Effect of NaCl on the coacervate volume with 20 m. aeq. $CaCl_2$

Conc. Na Cl in m. aeq p.l.	Coacervate volume in 0.01 cc.
—	3.35
20	3.3
50	3.6
120	4.0
400	4.6
560	4.4

We see here that as may be expected from the theory of the autocomplex systems, NaCl causes an increase of the water percentage (here = coacervate volume). But this influence will be the less evident, as the $CaCl_2$ concentration which is kept constant is chosen higher. With 80 resp. 160 m.aeq. $CaCl_2$ this can no longer be seen as a pronounced increase of the coacervate volume.

SUMMARY.

1. We measured the coacervate volumes of phosphatide sols coacervated with salts (chlorides), the order of increasing volume was found to be:

$$Ca < Mg < Sr < Ba < Li < Na$$

2. This order is the one of increasing reversal of charge concentration.
3. The theory of autocomplex coacervation foresees that in the order of increasing reversal of charge concentrations the water percentage of the coacervate will increase with optimal coacervation.

With phosphatide coacervates the coacervate volume is a measure for the water percentage of the coacervate and as moreover, the reversal of charge concentrations increase in the order:

$$Ca < Mg < Sr < Ba < Li < Na$$

the results of 1 may be fully expected.

4. With not too great $CaCl_2$ concentrations the coacervate volume increases with increasing NaCl concentration. This effect (increase of the water percentage) is also to be foreseen from the theory of autocomplex coacervation.
5. The significance of the foregoing for the problem of the nature of the protoplasmic membrane was touched upon.

Leiden, Laboratory for Medical Chemistry.

Anatomy. — *Biologic-anatomical Investigations on the Bipedal Gait and Upright Posture in Mammals, with Special Reference to a Little Goat, born without Forelegs.* II.

By E. J. SLIJPER (Utrecht). (From the Institute of Veterinary Anatomy of the State University, Utrecht, Holland; Director Prof. Dr. G. KREDIET.)

(Communicated at the meeting of March 28, 1942.)

5. **Length of the ilium, m. glutaeus medius.** HOWELL (25) and ELFTMAN (14) tried to demonstrate, that in bipedal Rodents and Marsupials the ilium was proportionally shorter than in their quadrupedal relatives. WATERMAN (64) on the contrary believes, that in upright going Primates the ilium is longer than in quadrupedal monkeys. These authors, however, used either the length of the whole ilium, or the length of the iliac blade as a fixed dimension to compare with the postsacral part of the ilium. For this postsacral part is the only part of the ilium, which is directly connected with the transmission of the body-weight to the supporting leg. My own researches surely showed that only the body-length may be used as a standard dimension, with which the dimensions of the pelvis may be compared.

The data given in table 3 show, that in all bipedal and upright going mammals, with the exception of man, the ilium has been lengthened. In most mammals this lengthening exclusively has been brought about by a lengthening of the presacral part of the ilium (the iliac blade). Only in hanging-climbing mammals the postsacral part too is a little elongated. It is further shown, that the length of the postsacral part of the ilium only to a very small extent depends on statical or mechanical forces. The length of this part is chiefly connected with the demands of space in the pelvis. Together with the length of the sacrum, the width of the lumbo-sacral and the width of the ilio-lumbar angle, the length of the postsacral part of the ilium determines the position of the pelvic inlet. The longer the sacrum and the narrower the ilio-lumbar angle are, the longer the postsacral part of the ilium must be, in order to bring the pelvic inlet in a plane that lies caudal to the last sacral vertebra (see for example *Capra hircus* L. and the Primates).

As we have seen above, in bipedal mammals the ilium has been elongated by an increase in length of its presacral part. This is easy to understand, because the length of the ilium determines the length of the fibres of the m. glutaeus medius. In consequence it determines the width of the angle that the upright or semi-upright body can make with the horizontal plane. Hence in the series of climbing, bipedal jumping and hanging-climbing mammals, the length of the ilium and in consequence the length of the gluteal fibres increase gradually. But in man, whose body is perfectly upright and kept in balance on the lower extremities, the ilium is comparatively short and the m. glutaeus medius shows a comparatively weak development. The broadening of the ala ilii is connected with the broadening of the whole body in anthropoids and man [SLIJPER (61)].

In the bipedal goat, which could not very easily attain an upright posture since it had no tail acting as a counterweight to the body, one might have expected, that the ilium would have been very long. Table 1, however, shows that this bone is nearly as long as in the control-animal. This may easily be understood since in the goat — as in most Ungulates — the length of the fibres of the m. glutaeus medius only to a certain extent depends on the length of the ilium. In the greater part of the Ungulates the muscle originates not only from the ala ilii but also, by the so-called gluteal tongue, from the superficial aponeurosis of the m. longissimus dorsi in the lumbar region cranial to the iliac crest (fig. 4). This gluteal tongue is absent in *Proboscidea* [CUVIER (11), MIALL and GREENWOOD (40), EALES (13)], *Rhinocerotidae* [HAUGHTON (22)], *Camelidae* (own observations) and *Dicotyles tajacu* (L.) [CUVIER (11)]. The tongue is comparatively small in the pig and all Ruminants [see for example KOLESNIKOV (31) and REISER (51)], but it shows a large development in the *Equidae* and especially in the *Tapiridae* [MURIE (42), CUVIER (11)]. The tongue is absent in all other mammals, the bipedal mammals included [CUVIER (11; *Macropus*), PARSONS (48; *Pedetes*), HOWELL (25; bipedal Rodents)]. Only in the kangaroo-rat (*Dipodomys*) HOWELL (25) described a small gluteal tongue.

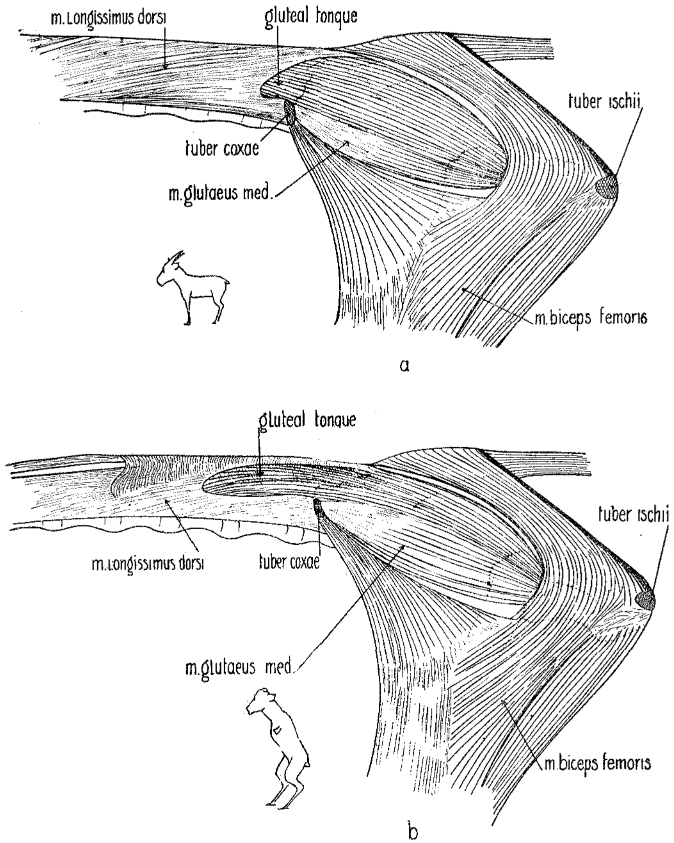

Fig. 4.
Lateral view (left side) on the muscles of the pelvic region in the normal (a) and the bipedal (b) goat. Special notice should be taken of the tongue of the m. glutaeus medius.

In the normal quadrupedal goat the tongue had a length of 25 mm. In the bipedal animal it had a length of 50 mm; moreover it was much thicker and it originated not only in the normal way from the superficial aponeurosis of the longissimus dorsi by fleshy fibres, but also by a system of comparatively long and flat superficial tendons, which were attached to the aponeurosis and the fascia lumbo-dorsalis in the median line (fig. 4). FULD (17) and KOWESCHNIKOWA und KOTIKOWA (32) found in the bipedal dog and cat only an increase of weight of the m. glutaeus medius. In the bipedal goat the m. glutaeus accessorius too showed a better development than in the control animal.

6. Length of the ischium. The data of table 3 show, that in the series of walking, climbing, bipedal jumping, hanging-climbing mammals and man, there has taken place a very marked increase in length of the ischium. ALEZAIS (2) has already shown for the kangaroo, that the lengthening of the ischium causes an increase in length of the hamstring-muscles and that it enables the adductor muscles to act as retractor muscles too. In consequence the lever-arm of the muscles that bring the body in an upright posture, is lengthened and the angle of erection widened. Moreover, the distance over which the femur can be moved when the animal jumps, is enlarged to a comparatively great extent. Thus the marked increase in length of the ischium of the bipedal goat (23 %; table 1) should not cause a surprise.

7. Symphysis pelvis. As has already been shown sub 1, the factors determining the length of the symphysis pelvis, are the weight that is supported by the hindlegs, the power of the propulsive stroke of this leg, the position of the acetabulum with regard to the ilio-sacral joint, as well as the manner of locomotion of the animal. So it appeared from the large amount of data given by MIJSBERG (45), that in quadrupedal mammals the length of the symphysis especially depends on the absolute size of the animal and its manner of locomotion (jumping or not). In bipedal mammals the position of the acetabulum does not differ very much from that in their quadrupedal relatives; only in the anthropoid apes the pelvis is very broad at the acetabular joint, to give the animal a large supporting surface. In opposition to the conclusions of ELFTMAN (14) and WEIDENREICH (65), but in accordance with the data of MIJSBERG (45) and HOWELL (25), table 3 shows, that — with the exception of man (see sub 1) — in all bipedal and upright mammals there has taken place an increase in length of the symphysis pelvis.

In spite of the position of the acetabulum (see sub 8), the large weight supported by the pelvis and the unfavourable position of the body (see sub I), have caused in the bipedal goat an elongation of the pelvic symphysis (27 %) and a marked thickening of the ischium and pubis (table 1, fig. 3).

8. Width of the pelvis. The data given in table 3 show, that in all bipedal and upright mammals the whole pelvis is wider than in allied quadrupedal animals. The widening of the pelvis enlarges the supporting surface of the hindlegs. This is especially striking in Primates [see also VAN DEN BROEK (7) and SLIJPER (61)]. A special divergence of the ischia or a convergence of the ilia does not occur in bipedal mammals.

Besides a small widening of the pelvic inlet, the bipedal goat on the contrary showed a very striking narrowing of the pelvis at the acetabulum and a compensating divergence of the ischia (table 1, fig. 5). Perhaps the pelvis of the bipedal cat, described by KOWESCHNIKOWA und KOTIKOWA (32) showed the same characters. Most probably the width of the pelvis at the acetabulum decreased in the bipedal goat in order to diminish the exorotating force, which in this animal was extraordinarely large (unfavourable position of the body; no long tail). For if the acetabulum lies almost in the same paramedian plane as the ilio-sacral joint, at least one of the forces that cause the exorotation is considerably diminished. In relation to the width of the supporting surface the decrease

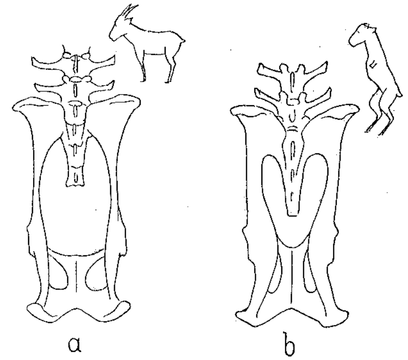

Fig. 5.
Dorsal view on the pelvis of the normal (a) and the bipedal (b) goat.

of the transverse diameter at the acetabulum partly is compensated by a lengthening of the collum femoris (see sub II and table 1).

9. Ligaments. In connection with the large body-weight that is transmitted to the ischium by the broad pelvic ligaments, it is not surprising at all, that in the bipedal goat these ligaments showed a very strong development.

10. Psoas musculature. On the whole the psoas musculature of the bipedal goat was apparently more feebly developed than in the normal one. The m. psoas maior originated only from the lumbar vertebrae (in the control-animal from the last thoracic vertebra too), the m. iliacus medialis originated only from the pelvis and the first sacral vertebra (in the control-animal from the last lumbar vertebra too), the m. psoas minor originated only from the centra of the 2d—last lumbar vertebra (in the control animal from the last thoracic until the last lumbar vertebra) and the area of insertion of this muscle at the pelvis was only half as large as in the quadrupedal goat. KOWESCHNIKOWA und KOTIKOWA (32) made the same observations in the bipedal cat, the weight of the m. iliopsoas amounted to only 87½ % from that of the quadrupedal animal.

The diminution of the psoas musculature may be explained by the fact, that in quadrupedal animals these muscles prevent the postsacral part of the pelvis from turning in a dorsal direction in consequence of the shock caused by the hindleg, when this comes down on the ground. In those bipedal animals that have no long tail the body-weight causes a rotation of the vertebral column in the ilio-sacral joint (see sub 1). This rotation neutralizes the dorsal rotation of the postsacral part of the pelvis. In bipedal animals its power is much larger than in quadrupedal ones, because the body-weight is not partly supported by the forelegs. In bipedal animals with a long and heavy tail, however, the body-weight is nearly counterbalanced by the weight of this tail. For that reason the psoas musculature of hanging-climbing mammals shows a comparatively feeble development [PRIEMEL (49)], while in bipedal Rodents and Marsupials especially the m. psoas minor is largely developed [PARSONS (47), SCHAPIRO (55), ELFTMAN (14)].

IV. *Thorax.*

In the normal quadrupedal land-mammals the shape of the thorax is characterised by: 1st. The fact that its walls are converging very markedly in a cranial direction; the thorax therefore has the shape of a bow-net. 2d. The fact that the proximal parts of the ribs are not, or at best to a very small degree, curved in a dorsal direction. 3d. The fact that in the middle of the thorax its transverse diameter is nearly as long as its vertical diameter. 4th. The fact that the lateral walls of the thorax converge very markedly in a ventral direction and that the sternum is very narrow. Among these quadrupedal land-mammals, however, two different types of the thorax again can be distinguished. The majority of the *Marsupialia*, the *Insectivora*, the smaller *Rodentia* and *Carnivora*, the *Prosimii* and the not-anthropoid *Simii* have an apertura thoracis that is more broad than high. The scapula of these animals is ventro-laterally directed (it makes an angle of average 45° with the vertical plane); the clavicula is long and dorso-laterally directed (see table 4 and fig. 6). In the bigger representatives of the above-mentioned orders and in general in the animals that show a more or less running type of locomotion [*Thylacinus, Cuniculus paca* (L.), *Leporidae*, majority of the *Carnivora* and all *Ungulata*; see fig. 1, 6, table 4 and SLIJPER (61)] the clavicula is very small or even wanting, the scapula shows a vertical position in the paramedian plane, or may even be ventro-medially directed, while the cranial part of the thorax is much more high than broad.

HASSE (20) made researches into the different shapes of the thorax in mammals. Previously I have already shown [SLIJPER (60)], that his denomination "kielförmig" better might be replaced by the name "reusenförmig" (shaped like a bow-net). Moreover from HASSE's considerations it does not appear very clearly to what causes these differences in the shape of the thorax must be ascribed. Most probably HASSE supposes

that the ribs are more or less deformed by the tension of the pectoral and serratus-musculature. It seems, however, better to accept, that everywhere in the thorax the bony substance of the thoracic wall arises in that direction in which it can resist the statical and mechanical forces in the best way. Moreover the shape of the thorax partially may be influenced by the fact, that the distribution of space in the thoracic cavity determines the position of the centre of gravity. So in running and especially in heavy mammals,

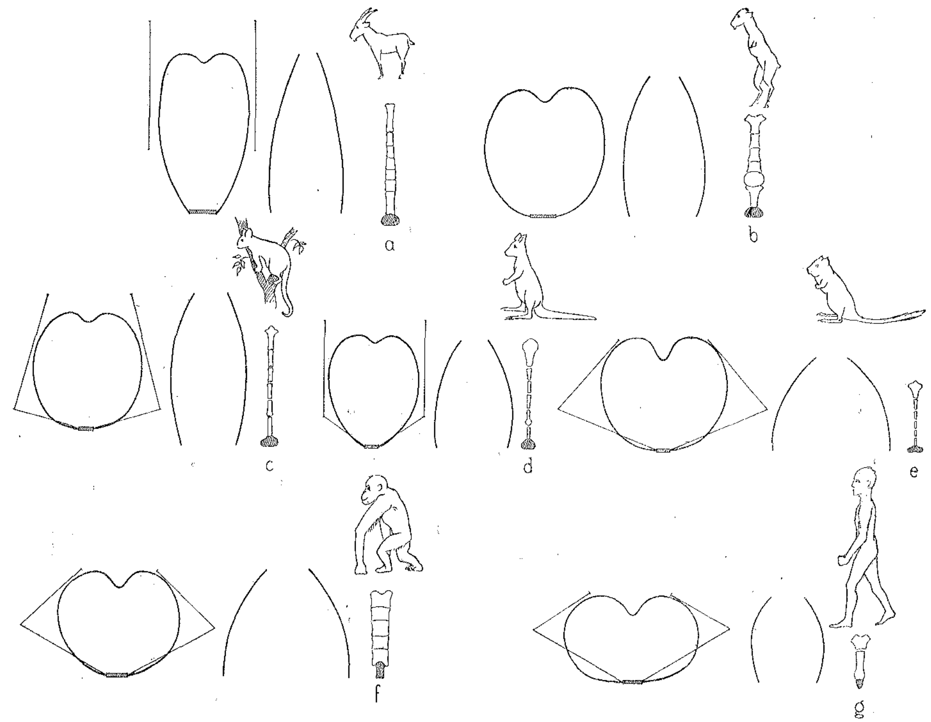

Fig. 6.

Schematic figures of the thorax of the different types of mammals, described in this paper. a. Normal goat (*Capra hircus* L.; running mammal). b. Bipedal goat. c. Cuscus (*Trichosurus vulpecula* (Kerr.); climbing Marsupial). d. Kangaroo (*Macropus giganteus* (Zimm.); bipedal, jumping Marsupial). e. Jumping-hare (*Pedetes caffer* (Pall.); bipedal jumping Rodent). f. Orang Utan (*Pongo pygmaeus* (Hoppius); hanging-climbing anthropoid ape). g. Man (*Homo sapiens* L.; bipedal walking Primate).

Every figure shows: Left: Transverse section of the cranial part of the thorax with the position of the scapula and the clavicula. Middle: Horizontal section of the thorax in the middle of the ribs. Right: Sternum from the ventral side.

the flat thorax enables the supporting foreleg to approach as nearly as possible the median plane (that is the plane in which the body-axis lies), while the nearly vertical ribs transmit the power from the body to the leg in the most favourable way. On the other hand, in these mammals the mobility of the foreleg has been considerably limited.

HASSE (20) thought that in every mammal whose body-weight is not supported by the forelegs, the thorax would acquire the shape of a barrel. Together with man and the anthropoid apes, however, he reckons among the mammals with a barrel-shaped thorax also the bipedal jumping Marsupials and Rodents as well as the aquatic mammals. I shall try, however, to demonstrate that this question is much more complicated than one can read from the work of HASSE.

In quadrupedal and especially in running mammals the body-axis has a horizontal position; the animals have an almost vertical scapula that lies very near to the body-axis and their upper arm forms part of the body (table 4, fig. 6). In climbing mammals the body-axis now and than is brought in a vertical position, the axis of the scapula as a rule is directed ventro-laterally and in many species the upper arm is almost perfectly free (see for example *Phascolarctos* and the Monkeys). All bipedal jumping mammals

TABLE 4. SOME CHARACTERS OF THE THORAX IN MAMMALS

Species	Clavicula 1)	Position of scapula 2)	Greatest breadth in % of height: Apertura thoracis	Greatest breadth in % of height: Middle of thorax	Dorsal curvature of ribs 3)	Number of ribs	Walls in % of body-length: Dorsal	Walls in % of body-length: Ventral (sternum)	Sternum in % of dors. wall	Sternum breadth in % of length: 1st rib	Sternum breadth in % of length: 4th rib
Equus caballus L. (dom.)	–	v.	56	87	–	18	49	21	44	3	10
Bos taurus L. (dom.)	–	v.	50	71	--	13	48	21	44	3	25
Lama glama (L.)	–	v.	62	86	--	12	33	22	63	6	13
CAPRA HIRCUS L. CONTROL	–	v.	40	55	--	13	41	26	62	6	15
CAPRA HIRCUS L. BIPEDAL	–	v.	48	105	+	12	40	23	57	10	21
Average of running mammals	–	v.	52	75	--	14	43	22	53	5	16
Sus scrofa L. (dom.)	–	v.	70	85	–	14	48	20	40	2	19
Canis familiaris L.	–	v.	140	115	–	13	39	28	71	5	5
Thylacinus cynocephalus (Harris)	–	v.	100	66	--	13	44	27	62	11	8
Lepus europaeus Pall.	±	v.	100	87	±	12	41	27	69	5	5
Average of walking mammals	–	v.	102	88	–	13	43	25	60	6	9
Trichosurus vulpecula (Kerr.)	+	i.	140	93	–	13	50	27	55	10	9
Phascolarctos cinereus (Goldf.)	+	i.	150	121	+	11	45	24	52	31	11
Sciurus vulgaris L.	+	i.	153	108	±	12	45	33	75	17	7
Anomalurus beecrofti Fraser	+	i.-h.	500	120	+	15	40	20	50	30	10
Cebus apella (L.)	+	i.	110	88	±						
Trachypithecus pyrrhus (Horsf.)	+	i.-h.	200	122	±	12	41	29	70	17	8
Average of climbing mammals	+	i.-h.	209	109	±	13	44	27	60	21	9
Dendrolagus inustus Müll.u.Schleg.	+	v.	180	84	±	13	45	31	70	14	7
Bettongia lesueuri grayi Gould	+	v.				13	43	29	67	14	11
Macropus giganteus (Zimm.)	+	v.	100	100	+	13	46	28	60	18	18
Pedetes caffer (Pall.)	+	i.	600	140	++	11	35	20	57	34	10
Jaculus jaculus (L.)	+	i.	600	160	+	12	35	30	62	25	8
Average of bipedal jumping mammals	+	i.-v.	370	121	+	12	41	28	63	21	11
Ateleus paniscus (L.)	+	h.	165	130	±	14	56	29	52	29	15
Hylobates lar leuciscus Geoffr.	+	h.	112	150	+	13	51	17	32	64	30
Pongo pygmaeus (Hoppius)	+	h.	131	119	+	11	63	26	41	38	34
Average of hanging-climbing mamm.	+	h.	136	133	+	13	56	24	42	44	26
Homo sapiens L.	+	h.	240	161	++	12	49	28	56	40	22
Pteropus spec.	+	h.	200	150	++						

1) + = Clavicula present. ± = Clavicula very small. – = Clavicula wanting.
2) v. (h.,i.) = Scapula has a vertical (horizontal, intermediate) position.
3) ++ = Proximal parts of ribs show a great curvature in dorsal direction.
+ = Curvature distinctly visible but not so high. ± (–, --) = Proximal parts of ribs are directed laterally (ventro-laterally ; ventrally).

are characterized by a nearly free humerus and a body-axis that makes an angle of average 45° with the horizontal plane. The bipedal Marsupials have an almost vertical scapula lying close to the body-axis; the bipedal Rodents on the contrary have a latero-ventrally directed scapula. The relative shortening of the thorax in bipedal Rodents (table 4) must be ascribed to a lengthening of the lumbar region. In hanging-climbing mammals the position of the body-axis is almost vertical, the upper arm is perfectly free and shows a great mobility, the scapula is directed so much laterally that it has a nearly horizontal position. Quite naturally the above-mentioned characters of the apes are extremely developed in man. KNAUER (30), LOTH (34) and other authors have shown, that in hanging-climbing mammals and man the body is shortened. This shortening, however, principally bears upon the lumbar region [KEITH (29), SCHULTZ (57, 58), PRIEMEL (49), WILLIS (67)], so that the thorax proportionally is lengthened [SCHULTZ (58)]. Finally in the flying mammals the position of the body-axis is mostly vertical, the scapulae have a nearly horizontal position and the upper arm is quite free and very mobile.

In adaptation to the above-described characters of the body and the anterior extremity, the following changes of the thorax have taken place (table 4, fig. 6): The climbing mammals only show an increase of the transversal and a decrease of the sagittal diameter of the apertura thoracis and the cranial part of the thorax. Moreover the first sternebra is much broader than in walking mammals. Besides the just mentioned characters, the bipedal Marsupials show a slight curvature of the proximal parts of their ribs in a dorsal direction. In the bipedal Rodents this curvature is more pronounced, the cranial part of the thorax is a little widened, the caudal part is very much widened and everywhere in the thorax the transverse section shows the beginning of a decrease of the sagittal and an increase of the transversal diameter. Finally in the hanging-climbing mammals and especially in man we meet a thorax with a very low sagittal and a very broad transverse diameter. The transverse section of this thorax has the typical oval shape, which is well known in man. The ribs show a pronounced curvature in the dorsal direction, by which the greater part of the space in the thorax is found at the dorsal side. The thoracic inlet and the cranial part of the thorax are much enlarged. In consequence of this enlargement the thorax has got the shape of a barrel, which HASSE (20) already described as the typical shape of the thorax of man. Finally the whole sternum is shortened and broadened to a very marked extent, while especially in older animals a synostosis of the different sternebrae has taken place.

KEITH (29) and RUGE (53) believed, that the broadening of the sternum and the synostosis of the sternebrae would be connected with the need for a greater area of origin for the pectoral muscles, especially because the sternum was so much shortened. This explanation, however, at the least is not quite satisfactory, because there is already a broadening of the first sternebra in mammals that have only a very feebly developed pectoral musculature (bipedal Rodents, Marsupials), while in *Choloepus,* which has an extremely strongly developed pectoral musculature, the sternum is very narrow. FREY (16) believes, that the broadening of the sternum would be a kind of compensation for the shortening of this bone. The broadening of the first sternebra, however, has taken place quite independently from the shortening of the sternum. In my opinion the shortening of the sternum is connected with the shifting of the space in the thorax in a dorsal direction. The broadening of the sternum in the first place seems to be connected with the broadening of the whole thorax, because the first sternebra is broadened as soon as a broadening of the thoracic inlet has taken place.

In his essential characters the thorax of the flying mammals (*Chiroptera*) quite agrees with that of the anthropoid apes and man. In almost every text-book of zoölogy one can read that the thorax of the aquatic mammals and especially that of the Cetacea has the same shape as the thorax of man and the flying mammals. Previously, however, I have already shown [SLIJPER (60)], that the thorax of the Cetacea has been influenced by quite other factors than that of the upright going land-mammals. In consequence the changes that have taken place in the cetacean thorax (widening of the whole thorax, special widening of the cranial part in adaptation to the torpedo-shaped body and to the stability, as well as a slight shifting of the space in a dorsal direction) differ very much from that of the upright going land-mammals.

From het foregoing description it is now evident that the shape of the thorax in bipedal and upright mammals is influenced principally by two factors. The first factor is the changed position of the body-axis. In connection with the stability of the body the upright posture demands a broadening of the body and a shifting of the centre of gravity in a dorsal direction, in order to bring this centre as near as possible to the body-axis [see also KEITH (29), RUGE (53), HASSE (20), BRAUS (6)]. The second factor is the position of the scapula and the upper arm. In a certain sense this must be considered as a limiting factor, because the broadening and widening of the cranial part of the thorax (which ultimately cause the barrel-shape of the thorax) can only take place, if the upper arm is completely free from the body and the scapula has an almost horizontal position.

The bipedal goat (table 1 and 4, fig. 6) showed the following characters: 1st. A very marked increase of the transversal and a decrease of the sagittal diameter of the thorax. 2d. A curvature of the proximal parts of the ribs in a dorsal direction. 3d. A broadening of the apertura thoracis. Probably in connection with the shape of the neck, however, the typical ungulate shape of the aperture was present in the bipedal goat too. 4th. A widening of the cranial part of the thorax. 5th. A broadening of the whole sternum and a very slight (5 %) shortening of this bone. Since one could not have expected, that in the time of a few months the thorax of this goat would have completely been changed into a human thorax, the above-mentioned changes may be considered as sufficient to confirm the considerations about the thorax of the bipedal and upright mammals. For example, this goat demonstrates very clearly that the broadening of the sternum cannot directly be connected with the demands of origin-area of the pectoral musculature. For in the bipedal goat the sternum is broadened in spite of the very feeble development of these muscles.

The dogs of FULD (17) did not show any change in the shape of their thorax. In the operated dogs of JACKSON (26), however, the thoracic index, which in normal dogs during the period of growth increases from 112 to 135, did not change at all during this period. In opposition to JACKSON, who expected too much of his dogs, I believe that his results are in perfect agreement with that of my own researches.

MARCUS (38) has shown, that in mammals the number of lobes of the lungs, among other factors (size and activity of the animal), can depend upon the shape of the thorax. According to MARCUS the widening and broadening of the thorax in Sirenia, Cetacea, anthropoid apes and man would have caused the decrease in number of the lobes of the lungs. These considerations are supported by the changes that have taken place in the right lung of the bipedal goat. In the control-animal this lung was composed of four lobes. In the bipedal animal there was only one lobus apicalis while the other lobus apicalis and the lobus cardiacus were coalesced with the lobus diaphragmaticus. The left lung on the contrary was quite normal. It is highly probable that these changes of the right lung were caused by the changes in shape of the thorax. For KATZ (28) recently has shown that already in the rhachitic and kyphotic thorax changes in the number of lobes of the lungs may very often occur.

V. *Literature.*

1. AICHEL, O.; *Verhandl. Anat. Ges.* 34, p. 133, 1925. 2. ALEZAIS; *C. R. Assoc. Anat.* 4, p. 87, 1902. 3. ARIËNS KAPPERS, J.; Biometrische bijdrage tot de kennis van de ontogenetische ontwikkeling van het menschelijk bekken. Diss. Amsterdam 1938. 4. BLUME, W.; *Zeitschr. Anat. Entw.* 103, p. 498, 1934. 5. BÖKER, H.; Einführung in die vergleichende biologische Anatomie der Wirbeltiere, I. Jena 1935. 6. BRAUS, H.; Anatomie des Menschen, I. Berlin 1921. 7. BROEK, A. J. P. van den; *Morph. Jahrb.* 49, p. 1, 1914. 8. BRUHNKE, J.; *Morph. Jahrb.* 61, p. 555, 1929. 9. BYKOV, N. and KOTIKOWA, E.; *Arch. Russ. Anat. Hist. Embr.* 11, p. 434, 1933. 10. COLTON, H. S.; *Journ. Exper. Zool.* 53, p. 1, 1929. 11. CUVIER, G.; Anatomie comparée. Recueil des planches de myologie. Paris 1849. 12. DAMANY, P. le; *Journ. de l'anat. phys.* 42, p. 153, 1906. 13. EALES, N. B.; *Trans. R. Soc. Edinburg* 55, p. 609, 1928. 14. ELFTMAN, O.; *Bull. Am. Mus. Nat. Hist.* 58, p. 189, 1928. 15. FENEIS, H.; *Verhandl. Anat. Ges.* 47, p. 187, 1939. 16. FREY, H.; *Morph. Jahrb.* 76, p. 516, 1935. 17. FULD, E.; *Arch. Entwicklungsmech.* 11, p. 1, 1900. 18. GRAU, H.; *Zeitschr. Anat. Entw.* 98, p. 380, 1932. 19. GREGORY, W. K.; *Ann. N. York Acad. Sci.* 22, p. 267, 1912. 20. HASSE, C.; *Arch. Anat. Entw.* 1893, p. 292. 21. HATT, R. F.; *Bull. Am. Mus. Nat. Hist.* 63, p. 599, 1932. 22. HAUGHTON, S.; *Proc. R. Irish Acad.* 9, p. 515, 1867. 23. HAWRE, C., MEYER, R. K., MARTIN, S. J.; *Anat. Rec.* 41, p.60, 1928. 24. HISAW, F. L.; *Americ. Naturalist* 58, p. 93, 1924. 25. HOWELL, A. B.; *Proc. Amer. Acad. Arts Sci.* 67, N° 10, p. 377, 1932. 26. JACKSON, C. M.; *Zeitschr. Morph. Anthr.* 10, p. 240, 1907. 27. JENNY, H.; *Anat. Anz.* 40, p. 624, 1912. 28. KATZ, E.; *Ziegler's Beitr.* 86, p. 224, 1931. 29. KEITH, A.; *British Med. Journ.* 1923, p. 451, 499,

545, 587, 624, 669. 30. KNAUER, S.; *Ergebn. Anat. Entw.* 22, p. 1, 1914. 31. KOLESNIKOW, W.; *Zeitschr. Anat. Entw.* 88, p. 397, 1928. 32. KOWESCHNIKOWA, A. und KOTIKOWA, E.; *Bull. Inst. Sci. Lesshaft, Leningrad* 17, p. 63, 1934. 33. LESBRE, F. X.: Traité de tératologie de l'homme et des animaux domestiques. Paris 1927. 34. LOTH, E.; *C.R. Assoc. Anat.* 22, 1927. 35. LÜHKEN, H.; *Zeitschr. Anat. Entw.* 104, p. 729, 1935. 36. LULL, R. S.; *Americ. Naturalist* 38, p. 1, 1904. 37. LYON, M. W.; *Proc. U. S. Nat. Mus.* 23, p. 659, 1901. 38. MARCUS, H.; Lungen. In: BOLK, L. c.s.: Handbuch der vergleichenden Anatomie der Wirbeltiere, 3. Berlin 1927. 39. MEYER, G. H.; Die Statik und Mechanik des menschlichen Knochengerüstes. Leipzig 1873. 40. MIALL, L. C. and GREENWOOD, F.; *Journ. Anat. Phys.* 12, p. 261, 835, 1878. 41. MÜLLER, R. J.; *Zeitschr. Morph. Ökol.* 17, p. 154, 1930. 42. MURIE, J.; *Journ. Anat. Phys.* 6, p. 131, 1872. 43. MURRAY, P. D. F.; Bones. Cambridge 1936. 44. MUYBRIDGE, E.; Animals in Motion. London 1899. 45. MIJSBERG, W. A.; *Anat. Hefte* (I) 58, p. 453, 1920. 46. NAUCK, E. TH.; *Anthrop. Anzeiger* 11, p. 259, 1934. 47. PARSONS, F. G.; *Proc. Zool. Soc.* 1896. 48. ——————; *Proc. Zool. Soc.* 1898, p. 858. 49. PRIEMEL, G.; *Zeitschr. Morph. Ökol.* 33, p. 1, 1937. 50. REGNAULT, F.; *Biologica* 1, p. 333, 1911. 51. REISER, E.; Diss. Bern 1903. 52. RUDOLF, B. de M.; *Journ. Anat.* 56, p. 137, 1922. 53. RUGE, G.; *Anat. Anz.* 51, p. 81, 1918. 54. RUTH, E. B.; *Anat. Record* 67, p. 69, 409, 1937. 55. SCHAPIRO, B.; *Morph. Jahrb.* 46, p. 209, 1913. 56. SCHMALTZ, R.; Anatomie des Pferdes. 2. Aufl. Berlin 1928. 57. SCHULTZ, A. H.; *Quart. Rev. Biol.* 11, p. 259, 425, 1936. 58. ——————; *Amer. Journ. Phys. Anthrop.* 24, p. 1, 1938. 59. SCHUMANN, A.; *Morph. Jahrb.* 32, p. 232, 1904. 60. SLIJPER, E. J.; Die Cetaceen. *Capita Zoologica* 7, p. 1—600; Diss. Utrecht 1936. 61. ——————; De Voortbewegingsorganen. In: IHLE, J. E. W. c.s.; Leerboek der vergelijkende ontleedkunde van de Vertebraten, 2e druk, dl. I, p. 95. Utrecht 1941. 62. STIEVE, H.; *Arch. Entwicklungsmech.* 110, p. 528, 1927. 63. STRASSER, H.; Lehrbuch der Muskel- und Gelenkmechanik, II. Berlin 1913. 64. WATERMAN, H. C.; *Bull. Am. Mus. Nat. Hist.* 58, p. 585, 1928. 65. WEIDENREICH, F.; *Anat. Anz.* 44, p. 497, 1913. 66. ——————; *Verhandl. Anat. Ges.* 31, p. 28, 1922. 67. WILLIS, Th. A.; *Americ. Journ. Anat.* 32, p. 95, 1923. 68. WERMEL, J.; *Morph. Jahrb.* 74, p. 143, 1934; 75, p. 92, 180, 1935.