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kerang yang berukuran kecil yang menunjukkan tingginya frekuensi penyaringan air per satuan waktu.

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cm) lebih rentan mengalami kerusakan insang dibandingkan kerang berukuran besar (4–5 cm), yang disebabkan oleh struktur filamen insang yang lebih tipis dan aktivitas filtrasi yang lebih tinggi. Kondisi tersebut meningkatkan risiko kerusakan jaringan akibat paparan senyawa toksik dalam media pemeliharaan (Fauziah et al., 2012). Paparan senyawa toksik yang terus-menerus turut melemahkan kerja enzim antioksidan (*superoksida dismutase*) yang berperan melindungi sel pada insang dari kerusakan akibat radikal bebas (Guo et al., 2023).

Secara keseluruahn, kerang berukuran kecil yang mengalami kerusakan berat pada jaringan insang (Gambar 3.6.KM) dan terpapar senyawa toksik secara terus-menerus tidak menunjukkan tanda-tanda regenerasi jaringan, sehingga lebih cepat mengalami kematian. Sebaliknya, kerang dengan tingkat kerusakan sedang (Gambar 3.6.A_1B_1 dan 3.6.A_1B_2) masih memiliki peluang untuk bertahan hidup yang diduga berkaitan dengan masih berlangsungnya proses regenerasi sel. Sementara itu, kerang yang hanya mengalami kerusakan ringan pada insang (Gambar 3.6.A_2B_1 dan 3.6.A_2B_2) tidak mengalami kematian, kemungkinan disebabkan karena tingkat kerusakan tersebut belum cukup parah untuk mengganggu fungsi respirasi secara signifikan.

3.5. Kesimpulan

Perubahan histopatologis insang kerang darah yang ditimbulkan akibat paparan limbah tambak intensif udang vannamei, antara lain nekrosis, edema, hiperplasia, dan fusi lamela. Kerusakan insang ringan sampai sedang berupa edema dan hiperplasia ditemukan pada kerang yang berukuran besar, sedangkan kerusakan berat pada insang berupa nekrosis menyebabkan kematian kerang darah, baik pada ukuran kecil maupun ukuran besar.

3.6. Referensi

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Kondisi ini meningkatkan kerentanan kerang darah terhadap stres lingkungan dan infeksi, yang pada akhirnya berkontribusi terhadap peningkatan risiko kematian.

4.5. Kesimpulan

Kerang berukuran kecil menunjukkan kerentanan yang lebih tinggi, yaitu tingkat mortalitas akibat kerusakan insang berat berupa nekrosis yang lebih parah dibandingkan dengan individu berukuran besar. Tingkat kepadatan menyebabkan mortalitas kerang darah yang lebih tinggi dibandingkan dengan individu pada kepadatan rendah, yang menunjukkan kompetisi di antara individu kerang darah dalam memperoleh oksigen dan terpapar amonia sehingga mengakibatkan stres fisiologis dan kerusakan pada jaringan insang.

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bioremediasi dengan menggunakan kerang darah dapat berjalan secara optimal dan berkelanjutan.

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