Uncovering the evolution of REM sleep: Ostriches sleep like platypuses

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(PhysOrg.com) -- The brain activity of ostriches in REM sleep is unique, alternating between fast, small waves - characteristic of REM sleep in other birds, and large, slow waves typical of those occurring during slow

wave sleep. Moreover, the amount of REM sleep in ostriches is greater than in any other bird species. In collaboration with an international team, John Lesku and Niels Rattenborg from the Max Planck Institute for Ornithology in Seewiesen showed that these flightless birds possess a sleep pattern similar to that in the platypus, an ancient mammal that produces eggs. Apparently during the evolution of sleep the two distinct sleep states arose from a single heterogeneous state. Thereby REM sleep represents an evolutionarily new feature.

Birds and most mammals engage in two types of sleep that are distinguishable from one another by brain wave patterns measured via the electroencephalogram (EEG). Deep sleep or slow wave sleep (SWS) is characterized by large, slow waves in the EEG, and rapid eye movement (REM) sleep as small, fast waves, an activated pattern similar to that occurring during wakefulness. REM sleep is also associated with rapid eye movements and reduced muscle tone. But how did these states come to be? That is the question the two Max Planck researchers sought to answer. “Understanding how SWS and REM sleep evolved might provide insight into their function”, says Rattenborg.

Unfortunately the brain activity that defines these states does not fossilize, so in order to study how these states evolved one must study living animals as representatives for extinct forms. For instance, while marsupial and placental mammals, including ourselves, engage in SWS and REM sleep, echidnas and platypuses – members of the most “ancient” group of living mammals, the monotremes – show only deep sleep patterns in the EEG. However, signs of ‘classical’ REM sleep such as rapid eye movements and reduced muscle tone have been observed in platypuses.

Like mammals, birds also engage in SWS and REM sleep, but until now it has been unknown if birds share a similar pattern of sleep evolution to the one inferred for mammals. In collaboration with Universities in

South Africa, Western Australia, and Switzerland as well as with the organization Ornis Italica, Rattenborg and Lesku conducted the first study of sleep in an "early" bird, the ostrich. They equipped six females originating from an ostrich farm in Free State in South Africa with electrodes in order to measure brain activity using EEG, as well as eye movements and muscle tone.

Remarkably, the brain activity of sleeping ostriches was reminiscent of that observed in sleeping monotremes. That is, ostriches periodically entered a REM sleep state characterized by rapid eye movements and reduced muscle tone; however, instead of an EEG consisting only of REM sleep-related activation, the EEG would flip between waves of the two sleep states.

Because ostriches have some activation during REM sleep, such ancient birds may be further along the sequence of evolutionary steps towards 'classical' REM sleep than are monotremes. "Overall, these findings suggest that activation – the hallmark of REM sleep in humans and most other mammals, and birds – is an evolutionarily new feature that may support new sleep functions not present in evolutionarily older animals", says Rattenborg.

More information: John A. Lesku, et al. Ostriches Sleep Like Platypuses, *PLoS One*, 24. August 2011

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