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Photographic Observation of the Mangrove Slug *Platevindex* sp. Across Selected Sites in Klang Straits, Selangor

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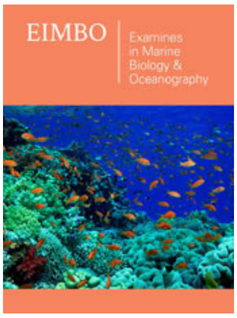

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Abstract

The *mangrove slug Platevindex* sp. is one of the most abundant non-shelled gastropods in the Straits of Malacca, yet it remains understudied, particularly in relation to habitat disturbance and pollution. This study provides the first photographic observational record of *Platevindex* sp. from several sites along the Klang Straits in Selangor. Field surveys were conducted from 4 October to 23 November 2025 to document the species' presence, microhabitat use, and visible pollution indicators within mangrove environments. Informal interviews with local residents were used to supplement field interpretations. Observations showed that in disturbed sites, slugs frequently occupied man-made substrates such as artificial rocks, discarded wood, and debris rather than natural structures such as pneumatophores. This apparent shift in microhabitat use suggests that habitat alteration and pollution pressures may be influencing behavioural responses. As this study represents an exploratory assessment, future systematic work is recommended to evaluate toxicological effects on the behaviour, habitat utilisation, and genetic diversity of *Platevindex* sp. public awareness on pollution in mangrove areas and potential ecological consequences is also needed.

Keywords: *Platevindex* sp; Mangrove pollution; Habitat stress; Microhabitat utilisation; Ecotoxicology

Introduction

The family *Onchidiidae* comprises diverse marine pulmonate slugs, with the Straits of Malacca recognized as a major biogeographical hotspot for mangrove *molluscs* [1,2]. Within this group, *Platevindex* sp. (Figure 1) is among the most diverse and widely distributed genera in Malaysia [1]. More than ten species are known globally, with at least five occurring in Peninsular Malaysia. Although common in mangrove ecosystems, *Platevindex* species remained poorly studied until recent taxonomic clarifications by Dayrat et al. [2]. which used genomic approaches to refine species delimitation, distribution patterns, and morphological characteristics [2]. These advances provide a foundation for ecological and environmental studies, particularly those concerning pollution impacts in mangrove habitats. Ecologically, *Platevindex* functions as a grazer of biofilms and microalgae [3,4] and serves as prey for benthic fish such as catfish and stingrays (local fishermen, personal communication, 1 November 2025). Its intermediate trophic position suggests that environmental changes affecting *Platevindex* populations may influence both energy flow and pollutant transfer within the mangrove food web. Understanding its microhabitat use and exposure to environmental stressors is therefore important for assessing ecosystem health. The Klang Straits contain extensive mangrove stands along Pulau Indah, Pulau Che Mat Zin, Pulau Ketam, Telok Gong, Sijangkang, and Pandamaran [5,6]. These areas are subject to strong anthropogenic pressures, including industrialisation, plantations, fisheries, and port-related activities. As a result, pollutants such as heavy metals and microplastics [7,8], and Polycyclic Aromatic Hydrocarbons (PAHs) [9,10] frequently accumulate in water, sediments [11-13], biota [13-16], and even air [17]. Such conditions may influence the abundance, distribution, and behavior of resident invertebrates. This study documents potential pollution sources and microhabitats used by *Platevindex* spp. across selected sites in the Klang Straits using photographic observations. The findings provide a preliminary ecotoxicological interpretation of environmental stressors affecting this little-studied mangrove slug.

Figure 1: Plate index sp. individual collected from the observed sites. The species is characterised by its slightly rough brownish texture on the hyponotum (dorsal part) and a creamy foot on the notum (ventral part) with a hole-like structure representing the anus. The photo was not edited with AI assistance.

Methodology

An on-site observational survey was conducted between 4 October and 23 November 2025 at four locations along the Klang Straits: Jeti Telok Gong, Kampung Pendamar in Pandamaran, an offshore island near Pulau Indah, and northern Pulau Indah. Site information, including coordinates, tidal conditions, and brief descriptions, is summarised in Table 1. At each site, photographs were taken to document the numbers of *Platevindex* individuals, the type of substrates they occupied, microhabitat conditions, and visible pollution sources. All photographs were captured by the observers without any AI editing. Informal interviews with local residents and fishermen provided qualitative insights into perceived pollution severity and long-term changes. Observational notes and photographic records were subsequently examined to assess patterns in habitat utilisation and to infer potential exposure to anthropogenic stressors.

Table 1: Descriptions of selected sites of plate index sp. in the Klang Straits.

Sites	Numbers
S1: Jeti Telok Gong	25
S2: Jeti Pendamar Pandamaran	5
S3: A nearby island near Pulau Indah	45
S4: Northern of Pulau Indah	8

Result

Observation of *Platevindex* sp. abundance and microhabitats

At Site 1 (Jeti Telok Gong), observations were made during low tide between 11:00 and 12:00. Weather conditions ranged from partly to intensely sunny. More than 25 active individuals of *Platevindex* sp. were recorded in the high intertidal zone near a small stream adjacent to the jetty. Slugs were found resting on mangrove tree trunks and pneumatophores as well as on shaded, slightly rough artificial surfaces such as wood and rocks (Figure 2a-2c). Only a few individuals were observed on discarded PVC pipes. The area was approximately 50m from small-scale fishing platforms and residential houses, with minor development opposite the site. Light but noticeable rubbish was scattered around the area, and vehicles were present at the jetty parking zone. At Site 2 (Kampung Pendamar jetty, Pandamaran), observations between 9:30 and 10:30 on a slightly sunny day recorded only five individuals of *Platevindex* sp. Three individuals were resting on Nipah (*Nypa fruticans*) fronds in the high intertidal area, while two were on artificial rocks (Figure 2d, 2f). The site represented a rural village environment with mainly young mangrove stands, fishing structures, small recreational areas, and residential settlements. The intertidal area was dominated by small rocks, zinc pieces, stone fragments, and dumped wood. A nearby plastic and chemical container dumping site was located close to the village. At Site 3 (an island near Pulau Indah), surveyed between 11:30 and 12:30, substantially less rubbish was observed compared with Sites 2 and 4, possibly due to its location and relatively higher mangrove canopy. Taller Avicennia trees were present, and approximately 40 individuals of *Platevindex* sp. were recorded within a 2m radius. Slugs were mainly found on tree trunks and branches and on decaying logs (Figure 2e & 2f), with none observed directly on mud surfaces. High local densities were recorded, with more than five individuals on a single piece of wood within a one-metre span. A possible instance of copulatory behaviour was also photographed at this site. At Site 4 (northern Pulau Indah), surveyed between 12:30 and 13:00 during the lowest tide of the day, the largest amount of rubbish was recorded among all sites. Plastic, mechanical debris, and medical waste were scattered from low to high intertidal zones. Although slugs were again associated with logs and branches, only eight individuals were recorded, each separated by distances of around 30m. Slug abundance across sites is summarised in Table 2, while representative habitat photographs for all four sites are shown in Figure 2.

Table 2: Numbers of plate index sp. observed at the four study sites.

Site	Location description	Number of individuals
S1	Jeti Telok Gong	25
S2	Jeti Pendamar, Pandamaran	5
S3	Island near Pulau Indah	45
S4	Northern Pulau Indah	8

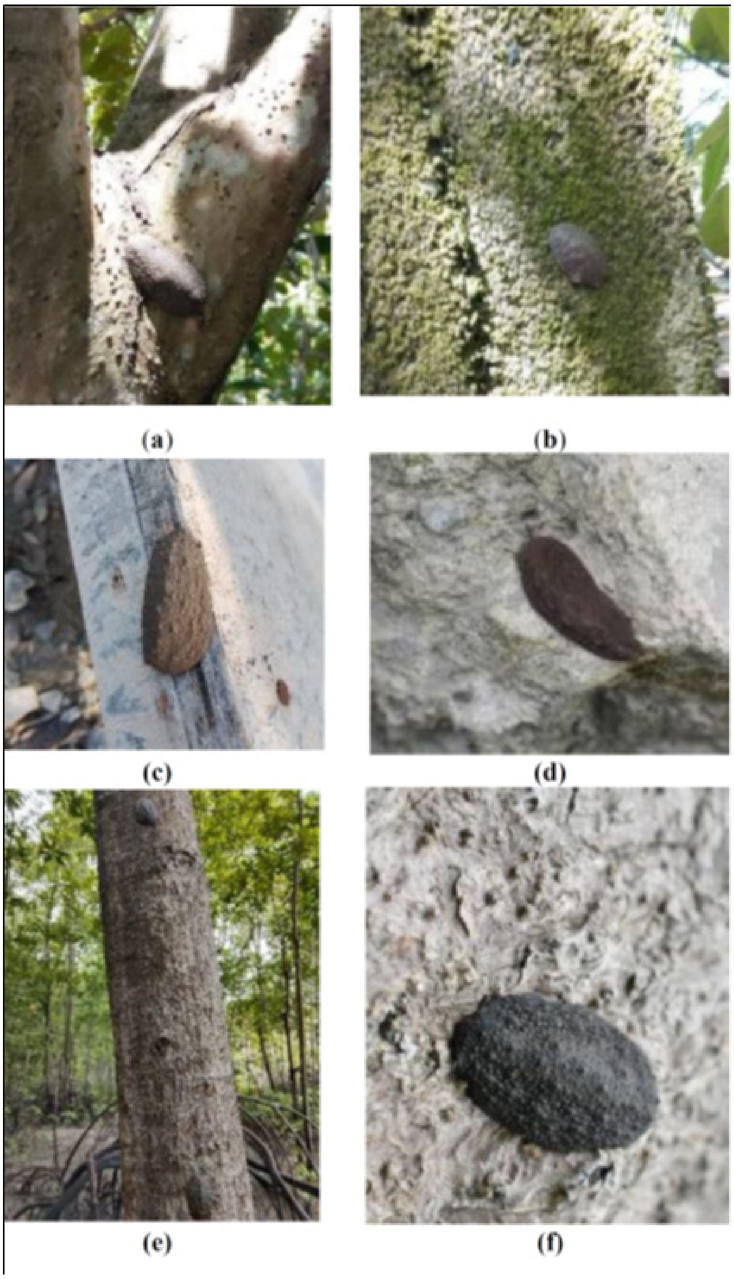

Figure 2: The habitat of plate index sp observed from four sites (a) The individual was observed on a tree trunk around 2m from ground in S1 (b) The individual was observed on an artificial rock with dense biofilm in S1 (C) The individual was observed on an abandoned wood S1 (D) plate index sp was found on rocks with less biofilm in S2. (e) Two individuals were found resting on a branch of tree in S3. (f) A direct zoom in photo of plate index inhabiting on rotted trunk in S4. All photos were captured by Mr. Izzuddin with a camera.

Discussion: An Ecotoxicological Perspective

Microhabitat utilisation and sensitivity to habitat condition

From the present study, the slug abundance followed a clear gradient: S2<S4<S1<S3. This ecological distribution pattern corresponds with the degree of habitat disturbance and mangrove structural complexity at each site. Site 3, which supported the highest number of *Platevindex* individuals, contained relatively undisturbed mangrove stands with abundant pneumatophores and mature trees [18]. These provide shaded, moist, and structurally complex substrates that favour *pulmonate slugs* [19]. The lower quantity of on-site rubbish suggests that much of the waste arrived indirectly via tidal transport, resulting in less direct disturbance. In contrast, Site 4 had substantial solid waste inputs across the intertidal zone, yet only a low number of slugs was recorded. Despite the presence of logs and branches suitable for attachment, extensive rubbish may have degraded habitat quality or forced slugs to migrate to higher or more remote intertidal areas not covered by this survey. Site 2, dominated by young mangroves and artificial

materials, showed further evidence of habitat modification: three of the five individuals were observed on Nipah fronds and two on artificial rocks, indicating a reliance on alternative vertical or artificial structures where mangrove complexity is reduced. The representative habitat photographs in Figure 2 illustrate these contrasts in microhabitat availability and disturbance.

Sources and spatial patterns of pollution stressors

As *Platevindex* habitats become increasingly degraded, the species faces greater exposure to nearby pollution sources. Two primary pathways of pollution were identified. First, direct anthropogenic inputs involve on-site dumping, local burning, and physical disturbance associated with fisheries and small-scale infrastructure (Figure 3) [20]. Second, tidal and hydrological transport carries pollutants from upstream regions into mangrove zones during high tide and heavy rainfall events (Figure 3) [21]. These pollutants may originate from wastewater discharge, urban runoff, industrial activities, and riverine transport within the catchment [22]. Information from a local fisherman at Site 2 indicated the frequent accumulation of microplastic debris in the intertidal zone during low tide. This observation strengthens the inference that degraded mangrove habitats in Klang Straits are vulnerable to pollutant deposition and that *Platevindex* populations inhabiting such areas are likely subjected to elevated environmental stress.

Figure 3: Possible pollution pathways affecting plate index habitats: (left) tidal transport that drives floating waste into mangrove stands; (right) direct anthropogenic inputs such as shipping, and other human activities.

Exposure pathways

Pollutants entering mangrove systems can reach *Platevindex* sp. through three principal exposure routes: surface contact, ingestion, and respiration [23]. Field observations suggest that surface contact is a dominant pathway because slugs move and rest on sediments, roots, trunks, and biofilm-covered surfaces (Figure 4). Their ocular tentacles and muscular foot, which maintain constant contact with substrates, may be especially vulnerable to contaminant uptake, similar to other *molluscs* [24,25]. Ingestion represents a second route. Slugs feed on algae, diatoms, bryophytes, and associated biofilms [3,4], which may accumulate microplastics, metals, and organic pollutants (Figure 4). Accidental ingestion of attached particles can introduce contaminants into the digestive tract. A third route is respiratory uptake. As *pulmonate gastropods*, *Platevindex* spp. respire through a pneumostome connected to a lung-like sac [19]. Airborne contaminants or those present in thin water films during high tide may be inhaled, contributing to internal exposure. Together, these pathways highlight the susceptibility of *Platevindex* spp. to environmental pollutants in degraded mangrove ecosystems.

Figure 4: Exposure interfaces of plate index sp.: (left) individual attached to an algal surface, indicating potential exposure via food and substrate; (right) the ventral surface in direct contact with sediments, illustrating continuous contact with possibly contaminated mud.

Bioaccumulation processes within individuals

The foot surface of *Platevindex* is likely the most susceptible body region because of continuous contact with potentially contaminated substrates. The radula, which scrapes biofilms during feeding, also facilitates ingestion of pollutants [3]. Once ingested, contaminants can travel through the *oesophagus* into the stomach and *gastrointestinal tract*, where absorption and subsequent accumulation in internal organs may occur [23]. Metabolically active tissues, such as muscles and digestive glands, often serve as principal storage sites [24]. Over time, contaminant burdens may exceed physiological tolerance thresholds, leading to cellular damage, oxidative stress, and altered metabolic processes [24]. Pollutants may also be transported to reproductive organs such as the penial sheath or ova, with possible implications for reproductive success and population dynamics [3]. Like other *molluscs,* slugs may employ detoxification mechanisms such as egestion of undigested materials, excretion of contaminants in granular forms, and sequestration within specific tissues [25-28]. Although these mechanisms have not yet been characterised in detail for *Platevindex* spp., their existence can be inferred based on evidence from other *molluscan* taxa.

Biomagnification within the mangrove food web

Pollutants retained in *Platevindex* tissues, including PAHs, heavy metals, and microplastics, may not only affect slug physiology, genetics, and behaviour but also contribute to broader ecological impacts. As primary consumers in mangrove ecosystems, *Platevindex* spp. represent a potential vector for contaminant transfer to higher trophic levels. Natural predators such as stingrays, catfish, and other benthic feeders may ingest slugs directly or indirectly (for example, when slugs are used as bait by local fishers). Through biomagnification, pollutant concentrations can increase along the food chain, resulting in higher body burdens among top predators [26]. Fish consumed by humans could therefore accumulate substantial contaminant loads over time, with possible health risks such as neurotoxicity, endocrine disruption, and other chronic outcomes depending on contaminant type and concentration.

Recommendations for a Future Ecotoxicological Framework

To deepen understanding of pollutant impacts in mangrove ecosystems from the perspective of *Platevindex* spp., future studies should emphasise dose-response relationships and mixture toxicity. Controlled laboratory experiments should determine pollutant concentrations that elicit sublethal and lethal effects in slugs, including changes in survival, growth, feeding, reproduction, and behavioural responses [29,30]. These thresholds can help explain field patterns in abundance and distribution and clarify whether *Platevindex* spp. can function as sensitive bioindicators of environmental health. Investigations into mixture toxicity are also necessary, as mangrove habitats are typically contaminated by multiple pollutants simultaneously [16]. Understanding whether contaminants act synergistically, additively, or antagonistically will provide a more realistic assessment of ecological risk. By combining field observations with dose-response and mixture studies, *Platevindex* spp. could be proposed as a novel biomonitor in mangrove ecosystems, complementing existing *molluscan* indicators and improving the assessment of pollutant dynamics.

Conclusion

This study documented the occurrence, abundance, and microhabitat characteristics of *Platevindex* sp. across four selected sites in the Klang Straits, Selangor. The results indicate that slug abundance and behaviour are closely linked to habitat quality and pollution levels. Less disturbed sites with structurally complex mangroves supported higher numbers of individuals, whereas heavily polluted and structurally simplified sites exhibited lower abundance and greater reliance on artificial substrates. These patterns suggest that *Platevindex* spp. may be sensitive to habitat degradation and pollutant exposure, making them promising candidates for future biomonitoring. Further research focusing on dose-response relationships and mixture toxicity could establish *Platevindex* sp. as a novel bioindicator and biomonitoring organism, contributing to improved assessment and management of mangrove ecosystem health in the Klang Straits and similar coastal environments.

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