 1966: 380–384; Hudson et al. 1969; Klemm 1969; Raikow 1970; and others), none of these studies shows any evidence for the presence of an independent muscle comparable to M. iliotibialis medialis. Furthermore the preacetabular part of M. iliotibialis lateralis is in no way that unusual in flamingos in comparison with many other birds.

The common innervation of M. iliotibialis anterior and M. iliotibialis medialis suggests that both may have been derived from the most anterior portion of the preacetabular or preaxial component of the superficial dorsal muscle mass that also gives rise to M. iliotibialis lateralis. According to Romer (1927), M. iliotibialis anterior is established rather early in development. The gross anatomical relationships of M. iliotibialis medialis are such that a similar independent and early establishment of M. iliotibialis medialis may be reasonably assumed. I conclude, then, that the M. iliotibialis lateralis spreads over the lateral surface of this muscle during the dorsal migration of both muscles in a manner similar to that by which the M. iliotibialis lateralis spreads posteriorly over the independently derived M. iliofibularis, the only muscle to be derived from the postacetabular part of the superficial dorsal muscle mass.

Moreover, if the M. iliotibialis medialis does represent a well-defined, independently derived component of the M. iliotibialis complex, then it seems reasonable to assume that some functional advantage must have

been gained in terms of posture and/or terrestrial locomotion in flamingos. The gross anatomical relationships again suggest possible functional correlation with M. femorotibialis internus, either by facilitating medial rotation of the tibiotarsus (see Cracraft 1971: 233) or by subserving the function of an "active" ligament (a property of two-joint muscles, according to Bock 1968: 39).

Whatever may be the case, M. iliotibialis medialis remains a morphologic variation unique to this group of birds, overlooked in previous studies, but of considerable interest in attempting to understand the functional morphology and musculature of the hind limb in birds.

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