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The Circadian Sleep-Wakefulness Rhythm

of the Golden Hamster

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Van Twyver and Allison [6] investigated spontaneous sleep in the golden hamster. Using electroencephalographic techniques, they recorded 6 adult male animals over periods of 48 h. Out of the numerical data they supply from their study, a striking feature stands out, namely the exceptionally great levels of paradoxical sleep (PS), amounting to as much as 14.6% of the total recording time. However, the authors' diagnostic criteria for sleep per se and for shifts from slow-wave sleep (SWS) to PS, and conversely, appear to be insufficiently defined; also, there is no exact information concerning the circadian sequence of waking (W), SWS and PS episodes in the paper referred to. In our opinion, accurate documentation of such circadian sequence is of fundamental importance to the comparative physiology of sleep. The aim of the present work was to extend

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the investigation by Van Twyver and Allison [6] ; special attention being paid to exact determination of the diagnostic criteria of SWS, PS and W.

Material and Method

Seven young adult hamsters, 2 males and 5 females, weighing between 80 and 120 g, were used as subjects. Each animal was chronically implanted with epidural silver electrodes for ECoG, bipolar concentric stainless steel electrodes inserted into the dorsal hippocampus for EHpcG, and a pair of stainless steel wires for monitoring the EMG from the neck muscles. Surgery was performed under Nembutal anesthesia, 90 mg/kg. An attempt at recording rapid eye movements (REM) using the EOG technique from a pair of extra-ocular electrodes was unsuccessful. The recording sessions began 10 days after implantation and were carried out in each animal's own cage, after careful adaptation to laboratory conditions, in dimmed natural light at a temperature of about 25 °C. The Kaizer 55 EEGraph with a time constant of 0.1 sec for ECoG-EHpcG and 0.03 sec for EMG was used. The scoring criteria of the three states W, SWS and PS were based on the morphology of the polygraphic traces and on the animals' behavior. The separation of the periods of sleep from that of wakefulness was simplified in this species by the fact that hamsters always exhibit marked locomotor activity when not asleep, whereas they always remain in the typical curled-up position when sleeping. Every segment of the EEG trace was classified as SWS when the ECoG was distinctly synchronized for a period longer than 20 sec and as paradoxical sleep when the ECoG was desynchronized and EHpcG exhibited a δ rhythm lasting longer than 5 sec.

Results

The experimental data comprise 20 polygraphic 24-hour records. The total sleep time was found to be 59.1% of the 24-hour period, and was composed of $47.2 \pm 5.0\%$ of SWS and $11.9 \pm 2.2\%$ of PS. The hamsters were awake and active for the remainder of the time, i.e. $40.9 \pm 4.8\%$. Except for amount of PS per 24-hour period and the duration of the single PS episodes, our results are not too dissimilar from those of Van Twyver and Allison [6], The average number of SWS episodes over the 24-hour period was 141 ± 38 , while the mean number of PS episodes over the same period was 69 ± 21 . Every PS episode was preceded by the SWS; 28.3% of the PS episodes were followed by another SWS episode, not by awakening. The single PS episodes lasted on the average 2 min 37 sec $\pm$ 34 sec, and single SWS episodes 5 min 9 sec $\pm$ 78 sec.

The EMG of the neck muscles was useless for identification of the

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Fig. 1. The average ($n = 20$) 24-hour total sleep-wakefulness (TST-W) sleep profile of 7 golden hamsters scored as percent TST-W at 20-min intervals.

transition between SWS and PS. The specific position of the body peculiar to hamsters when sleeping is identical in both kinds of sleep and therefore it is rare, and then only to a very slight degree, that the amplitude of the EMG is lower during a PS episode than during SWS. Superimposed on the EMG record was the EKG. This allowed the counting of the heart rate which, during the PS, was found to be lowered. This, in our opinion, reflects the transitory loss of the neurovegetative balance during desynchronized sleep.

In the golden hamster there is a distinct period of intense activity lasting for about 4 h which occurs in Mediterranean latitudes at dusk, i.e. between the hours from about 18.00 until 22.00 h. An interesting characteristic feature of sleep in hamsters is the high daily percentage of PS.

This figure is close to that found in cats [5], but very much different from that found in rabbits [3], rats [2], guinea pigs [4] and mice [7]. A similarly great amount of PS was found also in the ground squirrel, *Citellus tridecemlineatus*, but these latter data were based on rough documentation only [6].

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Discussion

When considering the 24-hour course of sleep and wakefulness in the golden hamster little correlation is found with the sleep profile of other rodents. The great amount of sleep in general, and especially of PS, shows that this species has a greater need of sleep than other rodents. We assume that this is related to the conditions of the hamster's natural habitat, and thus, to a far greater degree, to the pressure of the ecological niche than to taxonomic relationships. Similar conclusions have recently been reached regarding the surprisingly different sleep profiles of two taxonomically closely related monkeys *Macaca radiata* and *M. mulatto* [1].

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