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Research article

CREATION NERVES OF THE LUMBAR AND SACRAL PLEXUS IN CALIFORNIA SEA LIONS (*ZALOPHUS CALIFORNIANUS*) AND NORTHERN ELEPHANT SEALS (*MIROUNGA ANGUSTIROSTRIS*)

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The lumbosacral plexus was investigated in the California sea lion and Northern elephant seal. In 9 California sea lions and 2 Northern elephant seals the femoral nerve rises from the ventral branches of the 3rd and 4th lumbar nerves, whilst in one male and two specimens of the Northern elephant seal the 5th lumbar nerve was also involved. Ventral branches of the 3rd and 4th lumbar nerves comprised the obturatorius nerve in 7 specimens; in 3 specimens the 5th lumbar nerve additionally supplements the obturatorius nerve. In Northern elephant seals the obturatorius nerve originates from the ventral branches of the 3rd, 4thand 5th lumbar nerves. The ischiadic nerve originates from the ventral branches of the 4th, 5th lumbar and 1st sacral nerves in 8 specimens California sea lions and in 2 North elephant seals. In 2 specimens of both species the 2nd sacral nerve also participates. The gluteal nerve created ventral branches of the 5th lumbar and 1st sacral nerves in three specimens; however in one specimen the 4thand 5th lumbar nerves gave rise to the same nerve in the Northern elephant seal. In California sea lions the gluteal nerve originates from the ventral branches of the 5th lumbar nerve in seven specimens, nonetheless in 3 specimens the 4th lumbar nerve also participates in its formation.

Key words: elephant seal, *Mirounga angustirostris*, nerve, pinnipedia, sea lion, sea mammals, *Zalophus californianus*

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INTRODUCTION

*Pinnipedia*are are a rather small group of mammals that readapted themselves to life in the aquatic environment. During their adaptation to the marine environment numerous changes occurred in their anatomy in order to be able to move, forage and reproduce in the aquatic environment [1]. Currently there are numerous articles relating to their physiology, reproduction, ecology, behavior, nutrition, microscopic and gross anatomy. One of the first authors contributing to the knowledge of *Pinnipedia* morphology are Duverroy [2] and Murie [3,4]. In their works they provided us with a plethora of morphological data concerning organs and organ systems of manatees, sea lions and true seals. Subsequent research complemented their original works, hence Howell [5,6] described morphological characteristics of the narwhal, phoca and seal lions. In separate investigations Fraser [7], Green [8], Freea [9], St Pierre [10], King [11], Dierout and Gullard [12] described the morphological characteristics of other marine mammals. A second group of investigators [6,13-16] assessed their adaptations from the standpoint of functional morphology. Numerous investigations [17-21] of pinnipedia in that respect were associated with depth and duration of diving, as well as with the changes occurring in different organ systems during diving. Some authors [22-27] chose to investigate the behavior, growth and development of different species of sea lions. Genetic variability was also investigated in some pinnipedia [26,28-30]. However, very few authors investigated their nervous system, especially the peripheral nervous system. According to the available literature data Murie [4] first described the innervation of the pinnipedia hind limb, followed by Hawell [6], and subsequently Freea [9] and Green [8] addressed the same topics.

We could not find detailed information regarding the origination of the lumbosacral plexus in the California sea lion (*Zalophus californianus*) and Northern elephant seal (*Mirounga angustirostris*) in the available literature. Morever, statements regarding the origination of the lumbosacral plexus differ considerably. In addition they also report a different number of lumbar and sacral vertebrae. It is commonly known that there are some discrepancies in the origin of the lumbosacral plexus even amongst individual specimens of the same species in terrestrial mammals [23,31-37]. Therefore, it can be assumed that the same differences in the origination of the lumbosacral plexus would exist in pinnipedia. This notion directed us to investigate the lumbosacral plexus of the California sea lion (*Zalophus californianus*) and Northern elephant seal (*Mirounga augustirostris*).

MATERIALS AND METHODS

The investigation was conducted on 10 (4 males and 6 females) California sea lions (*Zalophus californianus*) and 4 (3 males and 1 female) Northern elephant seals (*Mirounga augustirostris*). Upon necropsy at the Marine Mammal Care Center, San Pedro, caudal body segments were transected just cranial to the last two ribs and transported to

the Western University of Health Sciences, Pomona. The bodies were stored in a freezer at -30°C and thawed as needed for dissection. Dissection was performed upon thawing and ventral branches of the lumbosacral plexus were investigated. Emphasis was placed on the nerves that participate in the innervation of the hind limb and caudal part of the body. Results were divided into two groups: one group comprised eared seals (California sea lions - *Zalophus californianus*) and the other group comprised true seals (Northern elephant seal - *Mirounga angustirostris*). For the calculation of the percentage of variations in the origin of the nerves of the lumbosacral plexus data were analyzed by relating the number of nerve origin of the lumbar and sacral nerve of the total number of animals.

RESULTS

Ventral branches of the lumbosacral plexus participate in the innervation of the abdominal wall, hind limb muscles and pelvic wall muscles. In the California sea lion the ventral branch of the first lumbar nerve (*n. iliohypogastricus*) bends ventrally upon exiting the intervertebral foramen, passing in between *m. psoas major* and *m. iliacus*. It reaches the surface of the fascia transversa and peritoneum, hence contacting the abdominal wall, where it divides into the cranial and caudal branch. Both branches of the iliohypogastric nerve have motoric and sensory fibers. As a result their terminal twigs after passing across the muscles of the abdominal wall terminate like sensory fibers of the corresponding dermatome. Immediately upon passing thorough the lateral vertebral foramen the ventral branch of the second lumbar nerve (*n. ilioinguinalis*) splits into a thicker branch that courses toward the abdominal wall (contacting the *fascia transversalis*) and markedly a thinner branch that connects with the cranial branch of the third lumbar nerve. This unified nerve continues alongside the ventral surface of the *m. psoas major* and iliac muscles until it reaches the *os coxae*. Here it interposes itself between the peritoneum and *m. transversus abdominis* and then navigates external to the transversal abdominal muscle, thereby contacting the internal abdominal oblique muscle. Subsequently, it splits into a shorter branch (terminating in the muscle) and a longer branch that reaches the *pecten ossis pubis* where it bends caudoventrally toward the insertion of the abdominal muscles into the pubic bone and the skin of that region (Figs. 1 and 2). The ventral branch of the third lumbar nerve (*n. genitofemoralis*) upon exiting the intervertebral foramen divides into two, or more often, three distinct branches. The most cranial branch is connected with the branch of the *n. ilioinguinalis* in the above described fashion. The middle branch perforates the iliopsoas muscle and then splits into the lateral and medial branch. The lateral branch then assumes its position on the lateral surface of the thigh just ventral to *tuber coxae*. The medial branch however, passes between the internal and external abdominal oblique muscles reaching the pecten of the pubic bone, where it supplies twigs for both of these muscles (Fig. 3). In males this medial branch gives rise to the *ramus genitalis* that passes through the inguinal canal and reaches the *scrotum* (Fig. 4). In females this nerve branch

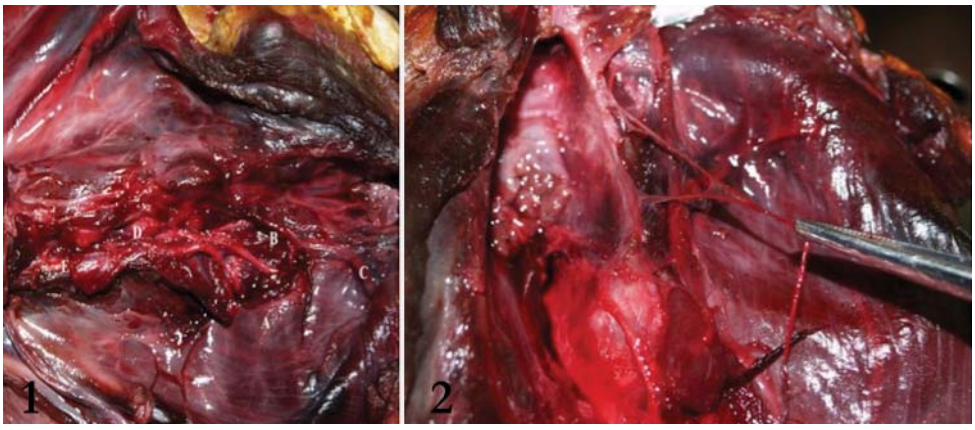

Figure 1. California sea lion: Inguinal region. A) branch n. iliohypogastricus, B) ventral branch of the 4th lumbar nerve for the femoral nerve, C) femoral nerve, D) spermatic nerve, E) testis.
Figure 2. California sea lion: Termination of the right medial twig, middle ventral branch of the 3rd lumbar nerve

is shorter and it reaches the broad ligament of the *uterus*. The caudal branch of the third lumbar nerve is directed caudally through the *psoas major* muscle and reaches the ventral branch of the fourth lumbar nerve, which itself is divided into the cranial and caudal branch. Confluence of the caudal branch of the third lumbar nerve and cranial branch of the fourth lumbar nerve gives rise to the femoral nerve (Fig. 5). Just cranial to this confluence, the caudal branch of the third lumbar nerve gives off a slender branch that courses caudally and merges with the caudal branch of the fourth lumbar nerve, thus giving rise to the obturatorius nerve. Subsequently, it leaves the pelvic cavity at the most cranial edge of the obturator foramen (Fig. 6). The ventral branch of the fourth lumbar nerve immediately upon departing through the intervertebral foramen detaches an additional branch (although not always). This branch courses ventrally to the spinal column to connect with the ventral branch of the 5th lumbar nerve (with its dorsal twig). Both branches are directed caudally alongside the ventral aspect of the spinal column and enter the pelvic cavity, where a branch detaches from the 4th and part of the 5th lumbar nerve giving rise to the gluteal nerve. The gluteal nerve progresses dorsocranially going caudally around the ventral branch of the first sacral nerve towards the cranial edge of the *incisura ischiadica major*. Subsequently, it resurfaces on the lateral side of the *os coxae* on the gluteal surface (Figs. 7 and 8). The ventral branch of the first sacral nerve together with the terminating branch of the 5th lumbar nerve passes through the pelvic cavity aiming towards the widest part of the of *incisura ischiadica major*.

In six specimens the ventral branch of the first sacral nerve detaches a very thin branch (within the pelvic cavity) that traverses under the diffuse connective tissue toward the internal obturator muscle. This nerve perforates the internal obturator muscle and deviates laterally, giving off thin twigs branching out on the lateral side of the external obturator and gracilis muscles (Fig. 9). In addition to the ventral branches

Figure 3. California sea lion: Lateral branch of the 3rd ventral lumbar nerve. A) branch of the 3rd lumbar nerve for n. obturatorius, B) branch of the 4th lumbar nerve for n. obturatorius, C) branch of 4th lumbar nerve for n. femoralis, D) confluence of the 2nd and 3rd lumbar branch, E) exit of lateral branch of the 3rd ventral lumbar nerve toward tuber coxae. **Figure 4.** California sea lion: Left inguinal space. A) spermatic nerve, B) funiculus spermaticus, C) testis. D) muscles of the abdominal wall in the inguinal region. **Figure 5.** California sea lion: Origin of femoral nerve. A) femoral nerve, B) saphenous nerve, C) branch of genitofemoral nerve, D) ventral branch of the 3rd lumbar nerve, E) ventral branch of the 4th lumbar nerve. **Figure 6.** California sea lion: Variation in origin of obturator nerve. A) femoral nerve, B) ventral branch of the 4th lumbar nerve, C) ventral branch of the 5th lumbar nerve, D) obturator nerve, E) ventral branch of the 5th lumbar nerve for obturator nerve. **Figure 7.** California sea lion: Origin of gluteal nerve. A) ventral branch of the 4th lumbar nerve, B) ventral branch of the 5th lumbar nerve, C) ventral branch of the 1st sacral nerve, D) obturator nerve, E) gluteal nerve. **Figure 8.** California sea lion: Lateral side of os coxe. A) gluteal nerve, B) ischiadic nerve, C) hip joint, D) gluteal muscles

of the 5th lumbar and 1st sacral nerve, the 2nd sacral nerve participates in the creation of the lumbosacral trunk that leaves the pelvic cavity at the greater ischiadic incisure. The lumbosacral trunk is caudally continued as the ischiadic nerve.

The ischiadic nerve is composed of two strong nervous branches mutually interconnected with smaller twigs (Fig. 10). Ventral branches of the first and second sacral nerve give off slender branches that course medial to *os coxae* and caudally join the ventral branches of the third sacral nerve. A segment of these nerve branches courses toward the area of the rectum, descending across the ischiadic arch (on the ventral aspect of the pelvis) and branch out in the skin of this region. The caudal cutaneous femoral nerve is composed by the ventral branches of the second, third and less commonly first sacral nerve. This nerve passes in between the vertebral bodies (of the sacral and coccygeal vertebrae) and greater ischiadic incisure in the cranial, and minor ischiadic incisure in the caudal part. Upon reaching the tuber ischii it bends distally toward the caudomedial surface of the thigh. As described above, this is the most common origination scheme for the nerves innervating the abdominal wall, pelvic wall and hind limb. The ventral branch of the fourth sacral nerve innervates the skin and the muscles in the region of the tail.

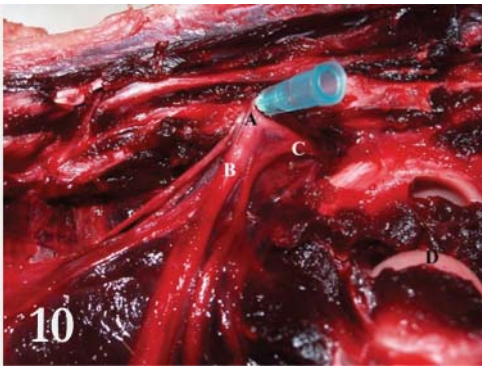

Figure 9. California sea lion: Pelvic cavity. A) obturator nerve, B) ventral branch of 5th lumbar nerve C) ventral branch of the 1st sacral nerve, D) twig of the 1st sacral nerve that passes through internal obturator muscle. **Figure 10.** California sea lion: Major ischiadic incisure. A) prominent branch of ischiadic nerve, B) weaker branch of ischiadic nerve, C) nervous twigs connecting both branches. D) head of femur

Some specimens exhibited variability in terms of origin of some nerves of the lumbosacral plexus. In most cases (8 specimens) the femoral nerve was created from the ventral branches of the 3rd and 4th lumbar nerves. However in 2 specimens it was created by the 3rd, 4thand 5th lumbar nerves (Table 1). The obturatorius nerve was originated by ventral branches of the 3rd and 4th lumbar nerve in seven specimens, whereas in three specimens the 3rd, 4th and 5th lumbar nerves were identified. The ischiadic nerve originated form the ventral branches of the 5th lumbar, 1st and 2nd sacral nerves in five specimens. In one specimen the 4th lumbar, 5th lumbar, 1st and 2nd sacral nerves give rise to the ischiadic nerve. However, in three specimens the 5th lumbar,

1st and 2nd sacral nerves were joined by a weak branch of the 3rd lumbar nerve (Table 1). The gluteal nerve is unified at the greater ischiadic inscisure (where it departs the pelvic cavity) and originated form the ventral branch of the 5th lumbar nerve in seven specimens. However, the 4thand 5th lumbar nerves gave rise to the gluteal nerve in three specimens (Table 1). The caudal cutaneus sural nerve rose from the ventral branches of the 1st, 2nd (second is the most prominent) and 3rd sacral nerves in eight specimens. In two specimens this nerve was originated by the ventral branches of the 2nd and 3rd sacral nerves (Table 1). Ventral branches of 3rd sacral (with some participation of the 2nd sacral) nerves participate in the creation of the cluneal nerves in nine specimens, whereas in just one female they are solely constituted by the ventral branches of the 3rd sacral nerve (Table 1).

Table 1. Variations in the origin of nerves of the lumbosacral plexus in the California sea lion

ID# and gender	Femoral nerve	Obturatorius nerve	Ischiadic nerve	Gluteal nerve	Cut. fem. caud. nerve	Pudendal nerve	%
80♀	3L, 4L	3L,4L,5L	4L,5L, 1S,S2	4L,5L	S2,S3	S2,S3	10
100♂	3L,4L	3L,4L,5L	4L,5L,S1,S2	4L,5L	S1,S2,S3	S2,S3	10
87♂	3L,4L,5L	3L,4L,5L	5L,1S,2S	5L	S1,S2,S3	S2,S3	10
289♂	3L,4L	3L,4L	5L,S1,S2	4L,5L	S2,S3	S3	10
66♀	3L,4L	3L,4L	5L,1S,2S	5L	S1,S2,S3	S2,S3	10
63♀	3L,4L	3L,4L	5L,1S,2S	5L	S1,S2,S3	S2,S3	10
171♀	3L,4L	3L,4L	5L,S1,S2	5L	S1,S2,S3	S2,S3	10
292♀	3L,4L	3L,4L	5L,S1,S2	5L	S1,S2,S3	S2,S3	10
255♂	3L,4L	3L,4L	5L,S1,S2	5L	S1,S2,S3	S2,S3	10
276♀	3L,4L	3L,4L	5L,S1,S2	5L	S1,S2,S3	S2,S3	10

Table 2. Variations in the origin of nerves of the lumbosacral plexus in the Northern elephant seal

ID# and gender	Femoral nerve	Obturatorius nerve	Ischiadic nerve	Gluteal nerve	Cut.fem. caud. nerve	Pudendal nerve	%
36♀	3L,4L	3L,4L,5L	4L,5L,1S	4L,5L	S1,S2.S3	S2,S3	25
204♂	3L,4L	3L,4L,L5	L4,5L,1S,2S	5L	S1,S2,S3	S2,S3	25
272♂	3L,4L,5L	3L,4L,5L	L4,5L,1S	L4,5L	S1,S2,S3	S2,S3	25
223♂	3L,4L,L5	3L,4L,L5	L4,5L,1S,2S	4L,5L	S1,S2,S3	S2,S3	25

Course and origination of the same nerves in the Northern elephant seal (*Mironuga augustirostris*) is similar. Hence the femoral nerve rises from the ventral branches of the 3rd and 4th lumbar nerves in two specimens and from the 3rd, 4thand 5th lumbar in other two specimens. Similarly, the obturatorius nerve originates via connection of the ventral branches of the 3rd, 4thand 5th lumbar nerves in three specimens, however in

one female specimen it originates from the ventral branches of the 4th and 5th lumbar nerves. The ischiadic nerve springs up from the ventral branches of the 4th, 5th lumbar, 1st and 2nd sacral nerves in two specimens, whereas in other two specimens the 2nd sacral addition was not evident (Table 2). The gluteal nerve originated from ventral branches of the 5th lumbar and 1st sacral nerves in three specimens, however in one the 4th and 5th lumbar nerves gave rise to it (Table 2). The ventral branch of the 3rd lumbar nerve is relatively weak, thus is does not participate in the innervation of the hind limb. It just gives twigs that coalesce with branches of 1st and 2nd sacral nerves giving rise to the caudal cutaneous sural and cluneal nerves. The caudal cutaneous sural nerve originates from ventral branches of the 1st, 2nd and 3rd sacral nerves, which makes it different than in California sea lions. Northern elephant seals exhibit a stronger ventral branch of the 2nd sacral nerve and somewhat weaker branch of the third sacral nerve that originates cluneal nerves (Fig. 11) (Table 2). The space between the ventral aspect of the sacral bone and pelvis is very narrow, therefore the sacral plexus is not positioned ventral to the sacrum such is the case in California sea lions. This plexus is positioned at the lateral aspect in between the major ischiadic inscisure and three sacral vertebrae (Fig. 12). In both, the California sea lion and Northern elephant seal the sacral plexus is not comprised like in domestic mammals. Namely, the gluteal nerve rises from the plexus as a single entity which branches out upon passing across the major ischiadic incisure. The ischiadic nerve is not a unified nervous trunk when it courses across the major ischiadic incisure. Instead it is comprised of two strong separated branches that communicate via numerous twigs. One strong branch bends cranioventrally in between the distal part of the biceps femoris muscle and insertion extremity of the vastus lateralis (peroneus nerve). The second stronger branch navigates moderately caudoventrally onto the medial aspect of the crus dispatching numerous twigs (tibial nerve). It can be stated that at least two prominent nerves (tibial and fibular nerve) innervate the hind quarters and hind limb in these two species, which needs to be thoroughly studied in future investigations.

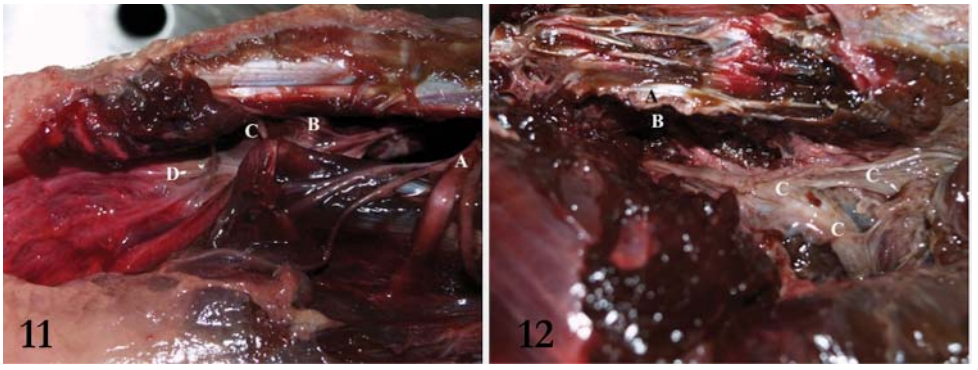

Figure 11. Northern elephant seal: caudal segment of major ischiadic incisure. A) ischiadic nerve with muscular branches of ischiadic nerve, B) ventral branch of the 2nd sacral nerve, C) ventral branch of 3rd sacral nerve, D) cluneal nerves. **Figure 12.** Sacral plexus in Northern elephant seal: left side. A) sacral bone, lateral side B) major ischiadic incisure, C) nerves of the sacral plexus

DISCUSSION

In order to correctly describe the lumbosacral plexus, we incidentally concluded that the California sea lion has three and Northern elephant seals four sacral vertebrae. Even though morphological descriptions of the lumbar and sacral spinal column are not uncommon literature data significantly differs. Murie [4] states that the California sea lion has four sacral vertebrae, whereas Freea [9] lists just three sacral vertebrae. Dierauf and Gallarad state that in pinnipedia the number varies between 3-5 sacral vertebrae, taking in consideration the age of the animal and the possibility of physiological and pathological fusion of the vertebrae (ankylosis).

Descriptions of the lumbosacral plexus are considerably uncommon, hence different fidings are reported. During our investigation we concluded that there is a prominent similarity in the origin of the femoral nerve in the California sea lion and the Northern elephant seal. In most specimens it rises from the ventral branches of the 3rd and 4th lumbar nerves. However, in just a small number of cases (10%) in California sea lions the 5th lumbar nerve will contribute to the femoral nerve. This indicates steadiness in the origination of the femoral nerve. On the other hand in Northern elephant seals in 50% of the specimens the femoral nerve originates from the 3rd and 4th lumbar nerves, and in the other half it originates from the 3rd, 4th and 5th lumbar nerves. Because we investigated just four specimens it is not possible to determine which variance is predominant, namely which one can be regarded as the reference value. It can be assumed that the femoral nerve rises from the cranial most ventral branches of the lumbar nerves, which differs from domestic mammals such are the dog and pig. If we take the above mentioned femoral nerve origin ratio as credible (despite the small number of animals investigated) and compare it with the origination of the same nerve in the dog and pig, we would see a greater similarity in the steadiness of variability [33,36,37]. The obturatorius nerve shows a somewhat greater variability as in 30% of specimens it rises from the ventral branches of the 3rd, 4thand 5th lumbar nerves, whereas in 70% of specimens it originates from (as femoral nerve) ventral branches of the 3rd and 4th lumbar nerve. In Northern elephant seals the origin of the obturatorius nerve is more consistent, because in all specimens it rose from the ventral branches the 3rd, 4th and 5th lumbar nerve. Our findings differ significantly from the findings of Murie [4] which include the obturatorius nerve into nerves of the sacral plexus and state that it originates from the ventral branch of the 1st sacral nerve. Murie's [4] findings can be in part justified by one slender branch (in numerous specimens) that courses toward the internal obturator muscle. The origin of the nerves is important for understanding of both the femoral and obturatorius nerve, however the thickness of nerve fibers is also very important. In all specimens the 4th ventral branch of the lumbar nerve was the strongest. However the ventral branch of the 3rd lumbar nerve was often very thin. At the same time the site of coalescence of these branches also differed from specimen to specimen. In some instances the femoral and obturatorius nerves were formed more cranially and in some occasions more caudally and ventrally.

We noticed that the femoral and obturatorius nerves originate form the same site in just four specimens, hence demonstrating their great aberrancy in this regard.

The ischiadic nerve did not show significant discrepancies in origination in California sea lions, because the ventral branch of the 2nd sacral nerve participated in just 20% of the specimens. However, in Northern elephant seals (such as in the case of the femoral nerve), in 50% of the specimens the nerve originated from the ventral branches of the 4th and 5th lumbar and 1st sacral nerve, whereas in the other 50% of the specimens it had an additional branch from the 2nd sacral nerve. It can be assumed that the cause for this mode of origin of the ischiadic nerve in Northern elephant seals is due to the existence of just 3 sacral vertebrae. This assumption is supported by understandings of Flecher [38] who lists three types of origination for nerves of the lumbosacral plexus in the dog, and Mihelic et al. [36] in the pig.

The gluteal nerve has significantly more variations in its origination (California sea lion, four specimens), whereas in the Northern elephant seal we recorded differences in just one specimen. It is interesting that in these two animal species we did not notice more types of origination of different nerves. We observed just two variations in the origination of the femoral, obturator, ischiadic and gluteal nerves. However, in domestic mammals these variations are much more numerous [33,35-39]. When we assessed the specimens with variations in origin of the femoral, obturatorius, ischiadic and gluteal nerves in California sea lions we noticed that they involved the same specimens (two males and single female). In one female and one male there was a variation in the origination of the femoral, obturatorius, ischiadic and gluteal nerves. In the second male, variations were observed in the origination of the femoral and obturatorius nerve. In addition two males had variations in the origination of the gluteal nerve. Because we investigated a small number of specimens we could not relate them to the gender, even thought they were more common in male specimens. It is more likely that variability in the making of the lumbosacral plexus is an individual trait. We are of similar opinion regarding the variations in origin of the lumbosacral plexus in the Northern elephant seal.

Femoral and obturatorius nerves in California sea lions rise from ventral braches of the 3rd and 4th lumbar nerves. Variations in origin of the femoral nerve are rare (one specimen), while they are more common with the obturator nerve (three specimens). The ischiadic nerve rises by combining the ventral branch of the 5th lumbar, 1st and 2nd sacral nerves (variability noticed in two specimens). The gluteal nerve predominantly originates from the ventral branch of the 5th lumbar nerve, less commonly ventral branches of the 4th and 5th lumbar nerves participate together. Caudal cutaneous femoral and pudendal nerves originate from the ventral branches of the 1st, 2nd and 3rd sacral nerves, whilst the ventral branch of 4th sacral nerve gives off twigs for tail muscles and skin at the root of the tail. The network of ventral branches of the sacral nerve gives off a slender nerve (in most specimens) that passes underneath the peritoneum of the pelvic cavity on its way toward the internal obturator muscle. This specific nerve perforates the internal and external obturator muscles, thus reaching

the lateroventral aspect. Variations in origin of the obturator nerve were not noticed in Northern elephant seals. However, the origin of the femoral and ischiadic nerves showed variability in two specimens, while one specimen exhibited variability in the origin of the gluteal nerve. The sacral plexus in California sea lions is formed ventral to the sacral bone. However, in Northern elephant seals (due to narrowness of the pelvic cavity), the plexus is formed laterally in between the major ischiadic inscisure and lateral aspect of the sacral bone and the first tail vertebra. At this site, fibers detach (chiefly from the ventral branches of the 2ndand 3rdsacral nerves), and course caudomedially toward the anal region comprising cluneal nerves. The caudal cutaneous sural nerve is predominately formed from the ventral branches of the 1st and 2nd sacral nerves. The sacral bone is composed from just three sacral verterbrae, hence there are just three sacral nerves. In both species we identified aberrations in origin of nerves of the lumbosacral plexus, however in just two variants. It is plausible that these variations could be more numerous. This assumption is derived from our experience in investigating the lumbosacral plexus of domestic mammals. As our investigations were preformed on a small number of animals, we anticipate that future investigations can expand our understanding of this topic.

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FORMIRANJE NERAVA IZ LUMBALNOG I SAKRALNOG PLEKSUSA KOD KALIFORNIJSKOG MORSKOG LAVA (*ZALOPHUS CALIFORNIANUS*) I SEVERNOMORSKOG SLONA (*MIROUNGA ANGUSTIROSTRIS*)

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Ispitivan je lumbosakralni pleksus kod kalifornijskih morskih lavova i severnomorskih slonova. Kod devet kalifornijskih morskih lavova i kod dva severnomorska slona, fermoralni nerv je polazio iz ventralne grane trećeg i četvrtog lumbalnog nerva dok je kod jednog mužjaka i dva primerka severnomorskog slona bio uključen i peti lumbalni nerv. Ventralne grane trećeg i četvrtog lumbalnog nerva formiraju n. obturatorius i to kod sedam životinja; kod tri jedinke peti lumbalni nerv takođe doprinosi formiranju n. obturatorius. Kod severnog morskog slona, *n. obturatorius* se formira iz ventralne grane trećeg, četvrtog i petog lumbalnog nerva. *N. ischiadicus* potiče iz ventralnih grana četvrtog i petog lumbalnog kao i iz prvog sakralnog nerva i to kod 8 jedinki kalifornijskog morskog lava i kod dve životinje vrste severnomorski slon. Kod po dve životinje obe vrste, drugi sakralni nerv takođe učestvuje u formiranju *n. ischiadicus*-a.

Glutealni nerv je formiran od ventralnih grana petog lumbalnog i prvog sakralnog nerva i to kod tri jedinke; međutim, kod jednog severnomorskog slona, četvrti i peti lumbalni nerv su takođe učestvovali u formiranju glutealnog nerva. Kod kalifornijskih morskih lavova, kod sedam ispitivanih životinje n. glutealis je polazio iz ventralnih grana petog lumbalnog nerva ali je kod tri jedinke četvrti lumbalni nerv takođe učestvovao u formiranju glutealnog nerva.