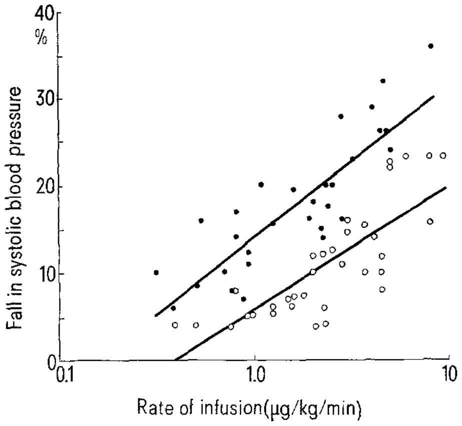
tensive action and the response was dose-related. As indicated by the Table, the fall in systolic blood pressure was most marked with intra-aortic infusions. The mean inactivation of PGE_1 upon passage through the pulmonary vascular bed was 72% in foetuses of gestational age from 126 days onwards. This value does not differ significantly from that obtained in newborn and 6-month-old lambs. Two successful experiments were performed in foetuses at an earlier stage of gestation (111 and 113 days), that is prior to the appearance of surface-active material in lung tissue[8]. In these animals, the lungs were still capable of PGE_1 inactivation. However, the percent loss of PGE_1 activity (52 and 62%) was in the low range of values obtained with older foetuses, suggesting a less efficient mechanism of inactivation. More results are needed to clarify this point.



Dose-response lines for PGE_1 infused into the aorta (●) and the pulmonary artery (○) of foetal lambs (111–142 gestation days). Each point applies to a single response. Calculated regression equations are $y = 18.06 \log x + 13.89$ (●) and $y = 14.05 \log x + 5.94$ (○).

The Figure illustrates the dose-dependent relation for PGE_1 given by pre- and post-pulmonary routes to foetal lambs. Regression lines were calculated with a least squares fit on pooled data from all experiments (8 animals, see Table). The 2 slopes did not depart significantly from parallelism, whereas the difference between the intercepts was significant ($P < 0.01$). Pulmonary inactivation calculated from the regression equations is 73%.

These experiments demonstrate that lungs of foetal lambs inactivate PGE_1 from 111 days gestation onwards and that the degree of inactivation is the same with mature foetuses and animals after birth. By inference from work with adult animals[6], we postulate that an enzymic process is responsible for the loss of PGE_1 activity. If PG-degrading enzymes develop similarly in lungs and other organs (e.g. liver), then it follows that also in foetuses near term PGE and PGF compounds are not fitted to the role of circulating hormones[9].

Résumé. Le poumon de l'agneau foetal a la propriété d'inactiver la prostaglandine E_1 à partir du 111ème jour de gestation (terme: 147 jours). Le degré d'inactivation, chez le foetus près d'être à terme, est de l'ordre de ce qu'on observe dans le poumon du nouveau-né et de l'agneau de 6 mois.

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[8] W. F. Howatt, M. E. Avery, P. W. Humphreys, I. C. S. Normand, L. Reid and L. B. Strang, Clin. Sci. *29*, 239 (1965).

[9] This work was supported by the Medical Research Council of Canada (grants No. MA-3310 and No. MA-3912). We thank Dr. J. E. Pike (Upjohn Company) for PGE_1, and Mr. F. Hamilton for technical help.

Rest-Activity Cycle and Sleep Patterns in Captive Foxes (*Vulpes vulpes*)

Comparative studies on sleep indicate that security of environment is the main factor influencing the amount of total sleep time (TST) and in particular the percentage of paradoxical sleep (PS). Allison and Van Twyver suggest that animals which rest normally underground or in a den are 'secure' sleepers, and that they will sleep readily under laboratory conditions[1]. This present work has been carried out on the fox, which apart from its predatory activity lives mainly in an earth.

Methods. Three foxes (2♂, 1♀); captured at the age of 2 months, were kept in a large cage which contained a smaller cage serving as a den. The animal were fed once a day (08.00 h) with canine food cubes and received water ad libitum. When they were 1 year old, their 24-h activity cycle was recorded on a kymographic apparatus from transducers placed under the support of the cage. The ECoG activity was next obtained from 3 pairs of silvered screws inserted under pentobarbitone anaesthesia (30 mg/kg) over the frontal, parietal and occipital cortex at 2 cm on either side of the sagittal suture. Electrodes were inserted into the neck muscles for electromyography. 2 screws fixed on the fifth rib on each side enabled recording of heart rate and by impedance changes the respiratory movements. A polygraph (Reega VIII Tr. Alvar) was used to obtain a continuous record during a week from the time after the surgical procedure. The first

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[1] Tr. Allison and H. Van Twyver, Expl Neurol. *27*, 564 (1970).

Sleep pattern characteristics and cardio-respiratory rates (mean value ± SE) in the fox

		Awake	Drowsiness	Slow wave sleep	Paradoxical sleep
Mean percentage per day		38.9	20.3	30.8	10.0
Individual periods	Length (min)	–	4.9 ± 0.36	8.9 ± 0.73	5.1 ± 0.42
	Number (per day)	–	59 ± 12	45 ± 11	28 ± 5
Heart rate (min) ($n = 10$)		101.7 ± 3.3	77.2 ± 0.6	77.7 ± 1.0	92.0 ± 1.7
Respiration rate 30 sec ($n = 10$)		12.9 ± 0.67	10.4 ± 0.40	9.9 ± 0.35	10.5 ± 0.48

2 days of recording were not included in the analysis of sleep.

Results. The actogram showed 2 phases of activity: one, the longest, between 20.00 h and 01.00 h, another between 07.00 h and 08.00 h. Despite the fact that food was supplied each morning, ingestion was restricted to the evening during the main period of activity.

Figure 1 shows the polygraphic correlates of awake and sleep states. During wakefulness, typical low voltage (10–50 µV) and high frequency (30–40 c/sec) activity were recorded from all leads. Short spindles (6–8 c/sec) were occasionally seen at the parietal level. Muscular tone was high and respiratory sinus arrhythmia was observed on the electrocardiogram. Drowsiness, which occurred for periods of 2–12 min, was characterized by spindle bursts alternating with low voltage fast activity, by slower heart and respiratory rates and by decreased muscular tone. During sleep (41% per day) slow waves (3–6 c/sec) were superimposed on a low-voltage background, respiratory sinus arrhythmia was more pronounced and muscular tone was reduced to its lowest level or was at times absent. In the latter case PS was only recognizable by the onset of cortical desynchronization, with the appearance of bursts of alpha-like (10–12 c/sec) activity of high amplitude (150 µV). The Table shows that heart rate was increased during PS but respiration rate was unchanged inspite of transient inspiratory pauses (10 sec instead of 6 between each breath) and compensatory acceleration. The percentage of each day spent in SWS was approximately 30 and in PS 10, the ratio of PS/TST being 1:4 (or expressed as a percentage: 24.5).

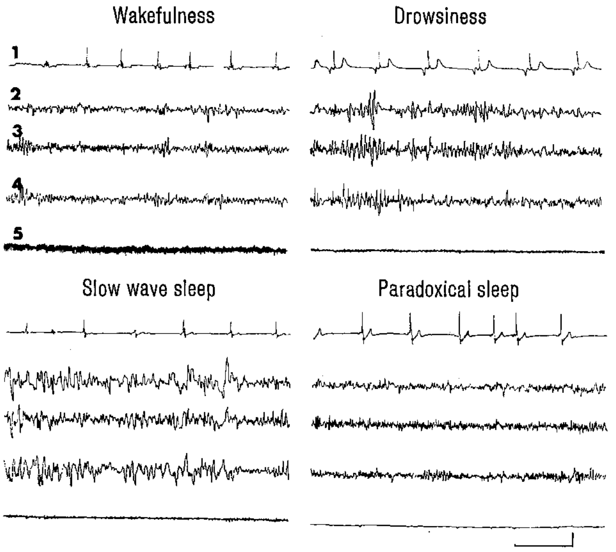

Fig. 1. Waking and sleep states in the fox. 1, electrocardiogram; 2, 3 and 4, frontal, parietal and occipital electrocorticograms; 5, neck electromyogram. Time and calibration: 1 sec and 100 µV. Note sinus arrhythmia during paradoxical sleep.

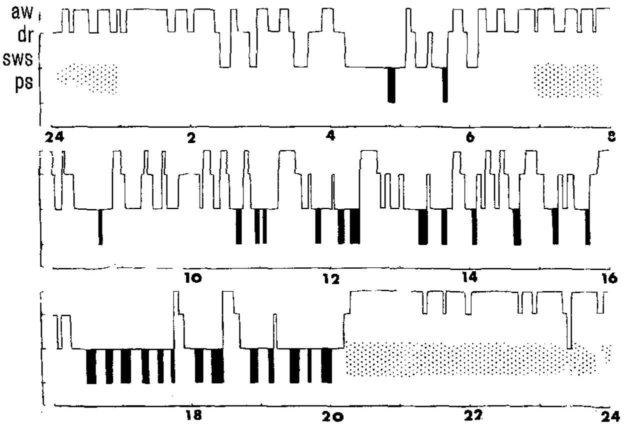

Fig. 2. Waking and sleep activity in 1 fox during a period of 24-h. The dotted area indicates the period of motility which, at 20.10 h, follows the main sleep period. Several periods of wakefulness are not accompanied by movement.

Figure 2 shows that sleep chiefly occurred during the day-time and that the major sleep period was in the afternoon between 16.00 h and 20.00 h. The duration of the sleep periods (12 to 15 per day) was 48.5 min and varied from 14 to 106 min. The mean length of sleep cycles, i.e. total length of time between 2 successive PS periods was 15.6 min and the mean duration of a single PS was 5.1 min like in the laboratory cat[2].

Discussion. Although food was available in the morning, ingestion behaviour was observed mainly in the evening indicating that captivity had not greatly modified the natural rest-activity cycle of these foxes. The fact that respiratory sinus arrhythmia did not disappear during PS does not support the hypothesis of an increase in sympathetic activity during PS[3].

The large amount of TST and the high percentage of PS suggest that the foxes were well adapted to their restrained environment. It is possible also that drowsiness is increased, as is the case in stabled animals, where time spent in search for food is eliminated[4]. The mean duration of sleep periods is approximately equal to that for other carnivores of similar body-weight, for example the cat (25 min), and is in accordance with the hypothesis[5] that differences in length of sleep epochs may be due to metabolic rates. The amount of PS to TST, which does not differ significantly from that of the rat and rabbit (20%), the hamster and squirrel (23–25%), is in agreement with the argument of VAN TWYVER[6] who states that the percentages are nearly equal for predator and prey. This would cast some doubt on the belief that predators necessarily indulge in more PS than non-predators.

Not only the total amount of PS should be compared between species but also the distribution of sleep and activity throughout the day. A comparison between hypnograms for the fox and the rabbit shows that the main periods of wakefulness correspond. This is expected since in nature a predatory-prey relationship exists between the two species.

Résumé. Etude du rythme d'activité et de l'alternance veille-sommeil de trois renards élevés après sevrage pendant un an dans une cage spacieuse munie d'un refuge. La durée de sommeil est comparable à celle des carnivores. Une longue période de sommeil (diurne) précède une phase hyperactive (nocturne) de l'animal.

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5 July 1973.

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[7] Supported by grant No. 110-2 D-115 from the Medical Research Council of Canada to A. DALLAIRE.