

Utilizing GPT-4 for Morphological Identification of Bed Bugs

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Abstract

Artificial Intelligence (AI) is transforming technology. GhatGPT-4 is a cutting-edge language model that enhances human-computer interaction and understanding. This study addresses the resurgence of bed bugs, a global concern due to increased international travel, pesticide resistance, and evolving pest control practices. It focuses on the distinct morphological features of *Cimex lectularius* and *Cimex hemipterus*, two species of bed bugs that predominantly feed on humans. These morphological differences facilitate their accurate identification, which is vital for effective pest management and public health. By developing a user-friendly application, this research contributes to various aspects of bed bug control. It promotes collaboration among researchers, enables the public to easily identify these pests, aids communicable disease control centers, expedites survey studies, and offers practical applications in places like airports, hotels, and ports for efficient pest species recognition, ultimately enhancing bed bug management efforts. This study emphasizes the morphological differences between *C. lectularius* and *C. hemipterus*, which can significantly impact the monitoring and management of bedbug infestations.

Keywords: Artificial intelligence, Agriculture, GhatGPT-4, Bed Bugs, *C. Lectularius* and *C. hemipterus*

1. Introduction

Artificial Intelligence (AI) stands at the forefront of technological innovation, promising to revolutionize the way we interact with computer systems and automate complex tasks. AI encompasses a diverse range of techniques and approaches, all aimed at enabling machines to mimic human intelligence, learning, and problem-solving abilities. From natural language processing to computer vision and machine learning, AI has found applications across numerous domains, transforming industries and shaping the future of technology.

One significant milestone in the AI landscape is the development of advanced language models. GhatGPT-4 represents a remarkable evolution in this field, building upon the foundations laid by its predecessors. This model is designed to enhance human-computer interaction and understanding by providing nuanced responses and comprehensive insights into a wide array of topics [1, 2]. In this exploration of Artificial Intelligence and GhatGPT-4, we will delve into the fundamental concepts of AI, its real-world applications, and the unique capabilities that GhatGPT-4 brings to the table. We will discuss how GhatGPT-4 is positioned at the forefront of AI development, with its extensive training data and knowledge, enabling it to provide valuable assistance and insights to users across various domains. Furthermore, we will explore the potential impact of GhatGPT-4 on industries, research, and society as a whole.

Consequently, it has entered most health and medical fields [3,4] science fields [5-8], engineering [9] and agricultural journals. Moreover, recently, GPT-4 has proven its efficiency in analyzing various types of images [10]. Therefore, our study will primarily focus on its importance in the field of classifying insect images.

The Bed bugs, one of the members of the Cimicidae family (Hemiptera: Cimicidae), are nocturnal parasitic insects that feed mainly on humans, domestic animals, birds and bats [11, 12]. Two species feed preferentially on humans: tropical bed bugs *Cimex hemipterus* and common bed bug *Cimex lectularius* [13].

The ability to transmit infectious agents between humans has not yet been proven, but there is suspicion [14].

The resurgence of bed bugs worldwide has been a growing concern in recent years. After decades of relative obscurity, this blood-feeding insect has reappeared noticeably in many regions worldwide. Several factors have contributed to the return of bedbugs: increased international travel, pesticide resistance, and changes in pest control practices [15-17].

Identification of medically important arthropods is essential for any monitoring procedure. Morphological identification requires expertise in entomology, which may lead to misidentification by ordinary people, especially since distinguishing between the two main species of bed bugs is difficult. For this reason, diagnostic technicians need to be taught how to identify them. These pests and their control [18].

This study emphasizes the morphological differences between *C. lectularius* and *C. hemipterus*, which can significantly impact the monitoring and management of bedbug infestations. We used ChatGPT-4 for this purpose. The Contribution in this study a) The study also contributes to increasing the exchange of experiences between researchers. b) Helping ordinary people identify bed bugs and distinguish between their species easily. c) Facilitating the task of workers at the Communicable Disease Control Centers in identifying the types of bed bugs. d) The speed of morphological identification will help prepare survey studies on this public health pest easily. e) The study also benefits from the possibility of using this application in airports, hotels and ports in order to identify the types of bed bugs.

2. Research Methodology

In order to evaluate the effectiveness of GPT-4 to identification species of bed bugs based on the discriminative morphological characteristics. These species are tropical bed bug *C. hemipterus*, and Common bed bug *C.lectularius*. The recognition of these discriminative features, we provide within the GPT-4's prompt input box a sample of bed bugs as illustrated in figure 1 and six questions have been asked to evaluate the ability of GPT-4, as shown below. The utilized on morphological characteristics

for identification purpose are based on "pronotum" measurement such that discrimination between the two species in terms of the size, shape, width to length of the pronotum. Moreover, identify the provided sample and specify the scientific name based on the provided measurement. In addition, discrimination is based on morphological characteristics such as pronotum measurement.

The prompt questions are listed below:

RQ1: Can you identify the image?

RQ2: Can you discriminate between these two species of bed bugs according to the pronotum measurement?

RQ3: Can you give me more information in terms of 2.5mm measurement?

RQ4: Can you indicate precisely the scientific name based on the provided measurement?

RQ5: How to discriminate between image A and B of these two species of bed bugs according to the pronotum measurement?

RQ6: Can you discriminate based on other features of pronotum measurement?

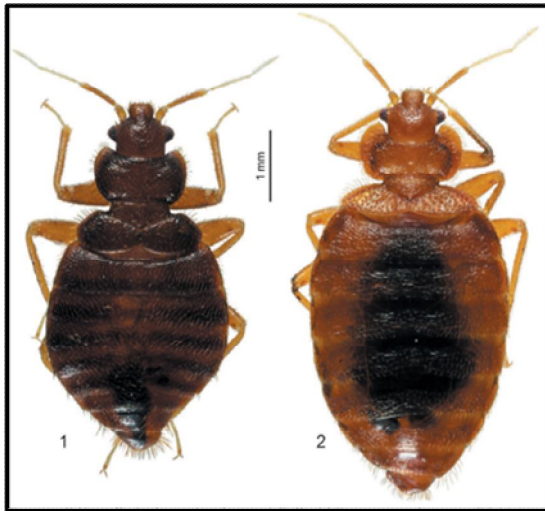


Figure 1 Tropical bed bugs *C. hemipterus*. 2. Common bed bug *C. lectularius* [19], in the same image.

3. Results



RQ1: Can you identify the image? (Figur1.)



Yes, the image depicts bed bugs. They are small, oval, brownish insects that feed on the blood of animals or humans. Adult bed bugs have flat bodies about the size of an apple seed. After feeding, however, their bodies swell and are a reddish color.



RQ2: Can you discriminate between these two species of bed bugs according to the pronotum measurement?



The image you provided shows two bed bugs, and you're asking about discrimination between the two species based on the "pronotum" measurement.

The pronotum is the plate-like structure that covers the thorax (upper part) of insects, just behind the head. In bed bugs, the shape and size of the pronotum can be a distinguishing feature between different species.

For instance, the common bed bug (*C. lectularius*) and the tropical bed bug (*C. hemipterus*) are two of the most prevalent species that affect humans. The pronotum of *C. lectularius* is more expanded laterally and is more squared off at the sides, while the pronotum of *C. hemipterus* is more rounded. To differentiate between the two species based on the pronotum:

Look at the width of the pronotum in relation to its length. Check the overall shape: squared-off vs. rounded. Examine the front margin of the pronotum to see if it's straight or concave.

However, accurately distinguishing between bed bug species usually requires a detailed examination, possibly under magnifi-

cation, and might also involve considering other morphological features. To make an accurate identification between the two bed bugs in the image based on the pronotum measurement, you'd need a clear and closer image, ideally with a scale, and potentially some expert knowledge or reference material.



RQ3: Can you give me more information in terms of 2.5 mm measurement?



If you're using a specific measurement of 2.5mm related to the pronotum to differentiate between the two species of bed bugs, it likely pertains to the width or length of the pronotum.

In some entomological studies or guides, measurements of specific anatomical structures like the pronotum are provided to help distinguish between closely related species.

For example, if one species has a pronotum width that is typically less than 2.5mm and another species has a width greater than 2.5mm, then that measurement can be used as a distinguishing criterion.

To use the 2.5mm measurement:

Measure the width or length (as specified in your reference) of the pronotum of the bed bug using precise instruments like a calibrated micrometer.

Compare the measurement to the 2.5mm benchmark.

If the measurement is less than 2.5mm, it would indicate one species, and if it's greater, it would indicate the other species.

However, it's essential to note that such measurements can sometimes vary based on the age and feeding status of the insect, so it's always a good idea to consult an entomological guide or expert when making species-level identifications.

If you have a specific guide or source mentioning this 2.5mm measurement, referring directly to that would provide the most accurate answer.



RQ4: can you indicate precisely the scientific name based on the provided measurement?



you're looking for a scientific name based on the 2.5mm measurement of the pronotum, it would help to know which specific species reach this measurement and which do not. Generally, when distinguishing between species, entomologists use a combination of morphological features, including size measurements. However, based on the commonly known bed bug species:

Cimex lectularius (common bed bug): This species is widespread in temperate regions and might have a specific pronotum measurement that differentiates it from other species.

C. hemipterus (tropical bed bug): Found mainly in tropical regions, this species may differ in pronotum size and shape compared to *C. lectularius*. To conclusively provide a scientific name based solely on a 2.5mm pronotum measurement, I'd need specific information or a reference indicating which species corresponds to that particular measurement. Without that reference, I can only provide general knowledge about the species.



RQ5: How to discriminate between image A and B of these two species of bed bugs according to the pronotum measurement? (Figure 2.)



Figure 2 Tropical bed bugs *C. hemipterus*. 2. Common bed bug *C. lectularius* [19], in separate image.

Given the two images (Image A and Image B) and focusing on the pronotum measurements:

The pronotum is the plate-like structure on the dorsal side of the insect right behind the head. In the images, the differences in the pronotum can be visually analyzed.

Image A: The pronotum appears to be broader, with more rounded sides.

Image B: The pronotum looks more squared off at the sides and might be narrower.

If we were to differentiate species like *Cimex lectularius* (common bed bug) and *Cimex hemipterus* (tropical bed bug):

Cimex lectularius typically has a pronotum that is more squared off at the sides.

Cimex hemipterus has a more rounded pronotum. Based on this general knowledge:

Image A could be indicative of *Cimex hemipterus* due to its rounded pronotum, and Image B might be *Cimex lectularius* because of its squared-off pronotum.

However, to make a definitive identification, precise measurements of the pronotum's width and length should be taken and compared to known standards for each species. Additionally, cross-referencing with a detailed entomological guide or consulting with an expert in bed bug identification is recommended for conclusive results.



RQ6: Can you discriminate based on other features of pronotum measurement?

Certainly, let's dive deeper into the distinctions.

When differentiating between *C. lectularius* (common bed bug) and *C. hemipterus* (tropical bed bug), several morphological features, apart from the pronotum shape, can be considered: Pronotum: As mentioned, the pronotum's shape is a primary distinction. The common bed bug has a more rectangular or squared-off pronotum, while the tropical bed bug has a pronotum that is rounded at the sides.

Size: While both species are roughly similar in size, their exact size can vary depending on factors like recent feeding. A well-fed adult bed bug can be larger and more elongated than a hungry one.

Color: After feeding, bed bugs tend to become redder. However, this is not a reliable method for species identification since the color can change based on the bug's last feeding time.

Geographical Distribution: While both species can be found worldwide due to human travel, *C. lectularius* is more common in temperate regions, while *C. hemipterus* is more prevalent in tropical and subtropical areas.

Hair Length: The hairs or setae on the body, especially on the lower margin of the pronotum, can be of different lengths in various species. Comparing these with known standards can aid in identification.

Eggs: The eggs of the two species can also differ slightly in size and shape.

For a precise identification:

It's essential to have good quality images that show the insect from different angles. Using a microscope or a magnifying lens can aid in observing small features that might not be visible to the naked eye. Consultation with entomological literature or experts specializing in bed bugs can provide a more accurate identification. Remember, while visual distinctions are helpful, molecular methods like DNA barcoding have also been employed for precise species identification in recent years.

4. Discussion

Regarding the fact that the study will contribute to increasing the exchange of experiences between researchers, the Chat GPT did not provide sufficient information about the scientific name, which is essential for the exchange of knowledge among researchers worldwide. Another contribution that the Chat GPT will help ordinary people to identify bed bugs and distinguish between their species easily.

Regarding the fact that ChatGPT-4 will facilitate the task of workers at the Communicable Disease Control Centers in identifying the species of bed bugs, the ChatGPT-4 provided information about the environment and ecology of bed bugs without indicating the scientific name. This information may be somewhat useful for those working in communicable disease control centers. Another notable shortcoming of ChatGPT-4 is its failure to provide information on how to differentiate between the two species of bed bugs based on measurements. ChatGPT-4 briefly mentioned measurements, such as the requirement for a measurement of less than 2.5 mm for species B, but it did not provide specific answers for distinguishing species A or measurements less than 2.5 mm. This lack of information remains a significant drawback. Therefore, the process of morphological classification becomes incomplete and becomes more complex. Although the ChatGPT does not provide the correct information about the scientific name of the bed bug from the images, it remains difficult to employ it in airports or hotels. This is primarily due to the striking resemblance of the bedbug's morphological form to other insects, which leads to confusion in the classification or diagnosis process.

5. Conclusion and Future Work

Artificial Intelligence, exemplified by GhatGPT-4, represents a transformative force in technology, enhancing human-computer interaction and understanding. However, the potential applications of AI extend beyond language modeling. Turning our attention to the study on bed bugs, while the morphological differences between *C. lectularius* and *C. hemipterus* are indeed vital for effective pest management and public health, there are limitations to the assistance provided by GPT-4. Gaps in the knowledge base include the failure to provide scientific names, essential for global research collaboration. Additionally, the model lacks specific information on distinguishing these species based on measurements, which impacts the completeness of the morphological classification process. Moreover, despite the potential for using AI in environments like airports or hotels, the inherent challenge of morphological similarity among insect species hinders practical application.

This study underscores the potential and limitations of AI in assisting with real-world challenges, emphasizing the need for further research and a holistic approach to pest management and public health efforts.

According to the analysis of the results, the current research reached many future recommendations as the following:

- **Enhancing Species Identification Accuracy:** Future work could focus on improving AI models, like GPT-4, in accurately providing scientific names and specific information for distinguishing insect species. This could involve training the AI with more comprehensive datasets that include detailed morphological measurements and characteristics of various insect species.
- **Integrating Image Recognition Capabilities:** Incorporating image recognition and analysis capabilities into AI models could significantly improve the identification and classification of insect species. This would allow for more accurate differentiation, especially among morphologically similar species, enhancing the effectiveness of pest management strategies.
- **Developing AI-Assisted Diagnostic Tools:** Future research can explore the development of diagnostic tools that use AI to assist in the rapid and accurate identification of pest species in various environments, such as airports and hotels. These tools could combine AI-powered language processing with image recognition and other sensory data analysis.
- **Collaborative AI Research Platforms:** Establishing global research collaboration platforms that leverage AI could facilitate the sharing of knowledge and data across borders. This would enhance the global understanding of pest spe-

cies and their management, benefiting public health efforts worldwide.

- **AI in Environmental Monitoring:** Investigating the use of AI in environmental monitoring to track and manage pest populations. AI could analyze data from various sources to predict infestations, aiding in proactive pest control measures.
- **Addressing Ethical and Privacy Concerns:** With the increased use of AI in public spaces, future work should also consider the ethical and privacy implications of deploying AI-driven tools in environments like hotels and airports.
- **Interdisciplinary Research:** Encouraging interdisciplinary research that combines entomology, AI, public health, and environmental science could lead to more holistic and effective pest management solutions.
- **AI Training and Education in Pest Management:** Lastly, integrating AI training into pest management and public health education programs can prepare professionals for the evolving landscape of technology-driven solutions in these fields.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

- [1] **Alyasiri, O. M., & Ali, A. H. (2023).** Exploring GPT-4's Characteristics Through the 5Vs of Big Data: A Brief Perspective. *Babylonian Journal of Artificial Intelligence*, 2023, 5-9.
- [2] **O. M. Alyasiri, D. Akhtom, and M. N. Alrasheedy (2023).** An Overview of GPT-4's Characteristics through the Lens of 10V's of Big Data. In 2023nd International Conference on Intelligent Cybernetics Technology \& Applications (ICICyTA), IEEE, in press.
- [3] **H. A. Younis, T. A. E. Eisa, M. Nasser, T. M. Sahib, A. A. Noor, O. M. Alyasiri, S. Salisu, I. M. Hayder, and H. A. K. Younis (2023).** A Systematic Review and Meta-Analysis of Artificial Intelligence Tools in Medicine and Healthcare: Applications, Considerations, Limitations, Motivation and Challenges. *Diagnostics*.
- [4] **A. O. Mohammed, S. A. Salisu, H. Younis, A. M. Salman, T. M. Sahib, D. Akhtom, and I. M. Hayder (2023).** ChatGPT Revisited: Using ChatGPT-4 for Finding References and Editing Language in Medical Scientific Articles. [Online]. Available: <https://ssrn.com/abstract=4621581>. Accessed on: Nov. 18, 2023. doi: 10.2139/ssrn.4621581.
- [5] **T. M. Sahib, O. M. Alyasiri, H. A. Younis, D. Akhtom, I. M. Hayder, S. Salisu, and Muthmainnah (2023).** A comparison between ChatGPT-3.5 and ChatGPT-4.0 as a tool for paraphrasing English Paragraphs. In *International Applied Social Sciences (C-IASOS-2023) Congress*. pp 471-480.
- [6] **Mohammed, O., Sahib, T. M., Hayder, I. M., Salisu, S., & Shahid, M. (2023).** ChatGPT Evaluation: Can It Replace Grammarly and Quillbot Tools?. *British Journal of Applied Linguistics*, 3(2), 34-46.
- [7] **O. M. AL-Janabi, O. M. Alyasiri, and E. A. Jebur (2023).** GPT-4 versus Bard and Bing: LLMs for Fake Image Detection. In 2023nd International Conference on Intelligent Cybernetics Technology \& Applications (ICICyTA), IEEE, in press.
- [8] **Dua'a, A. K. H. T. O. M., Alyasiri, O. M., Allogmani, E., Amer, M., & Salman, T. M. S. (2023).** Unlocking ChatGPT'S Title Generation Potential: An Investigation of Synonyms, Readability, and Introduction-Based Titles. *Journal of Theoretical and Applied Information Technology*, 101(22).
- [9] **Sahib, T. M., Younis, H. A., Alyasiri, O. M., Ali, A. H., Salisu, S., Noore, A. A., ... & Shahid, M. (2023).** ChatGPT in Waste Management: Is it a Profitable. *Mesopotamian Journal of Big Data*, 2023, 107-109.
- [10] **O. V. Johnson, O. M. Alyasiri, D. Akhtom, and O. E. Johnson (2023).** Image Analysis through the lens of ChatGPT-4. *Journal of Applied Artificial Intelligence*, 4(2).
- [11] **Akhoundi, M., Sereno, D., Durand, R., Mirzaei, A., Bruel, C., Delaunay, P., ... & Izri, A. (2020).** Bed bugs (Hemiptera, Cimicidae): overview of classification, evolution and dispersion. *International Journal of Environmental Research and Public Health*, 17(12), 4576.
- [12] **Baqir, H. A., & Ab Majid, A. H. (2023).** Genetic diversity and phylogenetic relationships of tropical bed bugs (Hemiptera: Cimicidae) infestation from different regions of Iraq. *Gene Reports*, 101866.
- [13] **Parola, P., & Izri, A. (2020).** Bedbugs. *New England Journal of Medicine*, 382(23), 2230-2237.
- [14] **Sheele, J. M., Libertin, C. R., Pritt, B. S., Wysokinska, E. M., & Pietri, J. E. (2021).** Investigating the association of bed bugs with infectious diseases: A retrospective case-control study. *Heliyon*, 7(10).
- [15] **Doggett, S. L., Miller, D. M., & Lee, C. Y. (Eds.). (2018).** *Advances in the biology and management of modern bed bugs*. John Wiley & Sons.
- [16] **Akhoundi, M., Sereno, D., Durand, R., Mirzaei, A., Bruel, C., Delaunay, P., ... & Izri, A. (2020).** Bed bugs (Hemiptera, Cimicidae): overview of classification, evolution and dispersion. *International Journal of Environmental Research and Public Health*, 17(12), 4576.
- [17] **Doggett, S. L., & Lee, C. Y. (2023).** Historical and Contemporary Control Options Against Bed Bugs, *Cimex* spp. *Annual Review of Entomology*, 68, 169-190.
- [18] **Berenger, J. M., & Delaunay, P. (2008).** Bedbugs (Hemiptera, Cimicidae): biting again. *Medecine Tropicale: Revue du Corps de Sante Colonial*, 68(6), 563-567.
- [19] **Bérenger, J. M., & Pluot-Sigwalt, D. (2017).** Présence en France de la punaise de lit tropicale, *Cimex hemipterus* (Fabricius, 1803)(Hemiptera, Heteroptera, Cimicidae). *Bulletin de la Société entomologique de France*, 122(4), 423-427.