THE LOCOMOTOR APPARATUS

Although bipedalism in birds is the consequence of an adaptation for flying, adaptive radiations in the hind limb locomotion are as varied as the intrafamilial radiations in the fore limbs. The hind limb locomotion often provides a clue to the avian food niche and also of the feeding behaviour within the niche. Those birds which dwell the terrestrial habitat in search of food are well adapted for a bipedal gait.

A. Osteology

The skeletal components in the birds studied here did not exhibit any significant variations as such either in their absolute sizes or the ratios of different elements. A common account therefore, of the salient features of these elements is given below.

Pelvis

The preacetabular ilium is slightly longer than the postacetabular part and latero medially flattened lying in a plane horizontal to the longitudinal axis of the vertebral column. The anterior iliac crest is well defined and turning downward at its anterior end forms an anterior iliac process. Posteriorly the preacetabular ilium turns slightly outwards and thereby comes to line in a more
vertical plane. The postacetabular ilium is divisible into a dorsal and a ventral part. Dorsal to the posterior iliac crest the postacetabular ilium lies at the right angle to the longitudinal axis of the vertebral column, extending to the junction of the synsacro-caudal vertebrae. This portion of the postacetabular ilium is raised and bulbous. The ventral part of the postacetabular ilium forms an ilio-ischiatic fenestra (lateral iliac fossa, Holms, 1963) in between the posterior iliac crest and the ischium. This fossa lies slightly medial to the crest. The ischium is narrow anteriorly, broad in the middle and then extends posteriorly and tapers to a fine point which joins the pubis by fibrous connective tissue. The obturator foramen is not ossified posteriorly and hence appears to be continuous with the ischio—pubic fenestra. The latter is long and narrow and extends almost up to the junction of ischium and pubis. The pubis is long and thin. It extends caudad beyond the ischium and forms an upcurved spine-like projection. The antitrochanter is moderately developed. There are seven free caudal vertebrae (including the pygostyle) of which the first five have well developed transverse processes.

**Femur**

The femur has a very well developed head which is marked from the neck by a groove. At the tip of the head
there is a deep pit for the attachment of the ligament. The neck is short and stubby. A broad rounded trochanter present above the neck has a poorly developed trochanteric ridge distally. The obturator ridge is not distinguishable from the shaft. The latter is rounded at the postero-proximal and rather flattened on the anterior side. Distally, again the shaft becomes flattened near the condyles, both anteriorly and posteriorly. Both the condyles are founded but the external condyle has a deep groove on its posterior side.

Tibiotarsus

Both the proximal head and distal heads (condyles) of the tibiotarsus are very prominent having a greater width antero-posteriorly than latero-medially. The cnemial crests are very well developed and more acutely deflected from the shaft. The inner cnemial crest is broad and plate like while the outer one has a narrow spine-like tip, projected downward and slightly outward. The shaft is straight both proximally near the head and distally near the condyles. Proximo-anteriorly the shaft is nearly flat, with slightly rounded sides, flattened on anterior side, near the distal end.

A short and thin fibula is joined to the main shaft
at about the one third distance from the head, by means of a long, flat crest which extends out from the shaft. The head of the fibula - high and angulated posteriorly - fits into the groove present on the outer condyle of the femur and slides over it smoothly. The body of the fibula is not long but the fibular spine, a very thin structure, extends up to the three fourth of the tibial length.

The patella is a very small bone and lacks pronounced lateral and mesial surfaces.

**Tarsometatarsus**

The anterior side of the bone is somewhat flattened proximally and slightly rounded distally. The lateral side of the shaft is twisted forward, while the medial side is twisted backward. The anterior metatarsal groove is shallow but broad, being deepest in the region of the proximal ligamental attachment. Posteriorly the shaft is flat and a long shallow groove is formed below the hypotarsus, extending up to metatarsal I. Postero-laterally a pronounced ridge is present which also extends up to the metatarsal facet. Hypotarsus is squarish in outline and has six canals.

The metatarsal I is placed postero-medially and the trochlea for the hallux is broad and rounded. The middle trochlea for the digit III is almost as well developed as
the trochlea for the hallux. It has a well-marked groove in the middle. Its medial margin is slightly larger than the lateral one. The inner trochlea, that is, trochlea for the digit II is less broad than the middle one but its inner margin is slightly longer than that of the latter. A longitudinal groove is also present which is shallow but distinct. The outer-trochlea for the digit IV is the least developed of the four. It is a small, thin round disk-like structure having an indistinct groove in the midline. The outer margin is slightly larger than the inner one.

**Digits**

The arrangement of the digits is of anisodactyl type. The hallux is long and posteriorly placed. It has a very strong and curved nail. The digit III is the longest one whereas, of the two remaining digits the IV is slightly longer than the II. The basal phalanges of these three anteriorly directed digits are free from each other and are not bounded in a common sheath of the skin.

The dimensions and per cent ratios of different bony elements of the pelvis and the hind limbs are represented in Tables XVII, XVIII, XIX and XX.
### TABLE XVII
MEASUREMENTS OF PELVIS IN MM

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Common Myna Mean</th>
<th>Common Myna Range</th>
<th>Rosy Pastor Mean</th>
<th>Rosy Pastor Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Length of Pelvis</td>
<td>35.6</td>
<td>34 - 37</td>
<td>32.7</td>
<td>31 - 33</td>
</tr>
<tr>
<td>2. Width of Pelvis</td>
<td>24.0</td>
<td>22 - 26</td>
<td>20.5</td>
<td>18 - 25</td>
</tr>
<tr>
<td>3. Length of Ilium</td>
<td>28.0</td>
<td>26 - 30</td>
<td>26.3</td>
<td>25 - 28</td>
</tr>
<tr>
<td>4. Preacetabular ilium length</td>
<td>14.6</td>
<td>14 - 15</td>
<td>13.5</td>
<td>13 - 15</td>
</tr>
<tr>
<td>5. Postacetabular ilium length</td>
<td>13.2</td>
<td>11 - 15</td>
<td>12.0</td>
<td>11 - 14</td>
</tr>
<tr>
<td>6. Length of Ischium</td>
<td>18.0</td>
<td>17 - 19</td>
<td>16.4</td>
<td>16 - 20</td>
</tr>
</tbody>
</table>

### TABLE XVIII
RATIOS OF PELVIC ELEMENTS EXPRESSED AS THE PERCENTAGE OF THE PELVIC LENGTH

<table>
<thead>
<tr>
<th>Ratios</th>
<th>Common Myna Mean</th>
<th>Common Myna Range</th>
<th>Rosy Pastor Mean</th>
<th>Rosy Pastor Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Width of Pelvis</td>
<td>67.12</td>
<td>64.71 - 78.84</td>
<td>62.70</td>
<td>58.06 - 75.77</td>
</tr>
<tr>
<td>2. Length of Ilium</td>
<td>78.66</td>
<td>76.47 - 81.08</td>
<td>80.44</td>
<td>80.13 - 84.86</td>
</tr>
<tr>
<td>3. Preacetabular ilium length</td>
<td>41.02</td>
<td>40.54 - 41.17</td>
<td>41.29</td>
<td>41.03 - 45.45</td>
</tr>
<tr>
<td>4. Postacetabular ilium length</td>
<td>37.09</td>
<td>32.35 - 40.54</td>
<td>36.70</td>
<td>35.48 - 42.42</td>
</tr>
<tr>
<td>5. Length of Ischium</td>
<td>50.58</td>
<td>49.99 - 51.36</td>
<td>50.16</td>
<td>49.61 - 60.60</td>
</tr>
</tbody>
</table>
TABLE XIX
MEASUREMENTS OF THE LEG ELEMENTS IN KM

<table>
<thead>
<tr>
<th>Element</th>
<th>Common Myna Mean</th>
<th>Range</th>
<th>Rocky Pastor Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total leg length</td>
<td>106.60</td>
<td>101.00 - 123.00</td>
<td>103.50</td>
<td>103.00 - 119.00</td>
</tr>
<tr>
<td>2. Femur</td>
<td>26.70</td>
<td>27.00 - 32.00</td>
<td>28.20</td>
<td>27.00 - 32.00</td>
</tr>
<tr>
<td>3. Tibiotarsus</td>
<td>46.50</td>
<td>45.00 - 55.00</td>
<td>49.00</td>
<td>46.00 - 55.00</td>
</tr>
<tr>
<td>4. Tarsometatarsus</td>
<td>29.60</td>
<td>29.00 - 36.00</td>
<td>31.30</td>
<td>30.00 - 32.00</td>
</tr>
<tr>
<td>5. Metatarsal I</td>
<td>06.20</td>
<td>07.00 - 10.00</td>
<td>06.00</td>
<td>06.00 - 09.00</td>
</tr>
<tr>
<td>6. Hallux</td>
<td>13.60</td>
<td>13.00 - 16.00</td>
<td>15.10</td>
<td>14.00 - 16.00</td>
</tr>
<tr>
<td>7. Digit III</td>
<td>27.00</td>
<td>24.00 - 30.00</td>
<td>29.20</td>
<td>25.00 - 30.00</td>
</tr>
<tr>
<td>8. Digit II</td>
<td>15.60</td>
<td>14.00 - 18.50</td>
<td>16.30</td>
<td>15.00 - 16.00</td>
</tr>
<tr>
<td>9. Digit IV</td>
<td>19.00</td>
<td>16.00 - 20.00</td>
<td>20.00</td>
<td>16.00 - 22.00</td>
</tr>
<tr>
<td>Ratio</td>
<td>Common Myna Mean</td>
<td>Range</td>
<td>Rosy Pastor Mean</td>
<td>Range</td>
</tr>
<tr>
<td>----------------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>2. Tibiotarsus length : leg length</td>
<td>45.41</td>
<td>44.55 - 46.72</td>
<td>45.16</td>
<td>45.10 - 46.23</td>
</tr>
<tr>
<td>3. Tarsus length : leg length</td>
<td>27.72</td>
<td>26.72 - 29.27</td>
<td>28.19</td>
<td>26.89 - 29.41</td>
</tr>
<tr>
<td>4. Metatarsal I length : leg length</td>
<td>07.68</td>
<td>06.93 - 08.32</td>
<td>07.37</td>
<td>06.86 - 07.56</td>
</tr>
<tr>
<td>8. Digit IV length : leg length</td>
<td>17.79</td>
<td>15.84 - 18.26</td>
<td>18.44</td>
<td>15.69 - 18.49</td>
</tr>
</tbody>
</table>
B. Myology

Since the morphology - structure and disposition - of the leg muscles in these birds has been described earlier in detail by Naik (1970), repetition is avoided here. However, a relative study of the muscles in correlating the functional aspects of the locomotory behaviour was undertaken. Different leg movements were observed and the muscles have been grouped as follows.

I. Muscles moving the Femur

Muscles of this one joint group extend from sacrum to femur. This group includes the following muscles:

- M. Iliotrochantericus ant. and post. parts
- M. Ischiofemoralis
- M. Adductor longus et brevis ant. and post.
- M. Piriformis pars caudofemoralis and
- M. Obturator ext.

II. Muscles moving the Femur and Tibia

M. Sartoris, M. Iliotibialis, M. Biceps femoris, M. Semitendinosus comprise this two-joint group which arise from sacrum and insert on tibia.

III. Muscles moving the Tibiotarsus

This one joint group of muscles extending from
femur to tibiotarsus is represented by only one muscle which is further divided into three distinct parts, viz.,

- M. Femorotibialis externus
- M. Femorotibialis medius
- M. Femorotibialis internus

IV. Muscles moving the Tarsometatarsus

Extending from femur to tarsometatarsus, this two joint group of muscles is represented by two well developed muscles: M. Gastrocnemius and M. Tibialis anterior. The former is divisible into three parts, of which the externus and internus parts are very well developed whereas the medius is poorly developed.

M. Peroneus brevis is the only one joint muscle which extends from tibiotarsus to tarsometatarsus.

V. Muscles moving the Tarsometatarsus and Toes

a. Toe Flexors and Tarsal Extensors

These two joint muscles are primarily flexors of the toes but they also serve as the extensors of tarsometatarsus when the flexion of toes is opposed. The muscles of this group are M. Flexor perforatus digiti II, M. Flexor perforatus digiti III, M. Flexor perforans et perforatus digiti III, M. Flexor perforatus digiti IV,
M. Flexor hallucis longus, M. Flexor digitorum longus, M. Peroneus longus and M. Plantaris.

b. Toe Extensors and Tarsal Flexors

M. Extensor digitorum longus along with the M. Gastrocnemius, M. Tibialis anterior and the toe flexors performs the functions of tarsal flexion and the extension of the toes.

c. Toe Extensors and Abductors

Of this one joint group only M. Abductor digit. IV and M. Extensor hallucis brevis are present in the birds studied. They are so weakly developed that they are insignificant functionally.

d. Toe Flexors and Adductors

Muscles representing this group are not represented in the two birds studied here.

It may, however, be pointed out here that the muscles of these interacting groups act simultaneously to produce an intricate balance in different actions which are responsible for the various degrees of movements of the hind limbs.
I. Muscles moving the Femur

1. M. Iliotrochantericus posterior: (Plates XI. 2 and XII. 1, 2)

A stout, fan-shaped muscle occupying the preacetabular ilium it arises fleshy from the entire surface of this bone. The fibers converge to form a flat tendon and the latter inserts on the lateral face of the femoral trochanter.

Action

Inward rotation and a slight flexion of the femur.

2. M. Iliotrochantericus Anterior: (Plates XI. 2 and XII. 1, 2)

This is also a fan-shaped muscle situated below the M. Iliotrochantericus posterior. It arises fleshy from the ventral edge of the preacetabular ilium where some of its fibers are fused with the overlying muscle. The fibers converge to insert via a flat tendon on the lateral surface of the femur just distal to the insertion of the M. Iliotrochantericus posterior.

Action

Flexion and inward rotation of the femur.
Plate XII
1

2

PL. XII
Plate XIII
Plate XIV
3. M. Ischiofemoralis: (Plates XI, 2, XII, 2 and XIII, 1)

Thick, narrow muscle extending between the ischium and femur it arises fleshy from the lateral surface of ischium posterior to the obturator foramen. Some fibers arise from the area between the posterior iliac crest and the ischio-pubic fenestra. The anterior one-third of the belly is covered with a dense aponeurosis which contributes to the tendon of insertion on the lateral surface of the femur opposite and posterior to the insertion of the M. Iliotrochantericus medius.

Action

Outward rotation and slight extension of the femur.

4. M. Adductor Longus Et Brevis: (Plates XI, 1, XIII, 1 and XIV, 1, 2)

This is a broad, flat muscle consisting of two parts - pars anterior and pars posterior. The pars anterior takes its fleshy origin superficially and aponeurotic on its deep surface from the ventro-lateral side of the ischium above the ischio-pubic fenestra. The pars posterior also arises in a similar fashion immediately caudal to the origin of the pars anterior. The two parts run side by side towards the femur of the pars anterior insert on the postero-medial
side of the femur extending between the insertion of the pars caudofemoralis and the medial femoral condyle.

Slightly longer belly of the pars posterior seeks its insertion just distal to that of the pars anterior in part on a raphe shared with the pars medius of the M. Gastrocnemius and in part on the medial femoral condyle.

**Action**

Because of the insertion on the posterior surface of the femur, this muscle acts as an extensor of the femur.

5. M. Piriformis Pars Caudofemoralis: (Plates X, I, XII, I, XIII, I and XIV, I)

This is a long, flat, somewhat spindle-shaped muscle extending from the pygostyle to the femur. Its belly passes between the Mm. Semitendinosus and Biceps femoris. It arises by a long tendon from the ventral surface of the pygostyle and its insertion on the posterior side of the femur is also tendinous. This tendon of insertion is short, thin and membranous.

**Action**

The fact that both the ends - the origin and the insertion - are on the movable parts it has a dual function. When the tail is fixed in position the muscle extends the
femur; but if the latter is fixed the muscle depresses the tail.

6. **M. Obturator Externus:** (Plates XI, 2, XII, 2, XIII, 1 and XIV, 1)

This very small fleshy muscle has two heads - dorsal and ventral - which are separated by the tendon of insertion of *M. Obturator internus*. The dorsal head arises from the ventral margin of the ilio-ischiatic fenestra whereas the ventral head arises from the antero-ventral border of the obturator foramen. The insertion of the two heads on the posterior surface of the femur is partly fleshy and partly tendinous. Some of the fibers are also inserted on the tendon of the *M. Obturator internus*.

**Action**

Supplements the action of the *M. Obturator internus*.

7. **M. Obturator Internus:** (Plates X, 2, XII, 2 and XIII, 1)

This leaf-like bipinnate muscle occupies the ischio-pubic fenestra, which gets plugged by its belly. The origin is from the medial surface of the ischium and pubis only. Anteriorly the fibers converge to form a strong tendon. The latter passes through the obturator foramen and inserts on the lateral surface of the proximal part of the femur.
Action

Outward rotation of the femur.

II. Muscles moving the Femur and the Tibia

1. M. Sartorius: (Plate X, 1, 2)

This strap-like muscle forms the anterior margin of the thigh. It originates by two heads one above the other, which fuse to form a single belly. The origin is aponeurotic superficially and fleshy in the deeper part, extending from the neural spine of the last thoracic vertebra to the anterior end of the ilium. The insertion is mainly on the antero-medial edge of the articular surface of the tibiotarsus by deep tendinous fibers and superficial fleshy fibers. A small portion also inserts fleshy on the tendon of insertion of M. Femorotibialis and also on the patellar tendon.

Action

Flexion of the femur, extension of the tibiotarsus and slight adduction of the entire limb.

2. M. Iliotibialis: (Plate XI, 1, 2)

M. Iliotibialis, the most superficial muscle of the thigh region, is situated posterior to M. Sartorius
and anterior to M. Semitendinosus. The muscle is thin
sheet-like and triangular in shape. The middle of the
muscle belly is fused with the aponeurosis of the underlying
M. Femorotibialis externus and medius. The origin, which
is from the iliac crest, is aponeurotic on the anterior
part but is fleshy on the posterior part. Distally the
muscle is divisible into anterior and posterior fleshy
insertions separated by an aponeurotic insertion which is
closely bound to M. Femorotibialis. The insertion is on
the patellar tendon and associated fascia on the lateral
side of the knee joint.

**Action**

Primarily this muscle acts as an abductor of the
limb. It also extends the tibiotarsus slightly.

3. **M. Biceps Femoris:** (Plates XIII, 1 and XIII, 1)

This is a long muscle broad at its origin becoming
narrow towards the insertion. The origin is fleshy from the
posterior iliac crest just posterior to the acetabulum. The
fibers converge distally to form a stout tendon which passes
through the biceps loop to insert on the shaft of the fibula.

**Action**

Extension of the femur and flexion of the tibiotarsus.
4. **M. Semimembranosus:** (Plates X, 1, 2, XII, 1 and XIV, 2)

It is a thin strap-like muscle with fleshy origin from the ventro-lateral margin of the ischium just posterior to the origin of **M. Adductor longus et brevis.** Distally this muscle is connected with **M. Semitendinosus** and forms a common tendon of insertion which inserts on the medial surface of the proximal end of the tibiotarsus.

**Action**

Extension of the femur and flexion of the tibiotarsus.

**III. Muscles moving the Tibiotarsus**

1. **M. Femorotibialis:** (Plates XII, 1, 2, XIII, 2 and XIV, 1, 2)

This muscle is the largest among the thigh muscles. It has three parts, an externus, a medius and an internus. Of the three, the bellies of the first two parts are fused except toward their proximal regions where they are separated by the tendons of insertion of **Mm. Iliotrochantericus anterior** and **medius.** The externus and medius parts occupy the antero-lateral side while the internus lies on the medial surface of the thigh.

**M. Femorotibialis externus** arises by two heads -
the proximal fleshy from the lateral surface of the proximal half of the femur and the distal head partly fleshy and partly tendinous from the lateral surface of the distal half of the femur. The muscle becomes tendinous at its distal end, contributing to the formation of the patellar tendon.

M. Femorotibialis medius has fleshy origin on the anterior side of the proximal half of the femur. The tendinous insertion contributes to the formation of the anterior part of the patellar tendon.

M. Femorotibialis internus has two bellies - the proximal and the distal. The proximal belly is narrow proximally and broad distally. On the medial side of the distal half it is provided with a prominent aponeurosis. The distal belly is comparatively very small. The proximal belly has a fleshy as well as tendinous origin from the medial surface of the femur. The distal belly also arises partly fleshy and partly tendinous on the medial surface of the femur. The insertion on the postero-medial corner of tibial head is by means of a tendon. The distal belly inserts by a small, broad tendon just proximal to the insertion of the proximal belly.

**Action**

M. Femorotibialis externus and medius are responsible
only for the extension of the tibiotarsus while the internus rotates inwards.

IV. Muscles moving the Tarsometatarsus

1. M. Gastrocnemius: (Plates XI. 2. XII. 2 and XIV. 1. 2)

It is the largest muscle in the hind limb musculature, located superficially and covering most of the posterior and medial surfaces of the shank region. There are three distinct heads - pars externa, pars media and pars interna.

Pars Externa

It occupies the postero-lateral surface of the shank and is almost as large as the pars interna. It arises tendinously from the patellar tendon anteriorly and from the femur just proximal to its condyle postero-laterally.

Pars Media

This is the smallest of the three parts and lies just lateral to the pars interna and is separated from it by the tendon of insertion of M. Semimembranosus. The origins, fleshy from popliteal fossa and tendinous from the inner condyle of the femur are fused with those of M. Semimembranous and M. Adductor longus et brevis, respectively.
Pars Interna

On the medial surface of the shank, it covers most of the muscles in that region. A small part of its head also wraps round the anterior surface which is visible on the lateral side. The origin is fleshy from the entire medial surface of the inner cnemial crest.

The common tendon of pars media and pars interna fuses with that of the pars externa to form a common tendon of Achillis which covers the tibial cartilage and the hypotarsus, then runs downwards and gets inserted on the tarsometatarsus.

Action

The major function is powerful extension of the tarsometatarsus. Slight flexion of the tibiatarsus is also accomplished because of the origins of pars externa and pars media from the femur.

2. *M. Tibialis Anterior* (Plates XII, 1 and XIII, 2)

This bipinnate muscle with two heads - tibial and femoral - occupies the anterior edge of the shank underneath the *M. Peroneus longus*. The tibial head has a tendinous origin from the cnemial crests and a fleshy
origin from the rotular crest. The femoral head arises by a short tendon from the anterior crest of the external femoral condyle. The two heads fuse to form a long belly that terminates into a tendon of insertion which passes below the ligamentum transversum. The tendon then passes between the condyles of the tibiotarsus and finally inserts on a tubercle present at the proximal end of the tarsometatarsus.

**Action**

Flexion of the tarsometatarsus. The deep head also flexes the tibiotarsus on account of its origin on the femur.

3. **M. Peroneus Brevis:** (Plates XII, 1, 2 and XIII, 1)

This slender bipinnate muscle is situated deep along the antero-lateral side of the shank. It arises partly fleshy and partly tendinous from the anterior surface of the fibula and from the lateral side of the tibiotarsus at the level of the biceps tendon. At the distal end the muscle is provided with a tendon which passes through a fibrous loop deep to the tendon of M. Peroneus longus and then inserts on the tubercle near the hypotarsus.

**Action**

It acts as an accessory to M. Gastrocnemius in
extending the tarsometatarsus. Its strong tendon also serves as a brace against the tarsal rotation.

V. Muscles moving the Tarsometatarsus and Toes

1. M. Flexor Perforatus Digitii II: (Plates XI, 1, XII, 1, 2 and XIII, 1)

This long bipinnate, spindle-shaped muscle occupies the lateral side of the shank beneath the pars externa of M. Gastrocnemius. Its tendinous origin from the lateral femoral condyle is shared with that of the M. Flexor perforans et perforatus digitiIII. The tendon of the origin is connected with the ligament capsule of the knee and the head of the fibula by a tendinous sheet. The tendon of insertion passes over the fibrous pulley in the intertrocchlear space and inserts on the medial surface of the base of the phalanx 1 of digit II.

Action

Mainly flexor of the digitii II; it also extends the tarsometatarsus and flexes the tibiotalarsus slightly.

2. M. Flexor Perforatus Digiti III: (Plate XIII, 1)

This is also a long bipinnate muscle situated on the postero-medial side of the shank deep to M. Gastrocnemius.
It arises from the popliteal fossa on the femur tendinously and this origin is shared with that of the M. Flexor perforatus digitii IV. A small fleshy portion of the muscle also arises from the head of the tibiotarsus. The tendon of insertion is enveloped by that of the M. Flexor perforatus digit IV and then they pass through posterolateral canal of the hypotarsus. At its distal end this tendon splits and the two slips insert on each side of the distal end of the phalanx 1 of digit III.

Action

Flexion of digit III as a whole and also of phalanx 2 over phalanx 1. It extends the tarsometatarsus and slightly flexes the tibiotarsus.

3. M. Flexor Perforans Et Perforatus Digit III: (Plates XI, 1, XII, 1, 2 and XIII, 1)

The belly of this long bipinnate muscle is partly fused with Mm. Peroneus longus, Tibialis anterior and Gastrocnemius pars externa. Its common tendinous origin with that of the M. Flexor hallucis longus and M. Flexor perforatus digitii II is from the small area on the lateral femoral condyle and from the tip of outer cnemial crest with M. Tibialis anterior. A small part of the muscle arises
by tendinous fibers from patellar tendon and by fleshy fibers from the head of fibula. The tendon of insertion passes through postero-medial canal of the hypotarsus. At the distal end, it perforates the tendon of M. Flexor perforatus digitii III and is perforated by the tendon of M. Flexor digitorum longus. The tendon finally splits and inserts on the medial and lateral sides of the phalanx 2 of the digit III. Vinculum is absent in these birds.

Action

Flexion of digit III, and extension of tarsometatarsus when digit III is fixed.

4. M. Flexor Perforatus Digitii IV: (Plates XI, 1, XIII, 1 and XIV, 1)

It is a long bipinnate muscle extending along the postero-lateral surface of the shank below the pars externa of M. Gastrocnemius. Its origin partly fleshy and partly tendinous from the popliteal fossa of the femur is shared by M. Flexor perforatus digitii III. The tendon of insertion ensheathes the tendon of M. Flexor digitorum longus. Its tendon inserts on the tip of the phalanx 2 of the digit IV. A small slip form the main tendon inserts on the tip of the phalanx 1.
Action

Flexion of the entire digit as well as flexion of its distal part. Extension of the tarsometatarsus and flexion of the tibiotarsus are also accomplished by this muscle along with the other toe flexors.

5. M. Flexor Hallucis Longus: (Plates XI, I, XII, 2, XIII, 1, and XIV, 1)

This bipinnate muscle has two heads - lateral and median. The median head has tendinous and fleshy origin from the popliteal fossa on the femur. The lateral head has a common tendinous origin with M. Flexor perforatus digiti II and M. Flexor perforans et perforatus digiti III from the lateral femoral condyle. The two heads join in a single belly which has a strong tendon of insertion. It passes through the antero-lateral canal of the hypotarsus and finally it perforates the massive tissue at the base of hallux and inserts mainly on the base of the ungual phalanx. A slip is given off to phalanx 1 also.

Action

Flexus the hallux and assists M. Flexor digitorum longus.
6. M. Flexor Digits Longus: (Plates XI, XII, XIII, and XIV)

This well developed bipinnate muscle lies in the deepest layer on the posterior face of the tibiotarsus. It arises from almost the entire posterior surface of the fibula by fleshy fibers and from most of the posterior side of the tibiotarsus. On the posterior surface of the belly an aponeurosis is present which forms a thick tendon at its distal end. This tendon passes through the antero-medial canal of the hypotarsus and then passes diagonally downward and divides into three slips one to each digit. These insert on the ungual phalanx of digit II and III and on the ungual, subungual and third phalanges of digit IV.

**Action**

Flexion of digits II, III and IV and extension of the tarsometatarsus.

7. M. Peroneus Longus: (Plates XI, and XIII)

This superficially located thin muscle spreads over the antero-lateral surface of the proximal two-third of the shank. Its belly is attached to the underlying muscles. It arises by an aponeurosis and some fleshy fibers from the cnemial crests and rotular crest. Its aponeurotic
origin is partly fused with that of the pars interna of M. Gastrocnemius. It forms a flat tendon at its distal end which bifurcates at its distal end. One wide short slip inserts on the lateral surface of the tibial cartilage. The main tendon continues across the lateral surface of the intertarsal joint and passes to the posterior side where it fuses with the tendon of M. Flexor perforatus digitii III.

**Action**

Extends the tarsometatarsus and strengthens the action of M. Flexor perforatus digitii III.

8. **M. Plantaris**

This is a small, slender muscle with a fleshy origin from the postero-medial surface of the proximal head of the tibiotarsus. Its short belly tapers to a thin and long tendon which is inserted on the medial corner of the tibial cartilage. It is not shown in figures.

**Action**

Draws the tibial cartilage proximally causing extension of the tarsometatarsus.

9. **M. Extensor Digitorum Longus:** (Plates XIII, 1, 2, and IX, 2)

It is a long, narrow, bipinnate muscle lying deep
between the M. Tibialis anterior and the tibiotarsus. It arises from the inner and outer cnemial crests just distal to the origin of Mm. Peroneus longus and Tibialis anterior. As the belly passes downwards some fibers arise from the antero-medial surface of the proximal two-third of the tibiotarsus. The tendon of insertion passes through the ligamentum transversum, the bony bridge and then traverses the anterior intercondylar fossa. At the distal end just proximal to the base of the toes the tendon trifurcates and gives one slip to each of the II, III and IV digits on its dorsal side, which again divide and get inserted at various points on the phalanges.

**Action**

Extension of digits II, III and IV. It also flexes the tarsometatarsus.

10. **M. Abductor Digitii IV**

It is a feebly developed muscle present at one end of the antero-medial side of the distal tarsal region and at the other end it is inserted between the trochlea and phalanx 1 of the digit IV. This muscle is not shown in figure.

**Action**

Abduction of the digit IV.
The relative development of the leg to the body and of the individual muscles to the leg are presented in the Tables XXI and XXII, respectively.

**TABLE XXI**

**RELATIVE DEVELOPMENT OF LEG**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Common Myna</th>
<th>Rosy Pastor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>------</td>
</tr>
<tr>
<td>1. Per cent of total leg wt. of body wt.</td>
<td>2.767 2.796-2.877</td>
<td>2.826 2.693-2.965</td>
</tr>
<tr>
<td>2. Per cent of total bulk of leg muscles of body wt.</td>
<td>1.616 1.600-1.638</td>
<td>1.498 1.470-1.582</td>
</tr>
<tr>
<td>3. Per cent of total bulk of leg muscles of total leg bulk</td>
<td>58.422 55.605-58.570</td>
<td>58.230 54.393-58.408</td>
</tr>
<tr>
<td>Muscle</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>1. M. Sartorius</td>
<td>4.017</td>
<td>3.189 - 4.777</td>
</tr>
<tr>
<td>2. M. Iliotibialis</td>
<td>5.803</td>
<td>4.784 - 7.014</td>
</tr>
<tr>
<td>3. M. Iliotrochantaricus (anterior, medius &amp; posterior)</td>
<td>3.571</td>
<td>3.184 - 4.158</td>
</tr>
<tr>
<td>5. M. Biceps femoris</td>
<td>4.553</td>
<td>4.158 - 5.010</td>
</tr>
<tr>
<td>7. M. Piriformis pars Caudofemoralis</td>
<td>1.785</td>
<td>1.592 - 2.079</td>
</tr>
<tr>
<td>8. M. Ischiofemoralis</td>
<td>1.337</td>
<td>1.002 - 1.599</td>
</tr>
<tr>
<td>9. M. Semimembranosus</td>
<td>2.176</td>
<td>2.004 - 2.392</td>
</tr>
<tr>
<td>11. M. Gastrocnemius (externus, medius &amp; internus)</td>
<td>17.857</td>
<td>17.515 - 18.711</td>
</tr>
<tr>
<td>13. M. Extensor digitorum longus</td>
<td>1.785</td>
<td>1.592 - 2.079</td>
</tr>
<tr>
<td>14. M. Peroneus longus</td>
<td>3.571</td>
<td>2.004 - 4.784</td>
</tr>
<tr>
<td>15. M. Peroneus brevis</td>
<td>0.625</td>
<td>0.400 - 0.799</td>
</tr>
<tr>
<td>17. M. Flexor perforans et perforatus dixti IV</td>
<td>3.750</td>
<td>3.503 - 4.158</td>
</tr>
<tr>
<td>18. M. Flexor hallucis longus</td>
<td>7.142</td>
<td>6.012 - 7.974</td>
</tr>
<tr>
<td>20. M. Extensor hallucis longus</td>
<td>0.265</td>
<td>0.200 - 0.318</td>
</tr>
</tbody>
</table>