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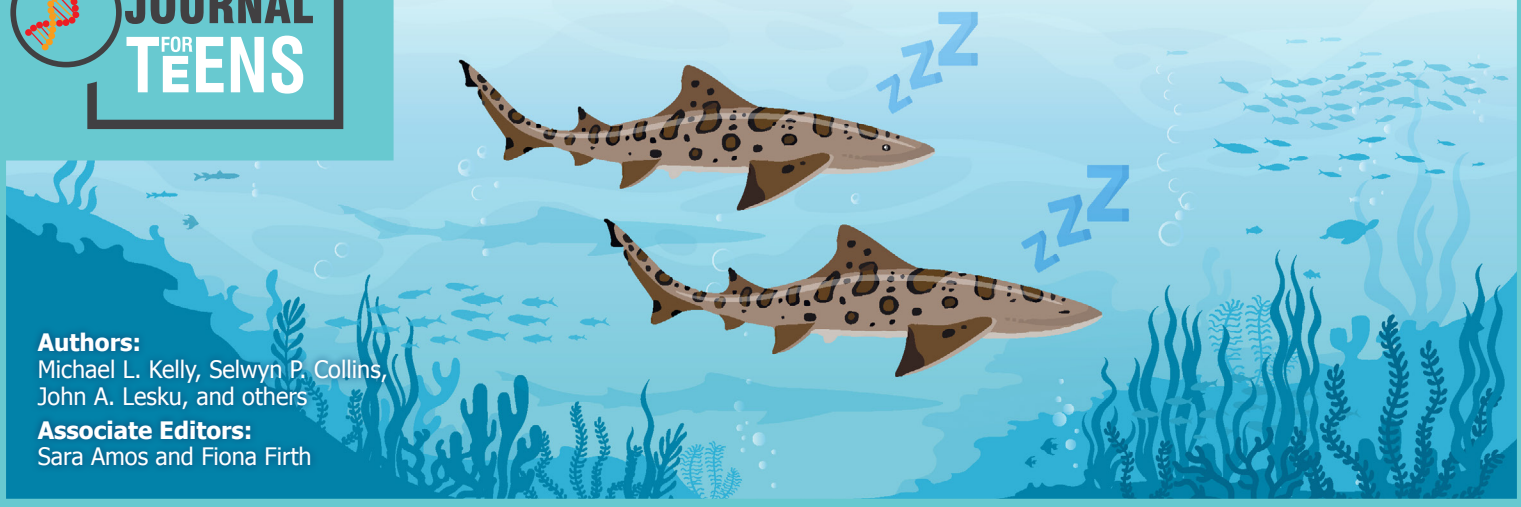
Why do sharks sleep?



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Abstract

UPPER READING LEVEL

We all know what it feels like when we have not had enough sleep. You might feel tired, have trouble concentrating, or even be grumpy and irritable. Despite it being such an important part of our daily lives, sleep still remains a bit of a mystery! To help answer the question of why we sleep, scientists have started researching sleep in other animals. This can help us understand how and why sleep evolved.

Sharks are hundreds of millions of years old. In fact, they are the oldest living group of jawed vertebrates! Because of this, we think they could help unlock important information about the evolution of sleep. So far, only one study has focused on sleep in sharks. We wanted to change this!

We studied the metabolic rate and behavior of draughtsboard sharks (*Cephaloscyllium isabellum*) over a 24-hour period. Our results show that when sharks sleep, they typically have a flat body posture and a reduced metabolic rate. Our study supports the hypothesis that the conservation of energy is a core function of sleep. It also provides insight into its evolution.

Introduction

We spend approximately 1/3 of our day asleep, but have you ever wondered why? Scientists believe that one of the main purposes of sleep is to save energy. When we fall asleep our breathing slows down, our body temperature drops, and our body moves less. This decreases the amount of energy we use; scientists call this our **metabolic rate**.

We study sleep by looking at behaviors, such as body positioning, and **physiological indicators**, such as metabolic rate. We know that most animals sleep. We can observe sleeping behavior in our pets at home, and sometimes we can even see them dreaming! However, it is difficult to measure what is happening inside their bodies while they are sleeping. Researchers have studied physiological indicators in many species. They have found that sleep reduces the metabolic rate in humans, cats, rats, birds, and even fruit flies!

Recent studies have shown that draughtsboard sharks (*Cephaloscyllium isabellum*) are nocturnal. Although they appear to be sleeping during the day, we wanted to investigate this further. We recorded their metabolic rate and behavior over a 24-hour period (Fig. 1). Our aim was to understand more about the purpose of sleep in sharks.

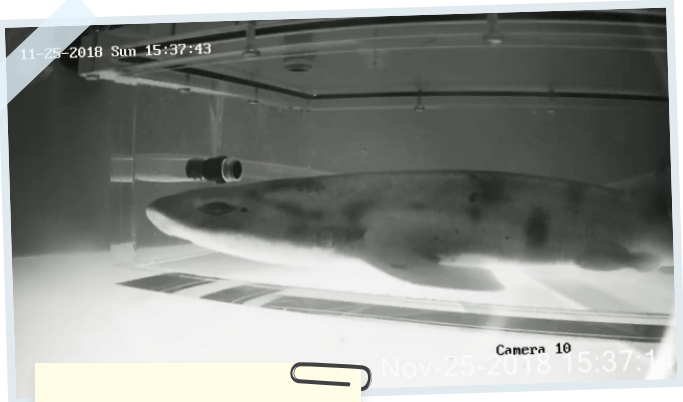

Figure 1: We observed draughtsboard sharks, *Cephaloscyllium isabellum*, inside respiratory chambers

Methods

We collected seven draughtsboard sharks from the ocean and kept them in tanks within the laboratory. We moved each shark into a special **respiratory chamber** two days before the experiment started. This was to give them time to adjust to their new environment.

The chamber was large enough for a shark to swim around in. A sensor was placed in the water and constantly measured the oxygen levels in the water. When a shark is active, it will respire more and therefore use more oxygen from the water. So we would expect to see the oxygen levels decrease more quickly when the shark is active, and more slowly when it is resting. Once oxygen levels reached low levels in the chamber, flush pumps expelled the old water and filled the chamber with fresh water so the oxygen measurement process could start again.

While the sharks were in the chamber, we also video-recorded them for 24 hours (12 hours of daylight, 12 hours of dark). Their behavior was split into three categories (Fig. 2).

1. Eye state: open or closed.
2. Body posture: lying flat or raised on their **pectoral fins**.
3. Activity state: swimming, rest (inactive for < 5 minutes), or sleep (inactive for > 5 minutes).

Finally, we used specialized software to convert the change in the water's oxygen levels into the shark's metabolic rate. This allowed us to record the shark's metabolic rate and behavior for every second during the 24-hour period!

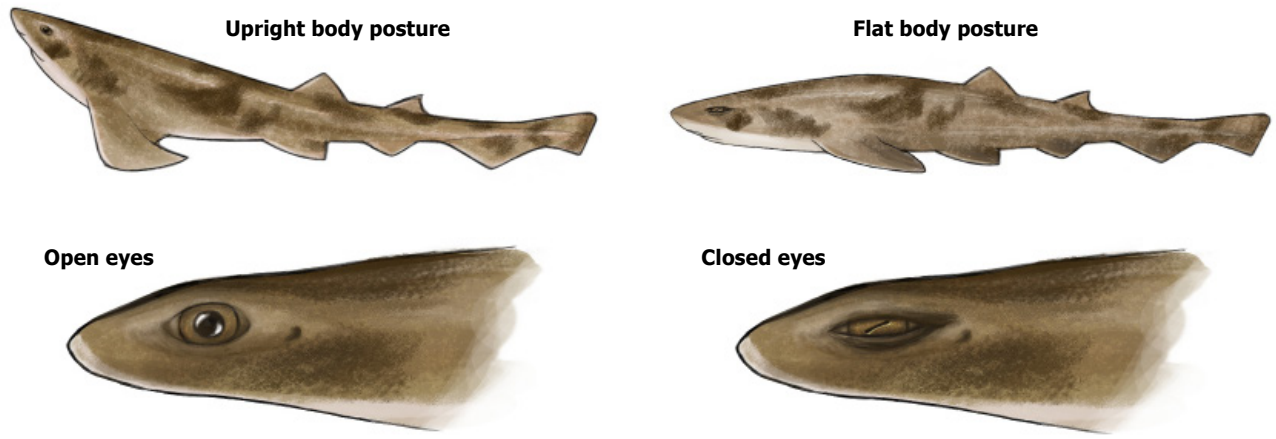

Figure 2: The sharks showed different kinds of behavior.

Results

Our results confirmed that sharks are more active at night. Their metabolic rate was highest when swimming, and lowest when sleeping. Our data also showed that the metabolic rate for each activity varied between the day and night (Fig. 3). For example, during the day, the shark's resting metabolic rate was significantly lower than during the nighttime hours. During the day, the shark's resting and sleeping metabolic rates were similar to each other. In contrast, at night, the shark's resting and swimming metabolic rates were more closely connected. This suggests that resting during the night might reflect quiet wakefulness rather than sleep.

Our analysis of eye state and body posture showed that body posture was the best indicator of sleep. During the day, sleeping sharks often had their eyes closed, but at night they were open 38% of the time. This suggests that eye closure could be a response to the presence of light, rather than sleep.

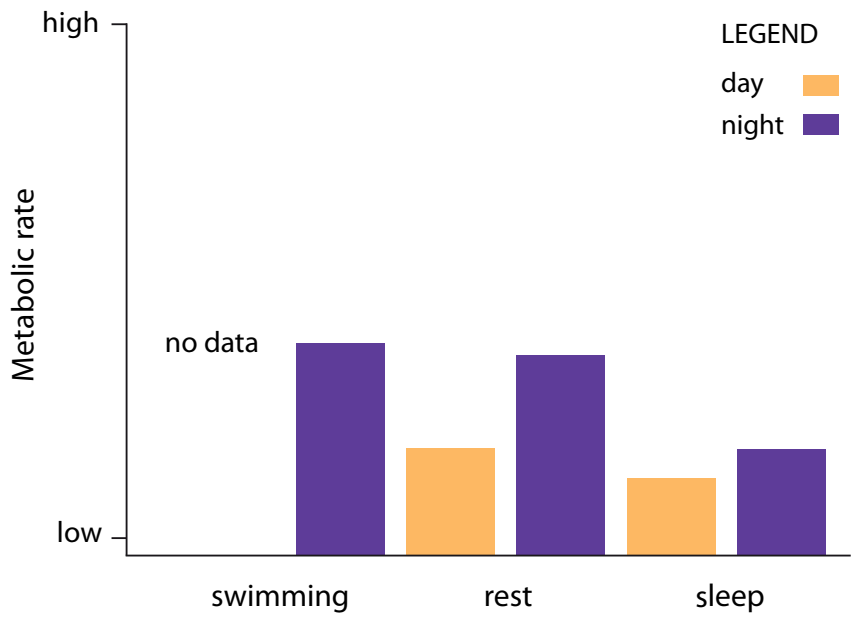

Figure 3: The sharks' average metabolic rate for each activity state during the day and at night.

When did the sharks have the highest metabolic rate?

Discussion

In this study we have provided the first physiological evidence of sleep in sharks. Our research shows that sharks have a reduced metabolic rate when they sleep. This supports the hypothesis that sleep is important for energy conservation.

Sharks have existed for hundreds of millions of years. Therefore, they could provide insights into the evolution of sleep. Further research should look at other physiological indicators of sleep, such as brain activity. This will help us to better understand sleep in sharks, as well as humans.

Conclusion

Sleep is an essential part of our daily lives. While we are sleeping, our body balances and regulates all its vital systems, such as circulation, growth, and immune response. Sleep is also important for our brain function. It helps to improve memory and can even improve your creative ability!

Here are some top tips to help improve your sleep routine:

- Put away electronic devices an hour before bedtime.
- Go to bed and wake up around the same time each day.
- Avoid stimulants like caffeine in the late afternoon or evening.
- Keep your bedroom quiet, cool, and dark.
- Exercise for at least 30 minutes a day.

Check your understanding

1. For how many seconds did we record the metabolic rate for each shark? And for how many seconds overall?
2. Why do you think there were no data for sharks swimming during the daytime?
3. We recorded metabolic rate in relation to activity state. What other factors might impact how much energy you/an animal uses in an hour?
4. Apart from eye state and body position, what other behaviors might indicate an animal is asleep?
5. What benefits do you think you get from sleep besides conserving energy? List at least three. Then find a partner and discuss.

Glossary of Key Terms

Metabolic rate – the amount of energy used by an organism in a given period of time.

Pectoral fins – the fins on either side of a fish. They help the fish move around in the water.

Physiological indicators – measurements and observations of an organism that provide insight into its internal state.

Respiratory chamber – a plastic tank that sits within a larger reservoir of water.

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