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ON THE AUTONOMIC AND SENSITIVE NERVOUS COMPONENTS OF DIGITAL, METACARPAL AND METATARSAL PADS OF THE COYPU (MYOCASTOR COYPUS)

SULLA COMPONENTE NERVOSA AUTONOMA E SENSITIVA DEI TORI DIGITALI, METACARPALI E METATARSALI NELLA NUTRIA (MYOCASTOR COYPUS)

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PAROLE CHIAVE:
nutria, tori, innervazione autonoma e sensitiva.

KEY WORDS:
coypu, foot pads, autonomic and sensitive innervation.

Riassunto

L'innervazione dei tori digitali, metacarpali e metatarsali della nutria è formata da una componente autonoma e da una sensitiva.

La prima è costituita da cellule gangliari, isolate o raggruppate, situate lungo il decorso di fasci nervosi, mentre la seconda è formata da terminazioni libere e capsulate classificabili, dal punto di vista morfologico, come corpuscoli di Pacini, paciniformi e Golgi-Mazzoni.

I menzionati corpuscoli mostrano struttura tipica e si possono rinvenire isolati, riuniti a costituire infiorescenze semplici e complesse, corpuscoli opposito-polari e fibre pecilomorfe.

Gli AA. rilevano la variabilità morfologica delle forme recettoriali, rinvenute in questa ed in analoghe precedenti ricerche, ma puntualizzano che sono tutte, funzionalmente, meccanocettori e quindi compatibili con l'impegno richiesto al distretto anatomico in esame.

Summary

The innervation of the coypu foot pads (digital, metacarpal and metatarsal) is represented by an autonomic and a sensitive components.

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The former is constituted by isolated or grouped ganglion cells located along the course of nerve bundles, while the latter is composed by free and encapsulated nerve endings morphologically classified as Pacini, Pacini-like and Golgi-Mazzoni corpuscles.

The above named corpuscles show the typical structure and can be found isolated or grouped to organize simple and complex flower-sprays, opposite-polar corpuscles and poikilomorphous fibres.

The AA. notice the morphological variability of the encapsulated receptors found in this and previous similar investigations but point out also that they are functionally mechanoreceptors and so compatible with the role of the considered anatomical district.

Introduction

In the support surface of the limbs of different animal species there are particular formations (footpads, tori) that have the role to absorb the pressure that unload on the ground.

Independently by their topography along the digital axis (digital pads) or distally to the metacarpo-metatarso-phalangeal joints (metacarpal and metatarsal pads), these formations are always covered by skin characterized by thick corneous coat that protects a remarkable fibro-elastic component. This last component is often characterized by remarkable adipose tissue that has a mechanical and not deposit function. In the thickness of the fibro-elastic component the vascular and nervous nets are often present.

Probably the nervous net has the role to collect the information about the ground characteristics (sandy, stony, uneven, etc) to adjust the limb position and the walk.

The importance of these structures in some animal species, in particular from a mechanical point of view, explains why the innervation of the pads are often studied (1-24).

The aim of the present research was to study the autonomic and sensitive innervation of the digital, metacarpal and metatarsal pads in the coypu (*Myocastor coypus*, fig. 1) that has never been studied.

Figure 1:
Coypu (Myocastor coypus).

Materials and methods

The study was carried out on samples taken from 3, 18-24 months old, coypus, that were sacrificed with an euthanasic medicine (Tanax®, Hoechst).

From each subject, immediately after the death, the digital, metacarpal and metatarsal pads were taken. The samples of same limb and of thoracic and pelvic limb were keep distinct (fig. 2). Moreover in the samples made in the metacarpal and metatarsal pads, the peripheral area was keep distinct from the central area.

The material taken from one subject was processed with the original gold chloride technique according to Ruffini (25). The other samples were processed with the aforesaid method modified by Goglia (26).

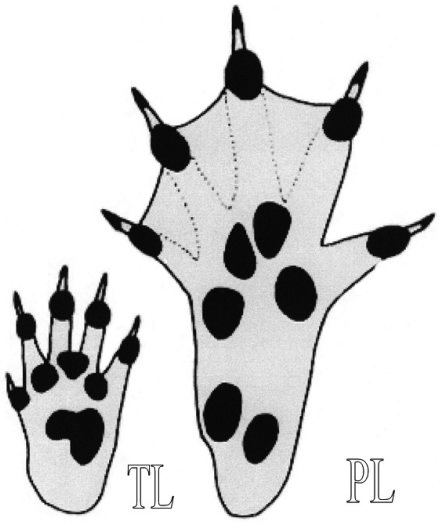

Figure 2:
Coypu: topography of foodpads in the thoracic limb (TL) and pelvic limb (PL) of the coypu (Myocastor coypus).

Results

The observations have documented a conspicuous nervous component represented by trunks with different diameter, distributed near the blood vessels (fig. 3). The finding was more conspicuous in metacarpal and metatarsal pads in respect to the digital ones. Always we did not found significant differences between the thoracic and pelvic limb.

We also observed an autonomic innervation represented by ganglion cells with spherical or ellipsoidal shape (diameter ranging between 7,3 and 23,7 μm). These cells were isolated or clustered to constitute little ganglia (9-84 cells) without the capsule. The autonomic cells were located along the nervous trunks. Rarely they were found in the epineurium and in the convergence point of 2 or more trunks (fig. 4).

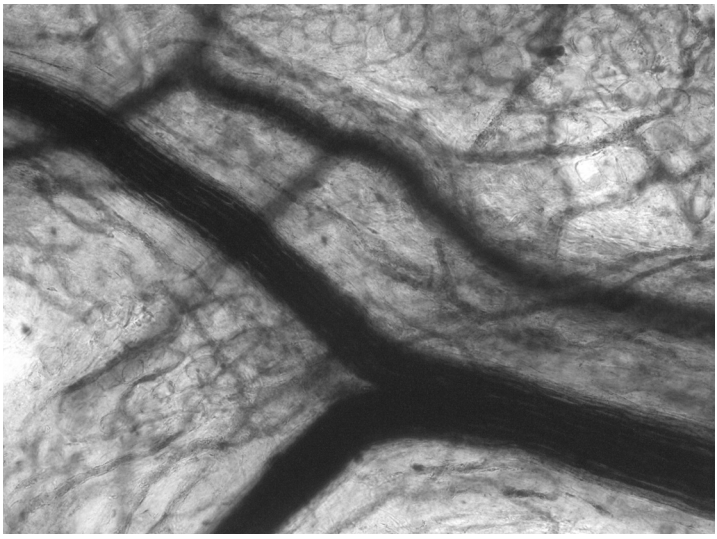

Figure 3:
Coypu: metacarpal pad. The nervous trunk run near the blood vessel. Gold chloride method according to Ruffini. 120x.

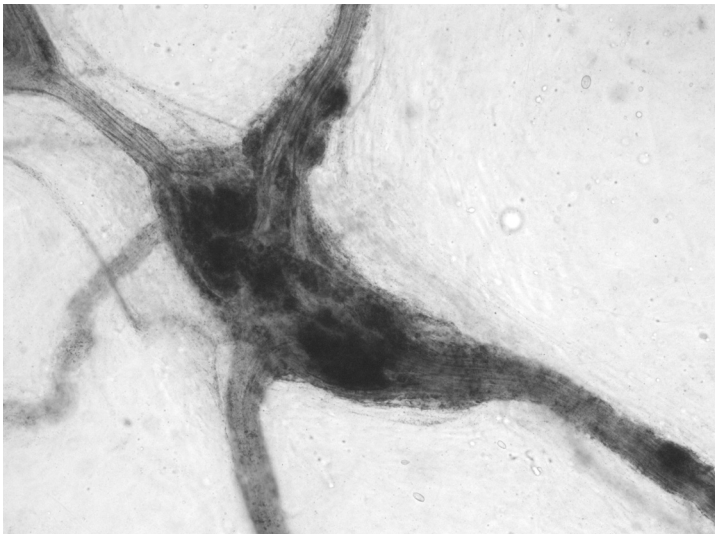

Figure 4:
Coypu: metatarsal pad. A little ganglion located in the confluence point of more nervous trunks. Gold chloride method according to Ruffini. 120x.

Isolated fibres departed from the nervous trunks. These fibres had different diameter and terminated in different ways. In fact the most thin fibres drew fine vo-

lutes with different ampleness (fig. 5) and interlacing gave origin to complicated nets. Differently, the most thick fibres finished in corpuscles that were morphologically referable to Pacini (fig. 6, A-C), Pacini-like (fig. 7), and Golgi-Mazzoni (fig. 8, A, B). The Pacini represented the most numerous corpuscles, while the Golgi-Mazzoni the most scarce.

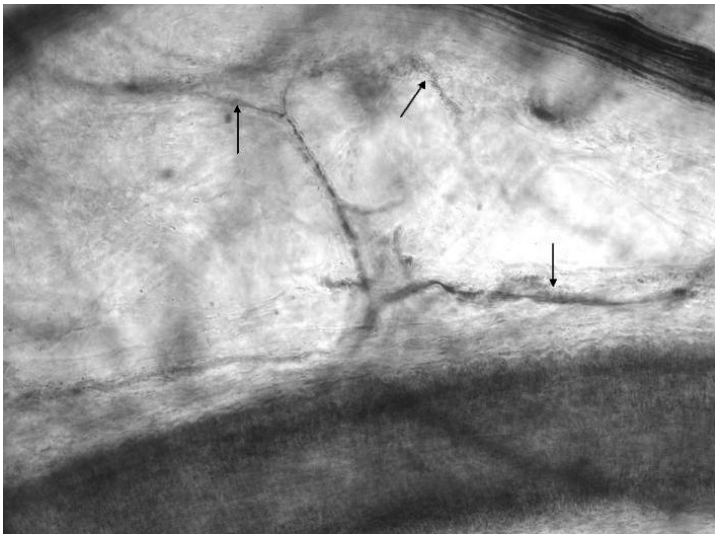

Figure 5:
Coypu: metatarsal pad. The picture shows the close relationship between blood vessels and nervous trunks. The arrows indicate thin nervous fibres terminate in free nerve endings. Gold chloride method according to Ruffini modified by Goglia. 120x.

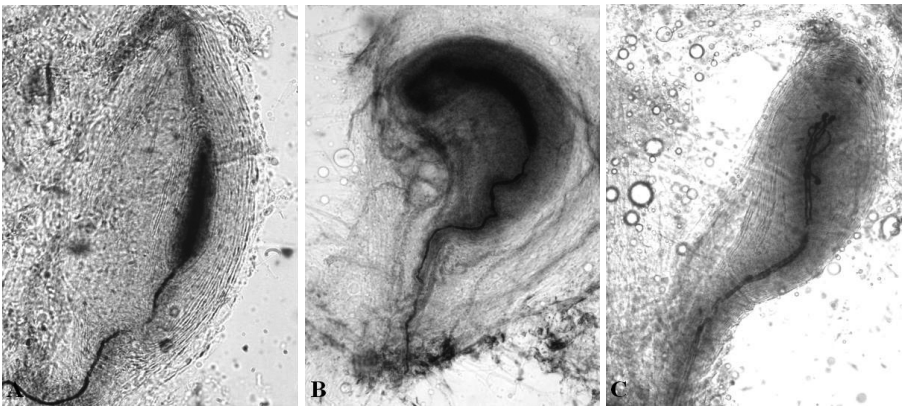

Figure 6 A-C:
Coypu: metacarpal (A), metatarsal (B, C) pads. The pictures show Pacini corpuscles with different morphology and aspect. The lamellar organization of the capsule and the manner of the expansional axon are fairly clear. Gold chloride method according to Ruffini. 250x (A), 120x (B,C).

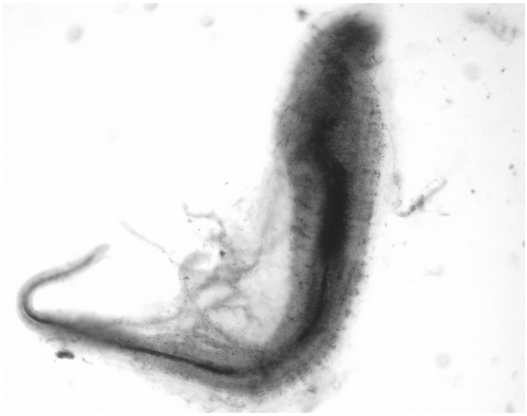

Figure 7: Coypu: metacarpal pad. Isolated Pacini-like corpuscle. Gold chloride method according to Ruffini modified by Goglia. 120x.

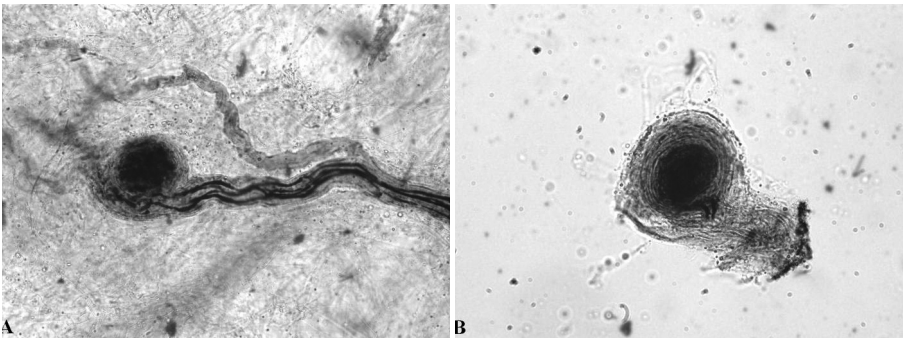

Figure 8 A, B: Coypu: metatarsal pad. Isolated Golgi-Mazzoni corpuscles. Gold chloride method according to Ruffini modified by Goglia. 250x.

Therefore, in the studied area we found not only the autonomic nervous component but also a sensitive contingent, represented by free and encapsulated endings. The obtained data documented that the nervous component, in particular the sensitive ones, was more represented into the metatarsal pads than the metacarpal ones and in these last more than digital pads of the same limb. Moreover, the sensitive component was generally located in the more superficial layer in respect to the autonomic ones.

The different corpuscles, in particular the Pacinian, were isolated or grouped (4-5 corpuscles) into simple (fig. 9, A, B) and complex (fig. 10) flower-sprays or they were located one after another along the same nervous fibre to constitute opposite-polar corpuscles (fig. 11, A, B).

The corpuscles had typical structure, even if the Pacinian with ellipsoidal shape could have rectilinear aspect or be curved. The capsule had remarkable thickness and showed a lamellar arrangement. The expansional axon was thick, undivided or branched, it showed the same behaviour of capsule and only rarely finished with

the typical end button. When the axon branched, the branches terminated with a little button (fig. 6, C).

We also observed the Pacini-like corpuscles even if they were less numerous. These corpuscles were characterized with a greater length, thinner capsule and thinner expansional axon in respect to Pacini.

The Golgi-Mazzoni corpuscles had a thick capsule that showed the lamellar arrangement. They had spherical and ellipsoidal shape and the connective of the inner core marked the course of the expansional axon (fig. 8, A, B).

A last finding was represented by poikilomorphous fibres. They dichotomically divided into 2 branches that ended in morphologically different corpuscles (fig. 12).

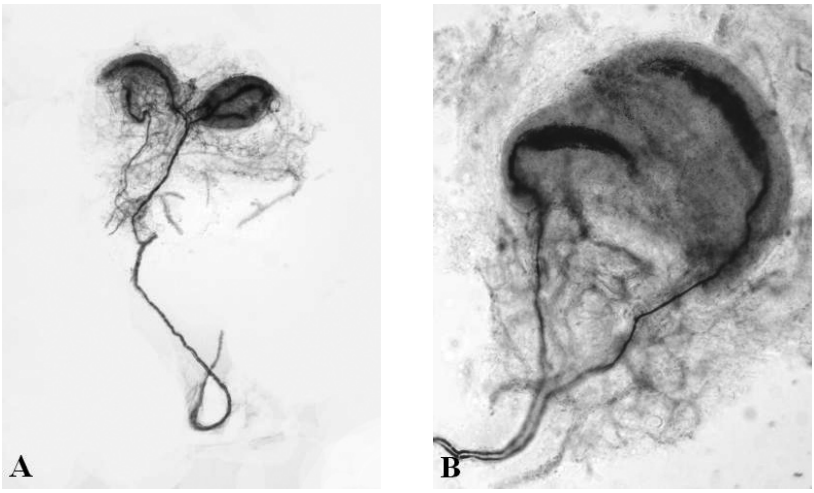

Figure 9 A, B: Coypu: metacarpal (A) and metatarsal (B) pads. Simple flowers-spray of Pacini corpuscles. Gold chloride method according to Ruffini. 40x (A); 120x (B).

Figure 10: Coypu: metacarpal pad. Complex flowers-spray of Pacini corpuscles. Gold chloride method according to Ruffini. 40x.

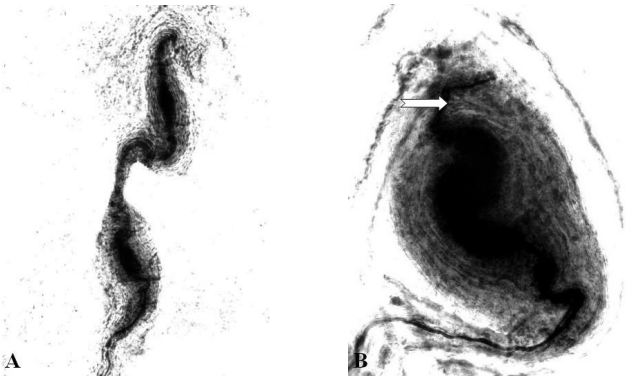

Figure 11 A, B: Coypu: metacarpal (A) and metatarsal (B) pads. The pictures show 2 opposite-polar Pacini corpuscles. The nervous fibre comes out (arrow, B) from corpuscle and sustains another corpuscle that yet disconnected during the isolation. Gold chloride method according to Ruffini modified by Goglia. 120x (A), 250x (B).

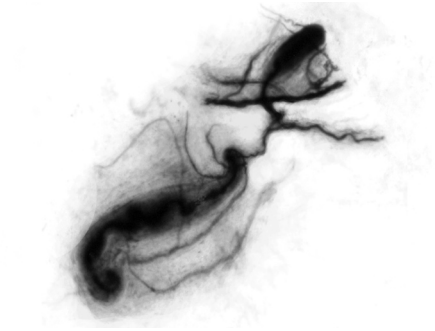

Figure 12: Coypu: metatarsal pad. Poikilomorphous fibre. It divides into 2 branches that innervate 2 corpuscles, morphologically different (Pacini corpuscles on the right, Pacini-like on the left). Gold chloride method according to Ruffini. 70x

Discussion

The presence of an autonomic and sensitive innervation was documented in the digital, metacarpal and metatarsal pads of the coypu, in accordance with that has been already reported (8-9, 13, 15, 17-19, 21-24). Both the component and in particular the autonomic ones, were near the blood vessels and sweat glands as it has been already documented in other anatomic districts (24, 27-32).

The sensitive innervation was represented by the presence of receptors (Pacini, Pacini-like and Golgi-Mazzoni). These corpuscles show the typical structure and can be found isolated or grouped to organize simple and complex flower-sprays, opposite-polar corpuscles and poikilomorphous fibres. They were analogous in the thoracic and pelvic limb. Instead we found numerical differences between the receptors of the metatarsal pad (more numerous) and the metacarpal ones. This finding

could be due to the different involvement of the limbs in the "station" and in the "movement" of the animals studied. In fact, both the pads are surely involved in the support phase, but the metatarsal pads are also involved into the propulsive push of the step. The sensitive nervous component was more conspicuous and located superficially that autonomic ones. In the past, in the pads of human foetuses (13) and in the pads of different mammals species (dog, cat, horse, pig, goat, buffalo, mouse, rat, guinea-pig, opossum) the encapsulated receptors have been documented (3-4, 7, 9, 15, 17, 19, 21-23) but non like that we found. In fact the aforesaid authors have been documented, as a more frequent finding, the Pacini corpuscles and then Golgi-Mazzoni, Pacini-like, Meissner and Ruffini corpuscles.

The Golgi-Mazzoni corpuscles have not been documented by all the aforesaid researchers. In fact these last receptors have been documented in the cat, pig, rat, guinea-pig, and goat (9, 17-19) and have not been documented by Goglia (3-4) in the dog, cat and buffalo, by Giordano and Rosati (6) in the sheep and by Rosati (7) in the horse. In particular, Giordano and Rosati (6) and Rosati (7) have documented, respectively in the pads of sheep and horse, the corpuscles with intermediate characteristics between the Pacini and Golgi-Mazzoni, but they have excluded the presence of the last ones.

We think that an accurate structural analysis allow to define if a corpuscle is a Pacini or Golgi-Mazzoni. Therefore, if it is not possible, the Golgi-Mazzoni corpuscles should defined as Pacinian-like.

Finally, we also found the poikilomorphous fibres. They are dicotomically branching fibres that terminate with morphologically different corpuscles. Also about these findings, there is not unanimity. In fact some authors refuse the presence of these fibres in the pads of the sheep (6), horse (7), rat and guinea-pig (18). Differently other authors admit the presence of these fibres in the pig (17) and in the goat (19).

In conclusion, we could highlight the casualness of some findings, as the presence of Meissner and Ruffini corpuscles, and the presence of corpuscles morphologically different. Moreover, we could affirm that, in the studied pads, the structural organization of the corpuscle is not so important as their functional role. Therefore, as all the receptors observed are the mechanoreceptors, we think that they perfectly correspond to the role that they have in the digital, metacarpal and metatarsal pads in the dynamic function of the limb.

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