中国科学院沈阳自动化研究所
SHENYANG INSTITUTE OF AUTOMATION CHINESE ACADEMY OF SCIENCES

CC: Prof. Bradley Nelson,

Dear Dr. Michael M. Lee,

Thank you very much for your efforts in handling our manuscript (abo7696) entitled "Uncover rock-climbing fish' s secret of balancing tight adhesion and fast sliding for bioinspired robots" We greatly appreciate it.

We are disappointed to learn, while both the Reviewers 1 and 2 had very positive comments, the paper was still rejected. We thoroughly studied the comments, especially the reviewer 3's comments. It appears that the reviewer 3 misunderstood our paper, in particular, the main points from a published that the reviewer 3 used against our paper. As a result, we made an effort recently to contact Dr. Jun Zhou to clarify the potential confusion. Dr. Zhou, the corresponding author, kindly read our paper and quickly returned to us his extremely positive comments about our paper and offered a letter to explain to you why he also believed the reviewer 3 made mistakes in understanding their paper and in reviewing our paper.

Due to the significance of the information, we thought we should write to you and ask for your kind reconsideration of our paper through potentially seeking additional reviewers for your decision. For your reference, we enclosed a detailed rebuttal letter.

Sincerely yours,

Lianqing Liu

Lianqing Liu, PhD
Professor and Director
The State Key Laboratory of Robotics, P. R. China

Rebuttal Letter：

1. Reviewer 3 compared the adhesion stress of the developed crawling robot (3 kPa) with a small-scale suction cup(300 kPa), then he drew his conclusion that the work had no scientific and performance contributions. This comparison is inappropriate. The key contribution of the manuscript is to uncover the mystery of tight adhesion and fast sliding of rock-climbing fishes (*B. kweichowensis*), and the development of a bio-inspired robot can not only perform underwater adhesion, but also slide underwater simultaneously. Many artificial suckers can generate much higher adhesion, but none of them could move like rock-climbing fishes (*B. kweichowensis*) freely. As a matter of fact, it is very impressive, as confirmed by other reviewers, that the development of the bioinspired robot could reach a similar pressure level as a truly climbing fish (3 kPa vs. 6 kPa).
2. Reviewer 3 misunderstood that the fish was swimming quickly near a fully submerged horizontal surface and concluded that no adhesion was needed during moving based on our recorded video. The reviewer should note that the fish is sliding on a vertical wall instead a horizontal wall (see Supplementary Movie_mov1), and adhesion is needed while sliding. Consequently, the reviewer concluded that there was no mystery in balancing tight adhesion and fast sliding. The reviewer's argument was that the fish can move only when released from the substrate, which was not the case here. We performed additional experiments to verify that the fish can slide fast even under large adhesion (See attached Movie R1). To the best of our knowledge, this unique mechanism for

underwater robotic motion has not been reported in the open literature, which will have broad interests from the robotic community and is worth archiving in the literature. We reported our discovery that the microfluidic hydrodynamic interaction and the negative pressure effect are employed to balance adhesion and sliding skillfully, based on which a bioinspired robot was developed and verified the effectiveness of the proposed theory. This is significant, as commented by the rest two reviewers.

3. Review 3 is wrong that it is impossible that a microstructured rim could outperform a smooth rim. Both the simulation based on a theoretical model and experiments based on a well-thought design shows that setae could generate a better sealing effect and generate a higher adhesion force. In addition, other published articles also support our experimental results, such as Ref. R8 (Tsujioka., et al, 2022).
4. Additionally, Reviewer 3 used preponderance misleading information to draw the rejection conclusion. The reviewer claimed Ref. R7 shows that there were two orders of magnitude higher performance of the smooth suction cup than the microstructured suction cup. In fact, Ref. R7 only reported that two orders of magnitude higher performance occur in cups on a substrate with a hole and a substrate without a hole, which is different from ours.
5. Review 3 pointed out several times that our analysis is different from the papers from Prof. Jun ZOU's group (Ref. 3 and 32). We have contacted Prof. Jun ZOU for a detailed discussion about the conflict addressed by Reviewer 3. Prof. ZOU believes our analysis is a significant step further to unlocking the adhesion-sliding secret of rock-climbing fishes (*B. kweichowensis*) rather than confliction. Please find the attached supporting letter from Prof. ZOU.

We provide a point-by-point response in the attached file.

As such, I am writing sincerely to ask for your reconsideration of our manuscript by potentially inviting additional reviewer(s). Should you need any additional information regarding this matter, please do not hesitate to contact me.

I am looking forward to hearing from you.

Checklist of Attached files:

1. Supporting Letter From Prof. Jun ZOU (addressed the concerns of reviewer 3 about the difference with the previous work)
2. Movie R1 (showed the fish could slide under large adhesion)
3. Movie R2 (showed the microbubbles are vesicles under the epidermis)
4. Response to Reviewer's Comments
5. Revised Manuscript
6. Signed Letter

References :

[32] J. Zou, J. Wang, C. Ji, The Adhesive System and Anisotropic Shear Force of Guizhou Gastromyzontidae. *Scientific Reports*. **6**,37221 (2016).

[R7] Y. Wang, Z. Li, M. Elhebeary, R. Hensel, E. Arzt, M.T.A. Saif, Water as a "glue": Elasticity-enhanced wet atta chment of biomimetic microcup structures. *Science Advances*. **8**, (2022).

[R8] K. Tsujioka, Y. Matsuo, M. Shimomura, Y. Hirai, A New Concept for an Adhesive Material Inspired by Clingfish Sucker Nanofilaments. *Langmuir*. **38**,1215-1222 (2022).

[3] J. Wang, C. Ji, W. Wang, J. Zou, M. Pan, An adhesive locomotion model for the rock-climbing fish, Beaufortia kweichowensis. *Scientific Reports*. **9**,16571 (2019).