On the Muscles of the Foot in Formosan Monkey and Crab-eating Monkey

Seiichiro INOKUCHI *

First Department of Anatomy,
Faculty of Medicine
Nagasaki University
Nagasaki Japan

Received for Publication January 30, 1967

Gross anatomical study of the origin, insertion, nerve supply and variation of the musculature of the foot of Formosan monkey (10 feet) and Crab-eating monkey (13 feet) was done. And the results were compared with the finding for other primates, particularly the findings obtained by OKUDA. In this study, the differences among various primates or among various species of macaque could be determined, standard condition for the genus could be elucidated.

INTRODUCTION

A number of studies have been done on the musculature of the foot in macaque including the investigation of a comparatively large sample of Rhesus monkey (Macaca rhesus) by OKUDA (1953). The author recently had the opportunity to study the muscles of Formosan monkey (Macaca cyclopis) and Crab-eating monkey (Macaca irus). The results shall be presented along with a comparison with the findings in other primates, particularly the findings obtained by OKUDA. In this study, it was hoped that the differences among various primates, or among various species of macaque could be determined. Even if the differences cannot be found, it was hoped that the standard condition for the genus could be elucidated along with an evaluation of the range of variability and also that possibly additional phylogenic findings could be obtained.

Although the number of cases examined were insufficient for statistical analysis, the results have been presented with indication of

* 猿口 清一郎
the percentages in order to show the general proportional distribution of findings.

MATERIAL AND METHOD

The material studied included 10 feet of adult Formosan monkey (Macaca cyclopis) (5 male, 5 female) and 13 feet of adult Crab-eating monkey (Macaca irus) (8 male, 5 female) selected at random from among the specimens preserved in this laboratory. These specimens had been fixed by the injection of 10% formalin solution into the femoral artery and stored in this same solution.

Gross anatomical inspection was done with a dissecting knife and tweezers. Observations were carried out under 3x and 5x magnifying lenses with an illumination attachment. Prior to dissection, acetone solution of laquer was injected into the femoral artery to permit easy discrimination of the peripheral nerves and blood vessels to insure accuracy of the findings.

FINDINGS

The musculature of the foot may be separated into 2 major groups: The plantar flexor group of the sole of the foot which is supplied by the plantar nerves, and the dorsal extensor group which is innervated by the deep peroneal nerve. The former includes the M. flexor digitorum brevis, M. abductor hallucis, M. flexor hallucis brevis, M. adductor hallucis, Mm. contrahentes digitorum pedis, M. abductor digiti minimi, M. abductor ossis metatarsi V, M. flexor digiti V brevis, M. opponens digiti V, Mm. lumbricales pedis, M. quadratus plantae and the Mm. interossei pedis, as well as the Aponeurosis plantaris. The latter group includes the M. extensor hallucis et digitorum brevis.

In addition to the above intrinsic muscles, many muscles of the leg end by tendon into the foot, but these will not be described here.

A) Plantar flexor muscle group

1) Aponeurosis plantaris (Fig. 1 and 2)

Macaca cyclopis: Phylogenically, this appears to be the insertion of the tendon from the M. plantaris into the sole of the foot. One portion of the terminal tendon of the M. plantaris attaches to the tubercle of calcaneum, but the remaining part proceeds to the sole to become the Aponeurosis plantaris which, after giving rise to the superficial head
of the M. flexor digitorum brevis, extends to the metatarso-phalangeal region.

In the tarsal region, the main bundle of this aponeurosis separates into the Aponeuroses tibialis and fibularis, between which is a small Aponeurosis intermedium.

The Aponeurosis tibialis is usually less developed than the Aponeurosis fibularis. Its condition may be classified as follows: cases in which fibers of the medial edge of the Aponeurosis fibularis simply showed a tendency of separating so that it could not be definitely called the Aponeurosis tibialis (2 cases, 20.0%); cases in which there

Fig. 1 Aponeurosis plantaris (1)
was the formation of a very small Aponeurosis tibialis (1 case, 10.0%); cases in which the Aponeurosis tibialis was well developed (3 cases, 30.0%); and cases in which it was better developed than the Aponeurosis fibularis (4 cases, 40.0%). In cases in which it was well developed, it extended to the metatarso-phalangeal region, as like the aponeurosis on the fibular side.

The Aponeurosis fibularis, which is generally well developed, attaches to the tuberosity of the fifth metatarsal bone and then runs to the distal part.

In some cases, this terminal portion, in other words, the fibers in the metatarso-phalangeal region, diverge distalward in fan-like shape from the tuberosity of the fifth metatarsal bone (2 cases, 20.0%), but in most instances it converged toward the fifth toe to form a conical band, the Fasciculus convergens digiti V (Lotth) (8 cases, 80.0%).

The Fasciculus transversus digiti I, which runs beneath the Aponeurosis tibialis transversely medialward from the Aponeurosis intermedialis or the tuberosity of the fifth metatarsal bone toward the first toe, is only rarely found (1 case, 10.0%; case number 16).

The Fasciculus proximo-medialis, which consists of the fibers that run medialward and distalward from the tubercle of calcaneum and the proximal portion of the medial edge of the Aponeurosis tibialis, may occasionally be absent (3 cases, 30.0%), but it usually is present, either well developed (3 cases, 30.0%) or poorly developed (4 cases, 40.0%).

Further, both the tibial and fibular sides of this aponeurosis unite at the terminal portion where it separates again into 4 bundles which run to the second, third, fourth and fifth toes, respectively.

Fig. 2 Development of Aponeurosis tibialis
Macaca irus: The general morphology of this aponeurosis is similar to that in Formosan monkey.

The Aponeurosis tibialis is less developed than in Formosan monkey. The conditions noted may be classified as follows: cases in which it is absent (1 case 7.7%); cases where it simply is an extension of fibers from the medial edge of the Aponeurosis fibularis (1 case, 7.7%); cases in which it is poorly developed (7 cases, 53.8%); and cases where it is well developed (3 cases, 23.1%). In very rare cases, it is larger than the Aponeurosis fibularis (1 case, 7.7%).

Frequently, the distal portion of the Aponeurosis fibularis forms the Fasciculus convergens digiti V, which runs to the fifth toe (9 cases, 69.2%).

The Fasciculus transversus digiti I is usually absent, although there are some cases in which it is noted as a broad, short fasciculus (3 cases, 23.1%) or as a slightly elongated fasciculus (1 case, 7.7%).

The Fasciculus proximo-medialis also is generally absent. It is present in only a few cases (4 cases, 30.8%) and is rarely large (1 case, 7.7%).

The distal portion of this aponeurosis usually separates into 4 bundles that run to the second, third, fourth and fifth toes, respectively, but the bundle to the second toe may occasionally be absent (4 cases, 30.8%).

2) M. flexor digitorum brevis (Fig. 3 and 8)

This muscle has 2 independent heads, a deep and a superficial, in both Formosan monkey and Crab-eating monkey.

The superficial head arises from the deep surface of the Aponeurosis plantaris by muscle and inserts by a slender tendon into the plantar surface of the middle phalanx of the second toe.

The deep head arises muscarily from the tendon of the M. flexor digitorum tibialis, between the level of the medial malleolus to the region of its bifurcation in the plantar region, where it separates into 3 heads, which run, respectively, toward the third, fourth and fifth toes to insert by slender tendon into the plantar surface of the respective middle phalanges.

At the base of the proximal phalanges, each tendon of insertion of this muscle is pierced by a corresponding tendon from the M. flexor digitorum longus.

There was no instance in which the superficial head had an excessive tendon nor was there any abnormality in the distribution of the tendons from either head to any toe. Although there is no fusion between the deep and superficial heads, one part of the muscle fibers of the superficial head may continue into the central part of the belly of the deep head in Crab-eating monkey (1 case, 7.7%), or the deep
surface of the muscle bundle that runs from the deep head to the
fourth toe may be fused with the superficial surface of the M. lum-
bricalis III in Formosan monkey (1 case, 10.0%).

The nerve supply is usually from the medial plantar nerve, the
superficial head by 1 branch which enters from the lower surface and
the deep head by 2 or 3 branches which enter from the upper surface.

Occasionally, the nerve supply was from the lateral plantar nerve.
In Formosan monkey, such instances were noted for both the superficial

![Diagram of plantar muscles](image-url)
head (2 cases, 20.0%) and the deep head (1 case, 10.0%), but in Crab-eating monkey, this was noted for only the superficial head (4 cases, 30.8%). Furthermore, supply from both the lateral and medial plantar nerves was noted to the superficial head (1 case, 10.0%) and the deep head (2 cases, 20.0%) in Formosan monkey, and to the deep head (1 case, 7.7%) in Crab-eating monkey.

3) M. abductor hallucis (Fig. 3, 4 and 5)

*Maca cyclopis*: This muscle, located on the lower surface of the calcaneum on the medial side of the sole, arises by 2 heads, a deep and a superficial.

The superficial head arises by aponeurosis from the medial portion of the tubercle of calcaneum and by muscle from the deep surface of the plantar aponeurosis, while the deep head arises muscularly from the ligament on the plantar surface of the navicular bone (internal tibio-tarso-metatarsal ligament: Keith).

The deep side of this muscle at the origin from the calcaneum lies adjacent to the origin of the M. abductor digiti minimi and its lateral edge is adjacent to the medial edge of the superficial head of the M. flexor digitorum brevis. Occasionally, there may be fusion with these parts. There may be cases in which the origin of the deep head may not be limited to only the navicular bone but involve the first cuneiform bone as well (1 case, 10.0%), and in other cases there may be fusion with the origin of the M. flexor hallucis brevis medialis (1 case, 10.0%).

Although a tendon from the M. flexor digitorum longus separates these 2 heads, the muscle fibers arising from the navicular bone and that from the calcaneum fuse with each other near the first cuneiform bone. At about the proximal portion of the first metatarsal bone, it forms a broad, thin tendinous bundle which runs along the M. flexor hallucis brevis medialis toward the first toe and inserts together with the M. flexor hallucis brevis medialis into the medial side of the proximal part of the proximal phalanx of the first toe.

The nerve supply is from the medial plantar nerve which enters the muscle from the lateral side.

*Maca irus*: The general form including the origin, course, insertion and nerve supply is identical to that in Formosan monkey.

However, there may be cases in which the origin of the deep portion of this muscle is not only the navicular bone but includes the first cuneiform bone (1 case, 7.7%) and in other cases, the origin from the calcaneum may be fused with the origin of the M. abductor digiti minimi (2 cases, 15.7%). At the insertion, it may attach widely into the medial edge of the body of the first metatarsal bone (1 case,
Fig. 4  Profound origin of the M. abd. hall. concerning the connection with the origin of M. flex. hall. brev. med., and insertion anomaly of the M. abductor hallucis.

1. Origin from navicular part
2. Origin from navicular body (macula inus, No. Z. 1.
4. Insertion on the 1. metatarsal

Superficial origin

M. flex. hall. brev. med.

Os cuneiforme

M. flex. hall. brev. lat.
4) **M. flexor hallucis brevis** (Fig. 4 and 5)

*Macaca cyclopis*: This muscle consists of 2 completely separate, independent heads, a lateral and a medial.

The origin of the medial head is from navicular bone and the first and second cuneiform bones. The individual cases, however, show some variations in the origin including cases in which there is origin from the navicular bone and the first cuneiform bone (3 cases, 30.0%), origin from the proximal portion of the first cuneiform bone (3 cases, 30.0%), origin from the area corresponding to the second cuneiform bone on the Vag. tendinis m. peronei longi (3 cases, 30.0%), and origin directly from the second cuneiform bone (1 case, 10.0%).

This medial head runs along the plantar surface of the first metatarsal bone on the medial side of the tendon from the M. flexor hallucis longus and attaches to the medial side of the base of the proximal phalanx of the first toe, after fusing by tendon with the...
inserting portion of the M. abductor hallucis.

The lateral head, in most cases, arises from the lateral side of the distal part of the first cuneiform bone (90.0%), usually by a common tendon with the M. interosseus dorsalis I and the M. interosseus plantaris I, and further with a portion of the M. interosseus dorsalis II.

The lateral head, which is covered by the oblique head of the M. adductor hallucis, runs along the lateral side of the first metatarsal bone and inserts into the lateral side of the base of the proximal phalanx of the first toe, after fusing tendinously with the inserting portion of the M. adductor hallucis oblique.

The nerve supply to both heads is from the medial plantar nerve. The branch of this nerve which innervates the medial edge of the first toe gives off branches that enter from the middle of the surface of each.

Macaca irus: The origin, insertion, course and nerve supply are similar to the above, except for some difference in the origin of the medial head. In other words, the origin may be the first cuneiform bone (11 cases, 84.6%), the second cuneiform bone (1 case, 7.7%), or the Vag. tendinis m. peronei longi (at the area corresponding to the second cuneiform bone).

5) M. adductor hallucis (Fig. 5 and 6)

Macaca cyclopis: This is the most medial among the Mm. contra-hentes. It inserts into the first toe and perhaps should be termed the M. contrahens digiti I. It consists of 2 heads, an oblique and a transverse.

The oblique head usually arises from the Vag. tendinis m. peronei longi, near the base of the third metatarsal bone, but there are cases in which the origin is slightly more medial, from near the base of the second metatarsal bone (30.0%). This muscle runs along the top of the first metatarsal bone on the lateral side of the M. flexor hallucis longus, by which it is definitely separated from the M. flexor hallucis brevis medialis. It inserts into the lateral side of the base of the proximal phalanx of the first toe. In this area, the M. flexor hallucis brevis lateralis and the transverse head of this muscle fuse with this muscle from both sides.

The transverse head usually arises from the heads of the second and third metatarsal bones (8 cases, 80.0%). There also are cases in which additional fibers are received from the fascia of the Mm. interosseus dorsales II et III (1 case, 10.0%), or in which the origin is from the head of only the second metatarsal bone (2 cases, 20.0%). At its insertion into the lateral side of the base of the proximal phalanx of the first toe, after fusing tendinously with the inserting portion of the M. adductor hallucis oblique. The nerve supply to both heads is from the medial plantar nerve. The branch of this nerve which innervates the medial edge of the first toe gives off branches that enter from the middle of the surface of each.
anx of the first toe, it overlaps the distal portion of the oblique head.

There was no case in which the transverse head was absent, or where it inserted into the first metatarsal bone, or in which it fused with the M. flexor hallucis brevis lateralis except at the insertion.

The nerve supply is from the deep branch of the lateral plantar nerve. The terminal branch of this nerve separates into 2 branches which enter into the belly of the muscle.

*Macaca irus:* The general morphology is not much different from that in Formosan monkey.

The oblique head usually arises from the Vag. tendinis m. peronei longi, near the base of the third metatarsal bone, but there are rare instances in which it may arise more medially from near the base of the second metatarsal bone (1 case, 7.7%).

The site of origin of the transverse head differs slightly from that in Formosan monkey. In about half of the cases, the origin was from the heads of the second and third metatarsal bones (6 cases, 46.2%), and in other cases, the origin was from the head of only the second

---

**Fig. 6** Origin of M. adductor hallucis transversus

1. Caput os met. I
2. Caput os met. I, II
3. Caput os met. I, II

M. interosseus dors. I

Os. cuneiforme I, II, III

M. flex. hall. brev. med.
M. flex. hall. brev. lat.
M. add. hall. obl.
M. add. hall. trans.

Mm. interossei dors.

Mm. interossei plant.

Mm. contrahens

1. Caput os met. I, II
2. Caput os met. I, II
3. Caput os met. I, II

M. interossei dors. I, II

M. contrahens digiti I.
metatarsal bone (5 cases, 38.5%), the head of only the third metatarsal bone (1 case, 7.7%), or from the heads of the third and fourth metatarsal bones (1 case, 7.7%). The frequency at which additional fibers were received from the fascia of the M. interosseus dorsalis II (8 cases) and the M. interosseus dorsalis III (1 case) was higher than in Formosan monkey. Moreover, in cases where the origin of the transverse head extended as far as the fourth metatarsal bone, fibers were also received from over the entire length of the fascia of the M. contrahens digiti II.

6) Mm. contrahentes digitorum pedis (Fig. 5 and 6)

Macaca cyclopis: This consists of 3 muscles which run toward the second, fourth and fifth toes, respectively. That to the third toe is absent. These muscles arise by a common tendon from the Vag. tendinum m. peronei longi, near the base of the third metatarsal bone, and then separate into these 3 portions.

The fasciculus to the second toe (M. contrahens digiti II), which is the smallest of the 3 muscles, runs along the deep side of the transverse head of the M. adductor hallucis and inserts into the lateral side of the base of the proximal phalanx of the second toe, but occasionally the tendon of insertion may extend to its dorsal side (1 case, 10.0%). In some cases, it may simply be a fasciculus which separates from the belly of the M. contrahens digiti IV (1 case, 10.0%).

In contrast to this, those to the fourth and fifth toes (Mm. contrahentes digitorum IV et V) insert into the medial side of the base of the proximal phalanx of the fourth and fifth toes, respectively, but there were some cases in which the insertion divided into 2 parts so that one portion attached to the head of the metatarsal bone as well as the base of the proximal phalanx (fourth toe: 2 cases, 20.0%; fifth toe: 3 cases, 30.0%), and in other cases, the tendon of insertion may extend as far as the dorsal side of the toe (3 cases, respectively, for the fourth and fifth toes, 30.0%).

The nerve supply to each is by the deep branch of the lateral plantar nerve. All muscles receive a branch from the their deeper surface.

Macaca irus: The general morphology, origin and nerve supply are the same as in Formosan monkey except that there is some difference in the insertion. There was division of the insertion so that there was attachment to both the base of the proximal phalanx and the head of the metatarsal bone for the Mm. contrahentes digitorum II (2 cases, 15.4%), IV (1 case, 7.7%) and V (2 cases, 15.4%), respectively. A marked variation in the insertion of the M. contra-
hens digiti IV was noted bilaterally in a single case; the insertion on the right side separated into two parts, which attach to the lateral side of the base of the proximal phalanx of the third toe and the medial side of the base of the proximal phalanx of the fourth toe, while the insertion on the left side separated into three parts, of which the most lateral bundle unites with the M. contrahens digiti V, and the other two attach respectively to the medial and lateral sides of the base of the proximal phalanx of the fourth toe.

It was rare that the tendon of insertion of the M. contrahens digiti IV extended to the dorsal side of the toe (1 case, 7.7%).

7) **M. abductor digiti minimi and M. abductor ossis metatarsi V** (Fig. 3)

*M. abductor digiti minimi* and *M. abductor ossis metatarsi V* (Fig. 3) are muscles in primate anatomy. The *M. abductor digiti minimi* arises from the lateral side, anterior region, and medial side of the tubercle of calcaneum and also from the deep surface of the Aponeurosis plantaris. These muscle fibers converge toward the lateral tarsal region and become a slender tendinous bundle in the metatarsal region which runs along the superficial surface of the M. flexor digiti V brevis with which it inserts into the lateral side of the base of the proximal phalanx of the fifth toe. The medial side of the origin is covered by the origin of the M. abductor hallucis. In all cases, some of the fibers on the lateral side of this muscle form a separate fasciculus, which attach to the tuberosity of the fifth metatarsal bone by tendon.

The separation of this fasciculus, in many cases, occurred from the origin of the M. abductor digiti minimi and formed the M. abductor ossis metatarsi V (7 cases, 70.0%).

The nerve supply is from the lateral plantar nerve. A branch separating from near the origin of this nerve entered the muscle from the deep surface. When the M. abductor ossis metatarsi V was present, there was separation into 2 branches.

*Macaca irus*: The origin, insertion, course and nerve supply are all identical to that in the former, except that the M. abductor ossis metatarsi V was less frequently seen (5 cases, 38.5%).

8) **M. flexor digiti V brevis and M. opponens digiti V** (Fig. 3 and 7)

*M. flexor digiti V brevis* and *M. opponens digiti V* (Fig. 3 and 7) are muscles in primate anatomy. The *M. flexor digiti V brevis* in all cases arises, by a common tendon with the M. interosseus plantaris III, from the sesamoid bone located above the base of the fifth metatarsal bone and the Lig. plantare longum. In some cases, additional fibers of origin are received from the tuberosity of the fifth metatarsal bone (3 cases,
30.0%). This muscle runs along the plantar surface of the fifth metatarsal bone, adjacent to the lateral side of the M. interosseus plantaris III with which there is no continuation of muscle fibers.

It attaches in all cases to the lateral side of the base of the proximal phalanx of the fifth toe together with the tendon of the M. abductor digitii minimi.

No muscle corresponding to the M. opponens digitii V could be found in Formosan monkey.

The nerve supply is from the lateral plantar nerve. A division from the superficial branch enters from the superficial surface.

_Macaca irus_: The origin, insertion and nerve supply are similar to that in Formosan monkey, but in some cases additional fibers of origin are received from the tuberosity of the fifth metatarsal bone (1 case, 7.7%).

In Crab-eating monkey, a small fasciculus, which arises from the tuberosity of the fifth metatarsal bone and attaches to the plantar surface of the body of the fifth metatarsal bone and the lateral surface of the base of the proximal phalanx of the fifth toe, was occasionally

---

Fig. 7. M. flexor digiti V brevis and M. opponens digitii V
found (2 cases, 15.4%). This was entirely separate and independent of the M. flexor digiti V brevis and the M. interossei plantaris III, and presumably corresponds to the so-called M. opponens digiti V.

9) **Mm. lumbricales pedis** (Fig. 8)

There are 4 of these muscles in all cases examined in both Formosan monkey and Crab-eating monkey. There was no case in which any was missing or absent. These muscles arise from the tendon of
the M. flexor digitorum longus, but the one to the second toe arises by a single head, while the others which run to the third to fifth toes, respectively, arise by two heads.

The M. lumbricalis I arises from the medial side of the tendon that runs to the second toe, while the Mm. lumbricales II-IV arise from the opposing edges of the respective tendons of the second to fifth toes. There were no case in which the latter 3 arise by a single head.

The insertion takes place into the medial surface of the base of the proximal phalanx of the second to fifth toes, but the tendons extend further to the dorsal side of the toes where they runs along the medial side of the tendons from the M. extensor digitorum longus together with the tendon of the M. extensor digitorum brevis located on the lateral side of this tendon. At the dorsal surface of the second phalanx the 3 tendons unite and terminate.

In both Formosan monkey and Crab-eating monkey, the M. lumbricalis I is the smallest and the other 3 are generally of about equal size. Occasionally, the M. lumbricalis III may be large and give off fasciculi to the Mm. lumbricales II et IV in Formosan monkey (1 case, 10.0%).

Nerve supply: In general, the lateral 2 muscle are innervated by the lateral plantar nerve while the 2 medial muscle are supplied by the medial plantar nerve. In rare cases, the M. lumbricalis II also was found to be supplied by the lateral plantar nerve in Formosan monkey (1 case, 10.0%) and in Crab-eating monkey(2 cases, 15.4%).

There was a case in Crab-eating monkey in which the Mm. lumbricales II et III were supplied by both nerves (1 case, 7.7%).

10) M. quadratus plantae (Fig. 8)

This muscle, in both Formosan monkey and Crab-eating monkey, arises generally by 1 head from the lateral side of the calcaneum, immediately below the Vag. tendinis m. peronei longi adjacent to the Retinaculum mm. fibularium inferius.

In addition, there were some cases among Crab-eating monkey in which a band of connective tissue was received from the Vag. tendinis m. peronei longi (3 cases, 23.1%). In Formosan monkey, there was a case in which in addition to the above origin there was a muscular head arising from the medial side of the tuberle of calcaneum that joined the intrinsic head of origin on the anterior side (1 case, 10.0%).

This muscle runs medialward and forward beneath the M. flexor digitorum brevis, but there was no case in which the belly of the muscle separated into the medial and lateral parts such as reported in
Rhesus monkey (Okuda).

The insertion is by muscle into the lateral side of the tendon to the fifth toe of the M. flexor digitorum longus. From the insertion, tendinous slips are sent off to the tendons from the M. flexor digitorum longus that run to the first to fifth toes. Of these slips given off from the five tendons, those to tendons coming from the M. flexor digitorum fibularis may occasionally be absent. In other words, the slips to the tendons running to the third and fifth toes were absent in 2 cases of Formosan monkey (20.0%) and in 1 case of Crab-eating monkey (7.7%), while the slip to the tendon that runs to the first toe was absent in 1 case of Formosan monkey (10.0%) and in 2 cases of Crab-eating monkey (15.4%).

Also, in rare cases among Formosan monkey, this muscle inserted into the lateral side of the main trunk of the M. flexor digitorum fibularis, from which a tendinous slip was sent off to the main trunk of the tendon of the M. flexor digitorum tibialis (1 case, 10.0%).

The nerve supply is from the lateral plantar nerve, a branch of which enters this muscle from the center of the superficial surface.

11) Mm. interossei pedis (Fig. 5)

In both Formosan monkey and Crab-eating monkey, there are in general 7 muscles which depending upon their general location may be classified into 4 Mm. interossei dorsales and 3 Mm. interossei plantares. Of these muscles, the 3 muscles on the medial side (M. interosseus dorsalis I, M. interosseus plantaris I and M. interosseus dorsalis II) usually arise from the first cuneiform bone together with the M. flexor hallucis brevis lateralis, while the 2 lateral muscles (M. interosseus plantaris III and M. interosseus dorsalis IV) arise from the sesamoid bone, located at the base of fifth metatarsal bone, and the Lig. plantare longum, together with the M. flexor digiti V brevis. The other 2 muscles (M. interosseus plantaris II and M. interosseus dorsalis III) and one part of the M. interosseus dorsalis II arise from the capsule of the tarsometatarsal articulation and the Vag. tendinis m. peronei longi.

In other words, there were no case in which these muscles arose directly from the metatarsalum.

The insertion takes place into the sides of the base of the proximal phalanx of the second to fifth toes.

Next, a description of the condition of origin and insertion will be made for each muscles in Formosan monkey and Crab-eating monkey, respectively.

Macaca cyclopis: (Table 1)

The M. interosseus dorsalis I, in the majority of cases, arises
from the first cuneiform bone (9 cases, 90.0%), and in rare cases from near the base of the second metatarsal bone (1 case, 10.0%). In all cases, it attaches to the medial side of the base of the proximal phalanx of the second toe.

The M. interosseus plantaris I similarly arises from the first cuneiform bone in the majority of cases (9 cases, 90.0%), but there are cases in which the origin is separated into 2 heads, with fibers also received from near the base of the third metatarsal bone (1 case, 10.0%) or from near the bases of second and third metatarsal bones (1 case, 10.0%). In all cases, the insertion is the lateral side of the base of the proximal phalanx of the second toe.

The origin of the M. interosseus dorsalis II is definitely separated and it is very rare that no separation is seen (1 case, 10.0%). In addition to the fibers from the first cuneiform bone, some cases receive fibers from near the base of the second metatarsal bone (1 case, 10.0%) and from near the base of the third metatarsal bone as well (1 case, 10.0%). while in others, additional fibers are received from only the base of the third metatarsal bone (4 cases, 40.0%), and further there may be cases in which fibers are received from near the base of the fourth metatarsal bone (2 cases, 20.0%). When there is no separation of the origin, this muscle arises from near the base of the fourth metatarsal bone. In all cases, it attaches to the medial side of the base of the proximal phalanx of the third toe.

The M. interosseus dorsalis II, in most cases, arises from near the base of the fourth metatarsal bone (7 cases, 70.0%). In other cases, the origin may be slightly more lateral, from near the base of the fifth metatarsal bone (2 cases, 20.0%) or, conversely, the origin

---

**Table 1. Origin of the Interossei of Formosan monkey**

<table>
<thead>
<tr>
<th>Origin</th>
<th>1. Cuneiform</th>
<th>Sheath of Peroneus longus</th>
<th>Number</th>
</tr>
</thead>
</table>
---

D = Mm. interossei dorsales  
P = Mm. interossei plantales  
× × : Double origin  
( ) : Origin only from Metatarsal base
may be more medial and separated into parts that arise from near the base of the third and fourth metatarsal bones (1 case, 10.0%). This muscle inserts into the lateral side of the base of the proximal phalanx of the third toe.

The origin of the M. interosseus plantaris II is never separated. It arises from near the base of the fourth metatarsal bone (5 cases, 50.0%) or from near the base of the fifth metatarsal bone (5 cases, 50.0%), and inserts into the medial side of the base of the proximal phalanx of the fourth toe.

The M. interosseus dorsalis IV and the M. interosseus plantaris II, in all cases, arise together with the M. flexor digiti V brevis from the sesamoid bone located at the base of the fifth metatarsal bone and the Lig. plantare longum. The former inserts into the lateral side of the base of the proximal phalanx of the fourth toe, while the latter attaches to the medial side of the base of the fifth toe.

There was no separation of the insertion of any of these muscles. The nerve supply is from the deep branch of the lateral plantar nerve. There was no case innervated by the superficial branch.

*Macaca irus* : (Table 2)

Both the M. interosseus dorsalis I and the M. interosseus plantaris I arise together with the M. flexor hallucis brevis lateralis from the first cuneiform bone. There was one case in which there was division of the origin of the M. interosseus plantaris I with fibers

Table 2, Origin of the Interossei of Cab-eating monkey

<table>
<thead>
<tr>
<th>Origin</th>
<th>1. Cuneiform</th>
<th>Sheath of Peroneus longus</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1D 1P 2D</td>
<td>3D 2P</td>
<td>4D 3P</td>
<td>1</td>
</tr>
<tr>
<td>1D 1P 2D</td>
<td>3D</td>
<td>2P</td>
<td>4D 3P</td>
</tr>
<tr>
<td>1D 1P (2D)×</td>
<td>2D×</td>
<td>3D 2P</td>
<td>4D 3P</td>
</tr>
<tr>
<td>1D 1P (2D)</td>
<td>3D</td>
<td>2P 4D</td>
<td>3P</td>
</tr>
<tr>
<td>1D 1P (1P)×</td>
<td>2D</td>
<td>3D 2P</td>
<td>4D 3P</td>
</tr>
<tr>
<td>1D 1P 2D×(2D)×</td>
<td>(2D)×3D 2P</td>
<td>4D 3P</td>
<td>1</td>
</tr>
<tr>
<td>1D 1P 2D×</td>
<td>2D×</td>
<td>2D×3D 2P 4DX</td>
<td>4D×3P</td>
</tr>
<tr>
<td>1D 1P 2D×(2D)×</td>
<td>2D×</td>
<td>3D 2P 4DX</td>
<td>4D×3P</td>
</tr>
<tr>
<td>1D 1P 2D×</td>
<td>2D×3D×</td>
<td>3D×2P 4D</td>
<td>4D×3P</td>
</tr>
<tr>
<td>1D 1P 2D×</td>
<td>2D×3D</td>
<td>3D×2P 4D</td>
<td>3P</td>
</tr>
<tr>
<td>1D 1P 2D×</td>
<td>2D×3D</td>
<td>2P 4D</td>
<td>3P</td>
</tr>
<tr>
<td>1D 1P 2D×</td>
<td>2D×3D</td>
<td>3D 2P</td>
<td>4D 3P</td>
</tr>
</tbody>
</table>

D = Mm. interossei dorsales
P = Mm. interossei plantales
× × × Double origin
( ) : Origin only from Metatarsal base
from also near the base of the second metatarsal bone (1 case, 7.7%).

The M. interosseus dorsalis II, as in Formosan monkey, arises from the first cuneiform bone, but different forms of separation of the origin were noted.

In other words, there were cases with separation of the origin into 2 parts (5 cases, 38.5%) or 3 parts (4 cases, 30.8%) with fibers from near the base of the second or third metatarsal bone, or occasionally from near the base of the fourth metatarsal bone. Conversely, in cases in which there is entirely no separation of the origin, this muscle arises from only the first cuneiform bone (2 cases, 15.4%) or from near the base of the second or third metatarsal bone (2 case, 15.4%).

The M. interosseus dorsalis III, in most cases, arises from near the base of the fourth metatarsal bone (9 cases, 69.2%), while in other cases, the origin is from near the base of the third metatarsal bone (2 cases, 15.4%). There also are cases in which the origin is separated with fibers received from both (2 case, 15.4%)

The M. interosseus plantaris II in all cases arises from near the base of the fourth metatarsal bone.

The M. interosseus dorsalis IV arises from the sesamoid bone located above the base of the fifth metatarsal bone and the Lig. plantare longum in about half of the cases examined (7 cases, 53.8%). There also are cases in which the origin is from near the base of the fourth metatarsal bone (3 cases, 23.1%), or in which the origin is separated with fibers received from both (3 cases, 23.1%).

The M. interosseus plantaris III, in all cases, arises from the previously mentioned sesamoid bone and Lig. plantare longum together with the M. flexor digiti V brevis.

The insertion of the above muscles as well as the nerve supply is the same as in Formosan monkey with no case showing any variation.

B) Dorsal muscle group

12) M. extensor digitorum et hallucis brevis (Fig. 9)

In both Formosan monkey and Crab-eating monkey, these muscle arise from the dorsal and lateral surfaces of the calcaneum, behind the calcaneocuboidal articulation, and should be considered to be a single muscle.

In general, this muscle separates into 4 muscular bellies which immediately become slender tendons that run along the fibular side of the dorsal surface of the proximal phalanges of the first to fourth toes. On the first toe, it attaches to the distal portion of the proximal phalanx together with the tendon from the M. extensor hallucis longus,
which runs along its tibial side. Those to the second to fourth toes run along the fibular side of the tendons from the M. extensor digitorum longus on the tibial side of which run the tendons of the M. lumbricalis. These 3 unite to insert into the distal part of the middle phalanx.

The nerve supply is from the deep peroneal nerve, several branches of which enter from the deep surface of the muscle.

In a small number of cases of Crab-eating monkey, this muscle separates into 3 bellies, and the most medial one gives off tendons to the first and second toes.

![Muscles and tendons of the dorsum pedis](image-url)

**Fig. 9** Muscles and tendons of the dorsum pedis.
1) Aponeurosis plantaris

The plantar aponeurosis in primates has been studied in detail by Loth, who felt that, phylogenically, it simply represents the insertion of the tendon from the M. plantaris in the plantar region, and that this primitive condition may be noted in Prosimiae among primates. However, from Galaginae, the aponeurosis is present as a broad terminal tendon from the M. plantaris which separates into 2 parts in the metatarsal region, one of which gives off the Fasciculus hallucis toward the first toe, while the other fasciculus extends to the metatarso-phalangeal region. In Lemurinae, there occurs secondary insertion (adhesion) of the terminal tendon of the M. plantaris to the tubercle of calcaneum with a gradual decrease in size of the tibial side of the aponeurosis. Shortly, there occurs separation of the Fasciculus hallucis from the original aponeurosis followed by decrease of size.

In Platyrhina, the Fasciculus hallucis disappears completely and, in most cases, the aponeurosis is present simply as a bundle on the fibular side.

In Catarrhina, one portion of the terminal tendon from the M. plantaris attaches to the tubercle of calcaneum to show some indication of independence of the aponeurosis, and at the same time, there is secondary insertion into the tuberosity of the fifth metatarsal bone. With further progress, there occurs the separation of the aponeurosis into 2 parts in the tarsal region so that there is the division and formation of the Aponeuroses fibularis and tibialis, as well as the appearance of the Fasciculus transversus digiti I, which runs transversely beneath the Aponeurosis tibialis toward the first toe, and the formation of the Fasciculus proximo-medialis. Moreover, the extend of progress of these changes in Catarrhina is not the same in the various genus, and there seem to be individual differences even in the same species. For example, in macaque, the separation and formation of the Aponeurosis tibialis is still incomplete in Macaca arctoides, whereas the formation of the Aponeurosis tibialis is well established in Macaca nemestrina, Macaca sinicus and Macaca rhesus.

The formation of the Fasciculus proximo-medialis, according to Loth, was noted in 32% of macaque while it was seen in 70% of Formosan monkey and in 30.8% of Crab-eating monkey that I examined, showing a considerable difference.

Although the formation of the Fasciculus transversus digiti I is seen in most macaque, it is not found in Macaca arctoides, while in Macaca nemestrina, its formation is noted in some cases but not in others.
There are similar individual differences in the formation of the Fasciculus convergens digiti V. Even the findings in my study of Formosan monkey and Crab-eating monkey, revealed a variety of individual differences in the separation and degree of development of the Aponeurosis tibialis. All of these conditions, however, can be explained if one considers the change in morphology with progress from Platyrrhina to Catarrhina, and the findings do not exceed the range of characteristics for Catarrhina reported by Loth.

Further, in anthropoid apes, the Aponeurosis fibularis undergoes devolution, in place of which there occurs the development of the Aponeurosis tibialis and Aponeurosis tibialis proximo-medialis. Moreover, there is loss of association between the tibial fasciculus and the M. plantaris so that the condition of the aponeurosis becomes more similar to that in man. It is said that the condition in chimpanzee is the closest to man.

2) M. flexor digitorum brevis

This muscle in primates usually has 2 heads, a deep and a superficial.

According to Glaesmer, the superficial head in Prosimiae, as a rule, arises from the deep surface (back) of the plantar aponeurosis and the calcaneum, but the origin from the latter may occasionally be absent (Galago) or the origin from the plantar aponeurosis may be absent (Peridicticus).

Among Simiae, the origin is reported to be the aponeurosis in Hapale while it arises from the calcaneum in Ateles so that the site of origin is not consistent in Platyrrhina. The origin is from only the aponeurosis in Catarrhina, except for Rhesus monkey (Okuda, Howell-Straus) in which it arises from both the aponeurosis and calcaneum.

In anthropoid apes, the origin is from both the aponeurosis and calcaneum in gibbon and orang-utan, while it is reported to arise from the calcaneum in chimpanzee. However, Kohlbrugge in his study of gibbon reported 2 cases with origin from only the calcaneum and 1 case having origin from only the aponeurosis, while Straus has noted the origin to be from the aponeurosis and calcaneum in chimpanzee and gorilla.

Thus, the origin of the superficial head in Simiae, as a rule, is the deep surface of the plantar aponeurosis, but with progress toward higher monkey, there appears to be a tendency for more origin from the calcaneum with gradual loss of origin from the aponeurosis.

Therefore, the condition in my study of Formosan monkey and Crab-eating monkey is the primitive form, in view that the origin was from only the aponeurosis with none from the calcaneum, which is similar to the condition in bonnet macaque (Macaca sinicus) of Glaesmer.
The origin of the deep head in primates, as a rule, is from the superficial portion of the tendon from the M. flexor digitorum longus tibialis. In lower monkey, an additional tendon is said to be received from the M. flexor digitorum longus fibularis, but in my cases of Formosan monkey and Crab-eating monkey like Rhesus monkey (Howell-Straus, Okuda), there were no fibers received from it.

With progress toward higher monkey, there is an increasing tendency of fusion with the superficial head and this appears in the form of the fusion of the tendon of insertion on the medial side.

The insertion of the superficial head, as a rule, is said to take place by a single tendon into the middle phalanx of the second toe. However, in the study of Lemur, Hapale and chimpanzee by GlAESMER, and gorilla of Straus, a tendon from the superficial head also attaches to the third toe, while in Ateles and orang-utan, there also is attachment to the fourth toe. Moreover, the tendon inserting into the third or fourth toe fuses with a tendon from the deep head.

The tendon of insertion from the deep head usually separates into 3 parts, which run to the third, fourth and fifth toes, respectively, but occasionally it may divide into 2 parts that insert into the fourth and fifth toes, (Ateles and orang-utan; according to GlAESMER) or there may be instances in which the insertion to the fifth toe is absent (gorilla; Straus).

This absence of the tendon of insertion to the fifth toe is rare in lower monkey and is more frequent in higher monkey (Straus). According to Kohlbrugge, this condition has been seen in 21.4% of orang-utan, 30.8% of chimpanzee and in 37.5% of gibbon, while it was seen in 41.2% of gorilla (Straus) and 24.4% of man (Adachi). Straus feels that a better picture of the progress of devolution of this muscle may be obtained from anthropoid apes, with the exception of orang-utan, than from the observation on man.

It has been suggested concerning the division and arrangement of the tendons of insertion that the number of tendons from the superficial head may increase with the development and evolution of the species (Hepburn). The findings in Platyrrhina, however, cause one to hesitate to make such a conclusion. Further studies on a larger number of cases must be awaited.

3) M. abductor hallucis

Among Prosimiae, a number of reports are available on this muscle in Lemur, Chironmys, etc. (Cunningham, Murie and Mivart, Zucker-Kandl, Straus). In all instances, the origin is from only the plantar aponeurosis with no bony origin.

In Platyrrhina, there is a report on Cebus in which there is origin
by 2 heads from both the calcaneum and plantar fascia (Champneys). Even in Catarrhina, there is origin by 2 heads, but in Cynocephalus, besides origin from the plantar surface of the calcaneum, the second head arises from the navicular bone or the deep fascia located in the corresponding area, with no origin from the plantar aponeurosis. Moreover, these 2 unite to form a common tendon which attaches to the lateral side of the base of the proximal phalanx of the first toe (Champneys).

This so-called second head of origin corresponds to the origin from the navicular bone found in all of my cases, but the site of insertion differs from Cynocephalus in that it attaches to the medial side of the base of the proximal phalanx of the first toe in my cases.

The insertion in Inus nemestricus (Champneys) and Rhesus monkey (Howell-Straus and Okuda) is the same as in my cases, but the origin is reported to be the medial side of the tubercle of calcaneum and the plantar aponeurosis with no origin from the navicular bone.

In gibbon, orang-utan, gorilla and chimpanzee, besides origin from the calcaneum, additional fibers are received from the navicular bone and the insertion is the same as in other primates. However, there are reports that one portion may extend further than the base of the proximal phalanx of the first toe in gibbon (Hepburn), while in gorilla, there are cases in which it arises by a single head from the surface of the tubercle of calcaneum and the navicular bone (Pira, Hepburn) or by 2 heads from the calcaneum and plantar aponeurosis (Deniker, Straus), and further there may be cases that are similar to man (Duvernoy). Thus, additional origin from the navicular bone seems to be frequent in anthropoid apes, except in gorilla studied by Deniker and Straus.

Thus, the absence of bony origin in Prosimiae, the 2 origins from the calcaneum and plantar aponeurosis but not from the navicular bone in Platyrrhina, the presence of cases with and without origin from the navicular bone besides the origin from the calcaneum and aponeurosis in Catarrhina, and the presence of origin from the navicular bone in most cases in anthropoid apes, all considered together, seem to indicate that the bony origin involves a wider area from the calcaneum to the navicular bone in higher monkey. Thus, the findings of Okuda and Howell-Straus for Rhesus monkey may be said to indicate a condition slightly more primitive than in Formosan monkey and Crab-eating monkey, in other words, a form closer to the condition in Platyrrhina. Straus has reported a muscle in gorilla that separates from the M. flexor hallucis brevis medialis and inserts into the neck of the first metatarsal bone which he called the rudiment of the M. opponens hallucis. The variation of the insertion seen in 1 case of Crab-eating monkey by the author suggests this condition.
4) M. flexor hallucis brevis

This muscle in primates is said to have 2 heads, a medial and a lateral (Kohlbrugge, Ruge), of which the medial head is always more powerful than the lateral head (Kohlbrugge). Furthermore, there is much controversy over whether these 2 heads are derived from a single anlag and much dispute concerning the phylogenic origin of the lateral head.

In Prosimiae, it appears to usually have 2 heads in Lemur (Murie and Mivart), Tarsius (Woodlard), etc. However, even in Lemur, there are cases in which only the medial head is present (Cunningham) and even among cases with a single head, it may be the medial head which is absent such as is the condition in Galago (Murie and Mivart) and in Tarsius (Burmeister).

Although it is always said to have 2 heads in Platyrrhina (Bruschoff), it is a single muscle in Ateles (Ruge).

Among Catarrhina, there are always 2 heads in lower monkey including Cynocephalus anubis (Champneys) and Rhesus monkey (Okuda, Howell-Straus), as noted in my cases. The findings described for Cynocephalus (Champneys) are similar to those for my cases, except that the origin of each head is farther apart than in the cases of the author and there apparently is greater relation between the 2 heads and the Mm. interossei, as well as between the lateral head and the M. adductor hallucis. However, there was no relation, such as noted in the cases of the author, between the medial head and the M. abductor hallucis.

The findings in Rhesus monkey are very similar to my findings (Howell-Straus, Okuda), but there is no adhesion at the origin between the medial head and the M. abductor hallucis, or between the lateral head and the Mm. interossei, as have been noted in my cases.

Among anthropoid apes, there are instances in which both the medial and lateral heads are present and others in which only the medial head is present. In the findings of Hepburn for gibbon, orang-utan, gorilla, chimpanzee, etc., there are 2 heads, a medial and a lateral, of which the finding for the medial head is similar to that in Cercopithecidae, and thus, the same as the findings in my cases, but the accessory insertion into the medial side of the distal half of the shaft of the first metatarsus noted by him in orang-utan and gorilla has not been found in my cases. However, instances have been reported in which there is particularly marked devolution of the lateral head (Hepburn, Ruge, Fick, Champneys) with even cases in which it is absent such as in gorilla (Pira, Sommur). However, this absence in gorilla is considered by some as not absence but probably fusion with the M. adductor hallucis obliquus (Straus). Further, in the study of orang-
utan by Hepburn, the lateral head was the same size as the small M. lumbricalis and though it arose from the first metatarsus he considered it to be simply a variation of the M. adductor hallucis. Also, the lateral head in orang-utan of Ruge formed a single muscular sheet together with the M. adductor hallucis, and although the boundary between the two was indistinct, the lateral head could be determined according to RUGE as the portion supplied by the medial plantar nerve. RUGE feels that since the M. flexor hallucis brevis is a single muscle in lower mammals, the medial and lateral heads originally had been a single muscle which later separated into the medial and lateral heads. He feels that it is the lateral head that separated from the medial head and it is due to the further devolution of the lateral head that the lateral portion of the medial head assumes this form.

In the cases of the author, as previously mentioned, the M. abductor hallucis has navicular origin, which sometimes is closely adhered with that of the medial head of this muscle, and further the lateral head of this muscle has the same origin as the Mm. interossei, which are thought to function as accessory muscles. Therefore, the view of RUGE concerning the genesis of the lateral head of this muscle is felt to be correct.

5) Mm. contrahentes digitorum pedis and M. adductor hallucis

The condition of the Mm. contrahentes digitorum pedis in Prosimiae has been described for Loris gracilis (Ruge) and Tarsius (Ribbing) in which they run to each toe. Particularly, in the former, the M. contrahens digiti I has 2 completely separated heads.

In the report by RUGE on Platyrhina, 4 Mm. contrahentes were found inserting into all toes except the third in Cebus and Ateles. Moreover, the lateral 3 muscles were fused at the origin from the base of the second and third metatarsal bones. On the other hand, the M. contrahens digiti I was separated into 2 heads, a transverse and an oblique. The transverse head arose by 2 independent tendinous slips from the capsule of the second and third metatarsophalangeal articulations, while the oblique head arose from the base of the second and third metatarsal bones.

Among Catarrhina, RUGE has reported that the condition in Cercopithecidae is similar to that in Cebus except for the absence of the transverse head. In contrast to this, Champneys in his description of Cynocephalus considered the M. adductor hallucis to be that muscle which arose from the fascia between the second and third metatarsal bones and the distal half of the muscular septum as well as from the base of the proximal phalanx of the second toe with insertion into the lateral side of the base of the proximal phalanx of the first toe. It is

Vol. 11
felt that this corresponds to the transverse head of the author while the previously mentioned muscle described by Champneys as the M. flexor brevis hallucis lateralis corresponds to the oblique head of the author.

The findings in Rhesus monkey (Howell-Straus, Okuda) are similar to those in Cebus. The Mm. contrahentes digitorum II, IV and V as well as the M. adductor hallucis are present and the origin, insertion, etc. are the same as in the cases of the author. The variation of the origin of the transverse head mentioned by Howell & Straus where it extended to the fourth metatarsal bone or in which it was limited to the second metatarsal bone has also been noted in my study.

The condition in anthropoid apes has been reported by Ruge (young orang-utan), Church (orang-utan), Duvernoy (gorilla), Straus (gorilla), Champneys (chimpanzee), Hepburn (orang-utan, gibbon, gorilla, chimpanzee) and Fick (chimpanzee, orang-utan). According to Hepburn, there is a tendinous septum or suture line extending from the tarsus to the phalanx along the edge of the second metatarsal bone. The Mm. contrahentes digitorum IV and V arise from the lateral side of this suture line, and the M. adductor hallucis from its medial side, but the M. contrahens digiti II is not present. Also, the M. adductor hallucis is always separated into the distal and proximal portions except in gibbon.

In the young orang-utan of Ruge, the Mm. contrahentes digitorum IV and V are the same as described by Hepburn, but the portion corresponding to the M. contrahens digiti II was simply a tendinous slip arising from the head of the second metatarsal bone. On the other hand, the M. adductor hallucis had a wider origin and more powerful than the Mm. contrahentes digitorum IV and V.

The description of orang-utan by Fick is largely the same except that the M. adductor hallucis arises from the tendinous arch of the plantar aponeurosis.

In chimpanzee, the Mm. contrahentes are all absent, but there is a large M. adductor hallucis (Champneys, Fick). In the cases of Champneys, there was origin from the entire length of the third metatarsal bone and the muscular septum between it and the fourth metatarsal bone as well as from the second metatarsal bone and the Vag. tendinis m. peronei longi. In the cases of Fick, there also was origin from the tibial and dorsal sides of the second metatarsal bone and insertion into the distal portion of the first metatarsal bone with no space between the transverse and oblique heads. In any case, among chimpanzee, the lateral muscle group, in other words, the Mm. contrahentes digitorum are absent in place of which there is a marked change in the M. adductor hallucis.

Therefore, the inference that may be drawn from the findings of
different investigators is that the following changes occur with evolution of primates. The Mm. contrahentes digitorum in *Prosimiae* consist of 5 fasciculi, which run to each toe, but in other primates, the muscle to the third toe is absent and the most medial muscle, which is the largest, becomes the M. adductor hallucis that separates into the transverse and oblique heads. Further, in anthropoid apes, devolution and disappearance of the lateral muscle group (Mm. contrahentes digitorum II, IV and V) occurs in place of which there is increase in size of the M. adductor hallucis, which runs to the first toe, and finally only the M. adductor hallucis remains, such as in gorilla and man. Therefore, the condition in Formosan monkey and Crab-eating monkey is the comparatively primitive form in which only the muscle to the third toe, the M. contrahens digiti III, is absent as in other macaque.

6) **M. abductor digiti minimi pedis and M. abductor ossis metatarsi V**

Reports on the condition of the M. abductor digiti V pedis and the M. abductor ossis metatarsi V in primates have been made for such *Prosimiae* as *Lemur, Chiromys, Tarsius, Galago*, etc. by *Straus, Murie & Mivart, Zuckerkandl, Oudemans, Woollard*, etc. In all of these cases, the M. abductor digiti minimi arose from the medial side of the tubercle of calcaneum while the M. abductor ossis metatarsi V originated from its lateral side so that these two are separated even at the origin.

In *Catarrhina* among *Simiae*, separation and independent presence of the M. abductor ossis metatarsi V has been reported in *Cynocephalus* (*Cunningham, Champneys*), *Pygathrix* (*Straus*), *Pithecus* (*Cunningham*), *Macaca* (*Okuda, Howell-Straus*), etc.

In the description of Rhesus monkey by *Howell-Straus* and *Okuda*, the M. abductor digiti minimi arises from the deep surface of the plantar aponeurosis and the tubercle of calcaneum which is the same as in my cases. Also, the M. abductor ossis metatarsi V had been found in almost all cases examined by *Okuda* (94.1%) which is more frequent than in Formosan monkey and Crab-eating monkey.

In anthropoid apes, the condition of the M. abductor digiti V is identical to that in man with origin from the calcaneum, but there are cases with one portion arising from the plantar aponeurosis (*Pira, Straus, Fick, Champneys*). In orang, however, the M. abductor ossis metatarsi V appears to be present in only rare cases so that some investigators even deny its presence (*Hepburn, Straus*). It is often found in chimpanzee (*Straus, Kohlbrugge*), but its frequency is extremely low in comparison with *Cercopithecidae*.

Moreover, it has been reported by *Church* that in chimpanzee and
Cebus, the M. peroneus tertius is absent in cases where the lateral portion of the M. abductor digiti minimi inserts into the base of the fifth metatarsal bone. In Inus, however, the M. peroneus tertius is also present which is similar to the condition in my cases.

7) M. flexor digiti V brevis pedis and M. opponens digiti V

The M. flexor digiti V brevis, one of the muscles of the fifth toe, is considered to be part of the Mm. interossei plantaris, while the M. opponens digiti V is a separation of the M. flexor digiti V brevis (SERAUS, BISCHOFF, HEPBURN, RIBBING, etc.). Among various primates, there is description of the M. flexor digiti V brevis in Lemur (MURIE & MIVART), while the latter has been noted in Lemur (MURIE & MIVART, ZUCKERKANDL), Galago (ZUCKERKANDL), etc.

Among Catarrhina, the presence of the M. flexor digiti V brevis has been reported in Cynocephalus (CHAMPNEYS) and Rhesus monkey (HOWELL-SERAUS, OKUDA). The condition of origin and insertion in Rhesus monkey is closest to that of the cases of the author, but some doubt remains as to whether the nerve supply is from the superficial or deep branch of the lateral plantar nerve.

In Cynocephalus, however, there is no mention of the M. opponens digiti V and it is reported to be usually absent in Rhesus monkey.

In both Formosan monkey and Crab-eating monkey of the author, supplementary origin of the M. flexor digiti V brevis from the tuberosity of the fifth metatarsal bone was noted but this is presumed to be the primitive condition prior to the separation of the M. opponens digiti V from this muscle especially in the cases of Crab-eating monkey.

Among anthropoid apes, the presence of the M. flexor digiti V brevis has been reported in gibbon (HEPBURN), orang-utan (HEPBURN), gorilla (SERAUS, HEPBURN, DUVERNOY, BISCHOFF, etc.) and in chimpanzee (HEPBURN, CHAMPNEYS, FICK, KOHLBRUGGE, etc.). The origin and insertion are much the same as in other primates and occasionally accessory origin from the base of the fourth metatarsal bone is seen (orang-utan: HEPBURN) or there may be the formation of the deep and superficial layers with additional fibers received from the tendinous sheath of the M. fibularis longus and from the base of the fourth and fifth metatarsal bones (gorilla: SERAUS).

The presence of the M. opponens digiti V has been noted in gibbon (HEPBURN, KOHLBRUGGE), orang (LE DOUBLE) and in chimpanzee (KOHLBRUGGE, RIBBING, HARTMANN), but there apparently are great individual differences in gorilla. In other words, there are reports of its independent presence (DENIKER, SOMMER), reports which indicate that it is absent (CHAMPMAKN, DUVERNOY, MACALISTER) or those in which it
is considered to be a part of the M. flexor digiti V brevis (Bischoff, Hepburn). In Man, it is frequently noted, although as a part of the M. flexor digiti V brevis.

Therefore, although there is an evident close relation between the M. flexor digiti V brevis and the M. opponens digitii V, there may be cases in which the M. flexor digiti V brevis is replaced by the M. opponens digitii V (Hepburn, Straus).

8). Mm. lumbricales pedis

As a rule, there are 4 of these muscles in primates and the relationship in the same as in man (Glaesmer, Straus, etc.). Among Prosimiae, there apparently are usually 4 such as in Lemur, Galago (Glaesmer) and Tarsius (Ribbing, Woolard, etc.), but there may be cases where there are 3 such muscles as in Nycticebus (Muir & Mivart) and Perodicticus (Ribbing) or even 7 such as in Loris (Glaesmer) and Tarsius (Allen). Moreover, in the cases of Stenops of Glaesmer, in which there were 7 muscles, each muscle arose from the several angles formed by the penetrating tendons from the Mm. flexor digitorum tibialis and fibularis, and inserted into the opposing sides of the base of the proximal phalanges of the second to fifth toes and into the medial side of the base of the proximal phalanx of the second toe.

In Simiae, according to Glaesmer, there are 4 muscles in such Platyrrhina as Hapale and Ateles, and in such Catarrhina as Cynocephalus, macaque, etc. (Glaesmer). The description of Rhesus monkey by Howell-Straus and Okuda differs in no way from the finding of the author.

Even in anthropoid apes, there are 4 muscles as in man (Glaesmer, Straus, Pira, Duvernoy, Hepburn, Bischoff, etc.) though there may be some cases with only 2 (Huxley).

Of these muscles, that to the second toe only usually has a single head while the others have 2 heads as in man. It has been reported that in Lemur there may be cases in which all 4 muscles have a single head (Muir & Mivart), while in Galago the lateral 2 muscles may have 2 heads (Straus), and in Pygathrix the muscles to the second and fifth toes may have a single head (Straus). Further, cases with a single head may be found in gibbon (Kohlburge), orang-utan (Straus, Pira) and chimpanzee (Straus).

Of course, in man a single head is only found as a variation. Although cases in which the M. lumbricalis III has one head have been reported (Testut), it is very rare (1.0%; Schmidt, Reissing and Heinlich).

Furthermore, there occasionally may be cases among man in which devolution and disappearance of the Mm. lumbricales II, III and IV
has occurred (approximately 10%: Reissing and Heinlich), but such a condition has not been found in macaque.

The nerve supply in macaque and anthropoid apes is reported to be similar in general to that in my cases in which the 2 medial muscles are supplied by the medial plantar nerve while the 2 lateral muscles are innervated by the lateral plantar nerve. Similar to my cases, there may be abnormal instances among anthropoid apes in which a wide area is controlled by the lateral plantar nerve, but in chimpanzee the medial plantar nerve may supply a wide area and provide control to the 3 medial muscles (Hepburn).

10) M. quadratus plantae

This muscle is always absent in Lemur (Glaesmer, Straus, Zucker-Kandl, Murie & Mivart, etc.). It also is absent in Tarsius (Burmeister, Woollard, etc.), Galago (Straus) and Loris (Glaesmer). Therefore, it may be considered to be absent as a rule in Prosimiae. Aside from the exceptional absence of this muscle in Cebus of Ribbing, this muscle is said to be present in Platyrhina (Straus) as in the Hapale and Ateles of Glaesmer. Moreover, it is always present in Cynocephalus (Glaesmer), Cercopithecus (Glaesmer), macaque (Howell-Straus, Okuda) as well as in Catarrhina (Bischoff, Kohlbrugge, Straus). In contrast to this, it is not necessarily present but rather more frequently absent in such anthropoid apes as gibbon, gorilla, orang-utan, chimpanzee, etc. (Straus, Hepburn, Macalister, Bischoff, Champman, Pira, etc.).

The frequency of this muscle in anthropoid apes has been reported by Straus to be 28.6% in gorilla, while Kohlbrugge has reported it in 50% of chimpanzee and in 46.2% of orang-utan, but it is reported as always being absent in gibbon.

The origin of this muscle in man is by 2 heads, but it usually is from the lateral portion of the calcaneum by 1 head in other primates. Among Platyrhina, it originates from the lateral side of the calcaneum in Hapale, and from its lower side in Ateles (Glaesmer). Even in Rhesus monkey among Catarrhina, it always arises from the lateral side of the tubercle of calcaneum (Howell-Straus, Okuda), but in Colobinae the origin is from the medial side of the calcaneum (Kohlbrugge). In anthropoid apes, when this muscle is present, it arises by a single head from the lateral side of the calcaneum, but it was by 2 heads in orang of Haffel, while the origin was from the medial side of the calcaneum in the chimpanzee of Kohlbrugge. In man, this muscle arises from the plantar and medial surfaces of the tubercle of calcaneum by 2 heads, which unite with each other later (Rauber). One case similar to this was noted among my Formosan monkey.

Glaesmer has reported that in many primates this muscle inserts into the tendon from the M. flexor digitorum tibialis, particularly the
tendon running to the fifth toe. This has been demonstrated in Rhesus monkey (Howell-Straus, Okuda), and in Formosan monkey and Crab-eating monkey of the author. Straus reports that in addition to muscular insertion into the tendons of the M. flexor digitorum longus, one portion contributes to the formation of these tendons. According to the description of Schultz, it contributes to the formation of only the tendon to the first toe in Callithrix and Pithcia among Platyrhina while there are contributions to the formation of the tendon to the fifth toe in Cebus, to those running to the second and fifth toes in Chrysothrix, and to the tendons to the fourth and fifth toes in Ateles. Further, among old world monkey, there was contribution to the formation of the tendons to the first, third and fourth toes in Cynocephalus of Page-Stecher (according to Straus), but this is an exceptional case. Apparently, there is contribution in most instances to the formation of the tendons to the second and fifth toes. The absence of the slip to the tendon running to the second and fourth toe was noted in my cases. This likewise has been noted in Rhesus monkey (Okuda) and, therefore, it may be considered as mostly not associated with the formation of the tendons derived from the M. flexor digitorum fibularis.

In the study of neonatal and adult human cadavers by Glaesmer, a portion of this muscle continued with 1 or 2 of the Mm. lumbricales. This was described as a retrogressive type of variation, but such a condition was not found in my cases of macaque.

11) Mm. interossei pedis

This muscle has long been a subject of much controversy, ontogenically and phylogenically with respect to the course of transition from the Mm. interossei plantares to the Mm. interossei dorsales (Champneys, Ruge) or with respect to the chief axis that acts as the center of the function (Hepburn, Okuda).

Concerning this muscle in primates, there is the description by Murie & Mivart for Prosimiae. According to them, the M. flexor digitii V brevis also was counted as one of the Mm. interossei in Lemur and Galago in which there are 2 Mm. interossei to each toe except the first toe and some of the Mm. interossei appear on the dorsal side of the foot. Further, in Galago and Tarsius, the presence of multiple superficial interosseous muscles arising from the tarsus has been reported. However, these multiple interosseous muscles are suspected as corresponding to the so-called Mm. contrahentes in view of their origin and insertion.

Among Catarrhina, there were 7 Mm. interossei dorsales in Cynocephalus of Champneys. The Mm. interossei I and II arise from the base of the second metatarsal bone, the M. interosseus III from the bases
of the second and third metatarsal bones, the M. interosseus IV from the bases of the third and fourth metatarsal bones, the M. interosseus V together with the M. interosseus IV from primarily the base of the fourth metatarsal bone, the M. interosseus VI from the base of the fourth and fifth metatarsal bones and the M. interosseus VII together with the M. flexor digiti V brevis from the base of the fifth metatarsal bone. Therefore, the origins of only the Mm. interosseus III, IV and VI are bicaudal and the others are by a single head. In addition to these Mm. interossei, Champneys has made mention of muscles considered to be the Mm. interossei plantares, which arose from the ligament extending from the base of the third metatarsal bone to the plantar space and inserted into the tibial side of the fifth and fourth toes as well as the fibular side of the second toe. These apparently correspond to the Mm. contrahentes. Thus, these muscles had been applied the name Mm. interossei dorsales simply because they were located on the dorsal side of the Mm. contrahentes, which he called the Mm. interossei plantares. If a separation of the Mm. interossei dorsales and plantares were to be made considering the findings in other primates, the Mm. interossei I, III, IV and VI compose the Mm. interossei dorsales while the Mm. interossei II, V and VII become the Mm. interossei plantares.

According to Howell & Strauss and Okuda, there are 7 Mm. interossei in Rhesus monkey. The third metatarsal bone was the chief axis of function, but a separation of the Mm. interossei dorsalis and plantaris had been made on the basis of the localization of the muscles. In other words, these muscles were classified into the medial group (M. interosseus dorsalis I, plantaris I, dorsalis II) and the lateral group (M. interosseus dorsalis III, plantaris II, dorsalis IV, plantaris III). In general, the former is said to arise by a common origin from the base of the second metatarsal bone and the proximal portion of the Vag. tendinis m. peronei longi while the latter arise from the bases of the fourth and fifth metatarsal bones and the proximal portion of the Vag. tendinis m. peronei longi. In my cases of macaque, however, most of the medial group arose from the first cuneiform bone and origin from the base of the second metatarsal bone was rare as previously mentioned. According to Howell & Strauss origin from the third metatarsal bone is absent in the typical case, but Okuda reports that the origin of the M. interosseus dorsalis II is separated with a high frequency of origin from the base of the third metatarsal bone (82.4%) while separation of the origin of the Mm. interossei dorsalis III and IV such as in anthropoid apes is very rare. Moreover, Okuda has mentioned that this separation of the origin of the M. interosseus dorsalis II indicates the tendency of transition of the chief axis from the third toe to the second toe in macaque. According to this, the cases of
the author can be said to be in the course of this process and further the few cases of separation of the origin of the Mm. interosseus dorsales III and IV may be considered to be approach to the anthropoid type.

According to Hepburn, each of the Mm. interosseus dorsales in anthropoid apes arises bicaudally from the respective metatarsal bones that form the interosseous space in which each muscle is located. In contrast to this, the Mm. interosseus plantares arise by a single head from the same side of the respective metatarsal bones (Hepburn, Straus, etc.). Exceptional cases in which the Mm. interosseus dorsales arise by a single head have been noted in gibbon (Hepburn), orangutan (Hepburn) and gorilla (Deniker) for the M. interosseus dorsalis II. Conversely, cases with 2 heads among the Mm. interosseus plantares have been reported for the M. interosseus plantaris I (Hepburn) and the M. interosseus plantaris II (Deniker) in gorilla. Moreover, Hepburn has mentioned that these 2 heads in gorilla indicate the transition of the chief axis of abduction and adduction from the third toe to the second toe. In general, the chief axis in Prosimiae is said to be the fourth toe while it is the third toe in Platyrhina, Catarrhina and anthropoid apes (Straus, Macalister, Duvernoy, etc.). There are some reports that mention that there is second toe axis in only gorilla (Bischoff, Hepburn, Deniker, Straus, Cunningham, etc.). In the macaque of myself and Okuda, there was a tendency of transition of the chief axis from the third toe to the second toe and it may be that this is more pronounced in gorilla or in some cases the transition of the chief axis to the second toe may even be completed. Therefore, though the condition in gorilla is said to indicate a change to the human type, it may be considered that the state is most similar to that in man. Moreover, in reviewing the above, there apparently is a change in the chief axis of abduction and adduction from the lateral side to the medial side with advance from Prosimiae through anthropoid apes to man.

12) M. extensor digitorum and hallucis brevis

In the first place these muscles are of pedal origin and had separated from the muscles of the peroneal group. Some consider the condition that can be observed in primates to be a secondary change or transformation (Cunningham, Ruge) while others feel that they are part of the intrinsic extensor muscles of the foot (Howell & Straus).

The site of origin of these muscles in the findings of various investigators is much the same for primates with occasional origin from a bone other than the calcaneum in Lemur (Murie & Mivart), macaque and apes (Kohleruggge).

In my study of Formosan monkey and Crab-eating monkey, such
origin from a bone other than the calcaneum or accessory origin from the Lig. cruciata, etc. such as noted by Straus in exceptional cases was not found.

To review the state of division of the muscular belly or the condition of absence of tendons among Prosimiae, there are reports of cases with 5 tendons that run to the first to fifth toes in Loris (Ruge) and Galago (Straus), tendons to the first to fourth toes in Tarsius (Ribbing), Lemur, Galago and Nycticebus (Murie & Mivart), tendons to the first and second toes in Galago and Perodicticus (Murie & Mivart), tendons to the first to third toes in Tarsius (Burmeister, Woollard) and Daubentonio (Owen), tendons to the second and third toes in Lemur (Ribbing) and tendons to the second to fourth toes in Lemur (Murie & Mivart) and Chiromys (Murie & Mivart, Zuckerkandl).

Thus, the condition is variable in Prosimiae and while there are cases with tendons to the fifth toe, a tendon to either the first, third or fourth toe may frequently be absent. However, the tendon to the second toe is never missing.

Among Platyrrhina, there usually are 4 tendons that run to the first to fourth toes in Pithecia, Callithrix, Arachytiles, Cebus, etc. (Bischoff, Ribbing), but the tendon to the first toe may be absent in Ateles (Kohlbrugge). Further, there may be duplication of the muscle belly to the second toe (Ruge).

There usually are 4 bellies among lower Catarrhina to the first to fourth toes in Cynocephalus, Colobinae, macaque, etc. with very little alteration (Bischoff, Kohlbrugge, Ribbing, Okuda, Howell-Straus). However, there may be duplication of the belly to the first toe such as noted Cynocephalus (Champneys).

Among anthropoid apes, there likewise is separation as a rule into 4 bellies that run to the first to fourth toes in gibbon, orang-utan, gorilla and chimpanzee as in other primates (Hepburn, Straus, Bischoff, Duvernoy, Sommer, etc.) with some cases with a muscle belly to the fifth toe in gibbon (Kohlbrugge), orang-utan (Kohlbrugge), gorilla (Keith: according to Straus) and chimpanzee (Keith: according to Straus). Further, there is mention of duplication of the muscle to the second and third toes in orang-utan (Fick) and nonseparation of the muscle to the first toe in Chimpanzee (Champneys). However, cases showing absence or variations are few.

In man, the condition is very similar to that in anthropoid apes. Although absence of a muscle to any given toe is few, it does not mean that absence is never seen at all (Le Double) and there may even be instances in which there may be none to any toe (Straus).

In summary with respect to the separation of the muscle belly and associated formation of tendons to each toe, there usually are 4 which
insert into the first to fourth toes. Occasionally, a tendon may be
given off to the fifth toe or there may be cases in which one or even all
are missing. There also may be instances in which there is duplica-
tion. The variations seem to be marked particularly in Prosimiae.

SUMMARY

Gross anatomical study of the origin, insertion and nerve supply
of the musculature of the foot of Formosan monkey (10 feet) and Crab-
eating monkey (13 feet) was done and the results were compared with
the findings for other primates.

1) The Aponeurosis plantaris in both Formosan monkey and Crab-
eating monkey consists of the Aponeuroses tibialis and fibularis. In ge-
eral, the Aponeurosis fibularis is larger than the Aponeurosis tibialis.
Among the cases examined, there were some instances in which only
the formation of the Aponeurosis fibularis was found such as in lower
monkey and conversely in a few cases the Aponeurosis tibialis was
larger such as noted in anthropoid apes. The Fasciculus proximome-
dialis is frequently found in Formosan monkey whereas it is often ab-
sent in Crab-eating monkey. Moreover, at its terminal portion, the 4
bundles to the second, third, fourth and fifth toes were found in all
cases of Formosan monkey, but the bundle to the second toe may be
missing in Crab-eating monkey.

2) The M. flexor digitorum brevis in both Formosan monkey and
Crab-eating monkey has 2 independent heads, a deep and a superficial.
The superficial head gives rise to only 1 tendon, which runs to the
second toe, while the deep head gives off 3 tendons that go to the
third, fourth and fifth toes. A portion of the muscle fibers of the
superficial head was found to continue into the central part of the
belly of the deep head in 1 case of Crab-eating monkey. Otherwise,
variations in the muscle and tendon are very few. The nerve supply
is from the medial plantar nerve. However, there were a few cases
for each head in which there was innervation by the lateral plantar
nerve or double innervation by both.

3) The origin of the M. abductor hallucis in macaque has been
reported to be the deep surface of the Aponeurosis plantaris and the
medial plantar surface of the tubercle of calcaneum. In all of my cas-
es of macaque additional fibers of origin were received from the area of
the navicular bone. The insertion is the medial side of the proximal
portion of the proximal phalanx of the first toe. A variation of the
insertion was noted in Crab-eating monkey in which there was attach-
ment to a wide area on the medial edge of the body of the first metatarsal bone. The nerve supply is from the medial plantar nerve.

4) The M. flexor hallucis brevis in both Formosan monkey and Crab-eating monkey has 2 completely independent heads, a medial and a lateral. There was little difference between these 2 species. The medial head arises from near the proximal portion of the first cuneiform bone and inserts into the medial side of the base of the proximal phalanx of the first toe. Its course and insertion are closely related to the M. abductor hallucis and a part of the fibers of origin may even be fused.

The lateral head arises from the distal portion of the first cuneiform bone and inserts into the lateral side of the base of the proximal phalanx of the first toe. At the origin there frequently is fusion with the medial muscles of the Mm. interossei while the insertion is located adjacent to the insertion of the oblique head of the M. adductor hallucis.

Both heads are supplied by the medial plantar nerve.

5) The M. adductor hallucis in both Formosan monkey and Crab-eating monkey has transverse and oblique heads. In rare cases, the 2 heads may not be clearly separated in Crab-eating monkey. The transverse head generally arises from the heads of the second and third metatarsal bones with additional fibers from the fascia of the M. interosseus dorsalis II and M. interosseus dorsalis III in some cases. The oblique head arises from the Vag. tendinis m. peronei longi, usually at the level near the base of the third metatarsal bone. Both heads insert into the lateral side of the base of the proximal phalanx of the first toe. The nerve supply is from the deep branch of the lateral plantar nerve by the terminal branch.

6) The Mm. contrahentes digitorum pedis may be separated into 3 muscles that run to the second, fourth and fifth toes. They arise by a common tendon from the Vag. tendinis m. peronei longi at near the base of the third metatarsal bone. The M. contrahens digitii II, which is the smallest of these, is covered by the transverse head of the M. adductor hallucis and inserts into the lateral side of the base of the proximal phalanx of the second toe. There are cases in which the tendon of insertion may be separated and extend as far as the head of the metatarsal bone or the tendon of insertion may extend to the dorsal side of the toe. Further, there may be cases in which the insertion of the M. contrahens digitii IV is separated with attachment to also the third toe. The nerve supply is from the deep branch of the lateral plantar nerve.
7) M. abductor digiti minimi and M. abductor ossis metatarsi V: These muscles arise from the lateral side as well as the anterior part and medial side of the tubercle of calcaneum. The main bundle of muscle fiber converges to the lateral tarsal region to form a slender tendinous band which runs on top of the M. flexor digiti V brevis and inserts into the lateral side of the base of the proximal phalanx of the fifth toe. In all cases, the muscle fibers on the lateral side separate and form a fasciculus which attaches by tendon to the tuberosity of the fifth metatarsal bone. Separation of this fasciculus was noted already from the origin forming an independent M. abductor ossis metatarsi V in many cases, but this independent muscle was absent in a considerable frequency of the cases, particularly in Crab-eating monkey. The nerve supply is from the lateral plantar nerve.

8) The M. flexor digiti V brevis arises in all cases from the Lig. plantare longum together with the M. interossei plantaris III, but occasionally additional fibers are received from the base of the fifth metatarsal bone. This fasciculus runs along the plantar surface of the fifth metatarsal bone adjacent to the lateral side of the M. interossei plantaris III and inserts into the lateral side of the proximal phalanx of the fifth toe. The nerve supply is by the superficial branch of the lateral plantar nerve.

Further, in Crab-eating monkey a small, independent fasciculus was found that arises from the tuberosity of the fifth metatarsal bone and inserts into the plantar surface of the body of the fifth metatarsal bone and into the lateral side of the base of the proximal phalanx of the fifth toe. This presumably is the M. opponens digiti V which frequently is reported in anthropoid apes. This was not found in a single case among Formosan monkey.

9) The Mm. lumbricales consist of 4 muscles in all cases examined. The M. lumbricalis I, which is the smallest of these, arises from the medial side of the tendon to the second toe from the M. flexor digitorum longus while the other 3 have origin from the opposing sides of the tendons to the second, third, fourth and fifth toes. The tendons of insertion run from the medial surface of the base of the proximal phalanges of the second to fifth toes to the dorsal side of the toe and terminate into the dorsal surface of the second phalanges. The nerve supply to the 2 lateral muscles is from the lateral plantar nerve while the 2 medial muscles are supplied by the medial plantar nerve. In rare cases, however, the M. lumbricalis II may be supplied by the lateral plantar nerve (Formosan monkey) or the Mm. lumbricales II and III may be controlled by both the lateral and medial plantar nerves (Crab-eating monkey).
10) The M. quadratus plantae is never absent. In general, it arises by a single head from the lateral side of the calcaneum, but there may be rare cases among Formosan monkey in which fibers are also received from its medial side so that it has bicaudal origin. This muscle inserts into the lateral side of the tendon to the fifth toe from the M. flexor digitorum longus. It then sends off tendinous slips to the tendons that run to each toe. Frequently, slips to tendons derived from the M. flexor digitorum fibularis (those to the first, third and fourth toes) are missing. In rare cases among Formosan monkey, this muscle inserted into the main trunk of the tendon from the M. flexor digitorum fibularis. The nerve supply is from the lateral plantar nerve.

11) The Mm. interossei pedis consist of 7 muscles which may be classified into 4 Mm. interossei dorsales and 3 Mm. interossei plantares.

The medial muscle group which includes the M. interosseus dorsalis I, M. interosseus plantaris I and a part of the M. interosseus dorsalis II, usually arises from the distal portion of the first cuneiform bone together with the M. flexor hallucis brevis lateralis. Origin from the base of the second metatarsal bone such as reported heretofore was rare. These muscles insert in sequence into the medial and lateral sides of the base of the proximal phalanx of the second toe as well as into the medial side of the base of the proximal phalanx of the third toe. Of these muscles, the origin of the M. interosseus dorsalis II was clearly separated with additional fibers of origin received from near the base of the second, third or fourth metatarsal bones.

The M. interosseus dorsalis III generally arises from near the base of the fourth metatarsal bone with occasional origin in Crab-eating monkey from near the base of the third metatarsal bone. It inserts into the lateral surface of the base of the proximal phalanx of the third toe.

The M. interosseus plantaris II arises from near the base of the fourth metatarsal bone or from near the base of the fifth metatarsal bone and inserts into the medial surface of the base of the proximal phalanx of the fourth toe.

The M. interosseus dorsalis IV and M. interosseus plantaris III arise in general from the sasamoid bone at the base of the fifth metatarsal bone and the Lig. plantare longum together with the M. flexor digiti V brevis. The M. interosseus dorsalis IV in some cases of Crab-eating monkey may have origin from the fourth metatarsal bone or the origin in few cases may be separated with fibers of origin received from both areas. These muscles insert into the opposing edges of the proximal phalanges of the fourth and fifth toes.
The nerve supply is by the deep branch of the lateral plantar nerve which send off branches in sequence to these muscles.

12) The M. extensor digitorum et halluces brevis in all cases examined arises from the dorsal and lateral surfaces of the calcaneum behind the calcaneo-cuboidal articulation. In general, the muscle is separated into 4 bellies which immediately become slender tendons that run to the first to fourth toes. In a case of Crab-eating monkey, it separated into 3 bellies of which the most medial gave off tendons to the first and second toes. The tendon to the first toe inserts into the dorsal surface of the proximal phalanx together with the tendon from the M. extensor hallucis longus while the tendons to the second to fourth toes insert into the dorsal surface of the middle phalanges together with the tendons from the M. extensor digitorum longus and the M. lumbricalis.

There was no case in which absence or duplication of the tendons was found.

The nerve supply is from the deep fibular nerve.

REFERENCES

3) Champneys, F., On the muscles and nerves of a chimpanzee (Trogloides niger) and a Cynocephalus anubis. Jour. Anat., 6, P. 176 (1870).
4) Cunningham, D. J., Report on the some points in the anatomy of the thylacine (Thylacinus cynocephalus), cuscus (phalangista maculata), and phascogale (phascogale calura), collected during the voyage of H. M. S. Challenger in the years 1873–1876: with an account of comparative anatomy of intrinsic muscles and nerves of the mammalian pes. Challenger Report V (Zoology), Part XVI P. 192 (1881). (cited by Hepburn and Straus).
11) Howell, A. B. and Straus, W. L. Jr., The anatomy of the Rhesus monkey (Chapter VII. The muscular System), Baltimore. 1933.


