# Supplementary material

Article title: **Differential response of macrobenthic abundance and community composition to mangrove vegetation**

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Table S1. List of taxa in the macrobenthic community identified in the four sites on the western coast of Taiwan and their corresponding living and feeding habits based on Cai [1] and the World Register of Marine Species (WoRMS) [2].

| Phylum | Class or Order | Taxon | Living habit | Feeding habit | Functional group |
|---|---|---|---|---|---|
| Sipuncula | Phascolosomatidea | *Phascolosoma arcuatum* | free | detritivore | Infauna |
| Cnidaria | Actiniaria | | attached | omnivore | Epifauna |
| Nemertea | | | free | carnivore | Infauna |
| Annelida | Oligochaeta | | free | detritivore | Infauna |
| | Polychaeta | Capitellidae | free | detritivore | Infauna |
| | | Cossuridae | free | detritivore | Infauna |
| | | Maldanidae | free | detritivore | Infauna |
| | | Eunicidae | free | carnivore | Infauna |
| | | Lumbrineridae | free | carnivore | Infauna |
| | | Glyceridae | free | carnivore | Infauna |
| | | Goniadidae | free | carnivore | Infauna |
| | | Nereididae | free | carnivore | Infauna |
| | | Ampharetidae | tube dweller | detritivore | Infauna |
| | | Cirratulidae | free | detritivore | Infauna |
| | | Orbiniidae | free | detritivore | Infauna |
| | | Sabellidae | tube dweller | filter feeder | Infauna |
| | | Spionidae | free | detritivore | Infauna |

Table S1. continued.

| Phylum | Class or Order | Taxon | Living habit | Feeding habit | Functional group |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Mollusca | Bivalvia | Shellfish larvae | attached | filter feeder | Infauna |
| | | Ostreidae | attached | filter feeder | Infauna |
| | | Tellinidae | attached | filter feeder | Infauna |
| | | Laternulidae | attached | filter feeder | Infauna |
| | | Corbulidae | attached | filter feeder | Infauna |
| | | Cyrenidae | attached | filter feeder | Infauna |
| | | *Glauconome chinensis* | attached | filter feeder | Infauna |
| | | Veneridae | attached | filter feeder | Infauna |
| | Gastropoda | Lymnaeidae | free | detritivore | Epifauna |
| | | *Acteocina koyasensis* | free | herbivore | Epifauna |
| | | Ellobiidae | free | herbivore | Epifauna |
| | | *Peronia verruculata* | free | detritivore | Epifauna |
| | | *Batillaria zonalis* | free | detritivore | Epifauna |
| | | *Pirenella alata* | free | detritivore | Epifauna |
| | | *Pirenella cingulata* | free | detritivore | Epifauna |
| | | Assimineidae | free | herbivore | Epifauna |
| | | *Iravadia quadrasi* | free | herbivore | Epifauna |
| | | *Iravadia reflecta* | free | herbivore | Epifauna |

Table S1. continued.

| Phylum | Class or Order | Taxon | Living habit | Feeding habit | Functional group |
|---|---|---|---|---|---|
| Mollusca | Gastropoda | *Hyala bella* | free | detritivore | Epifauna |
| | | Littorinidae | free | herbivore | Epifauna |
| | | Naticidae | free | carnivore | Epifauna |
| | | Stenothyridae | free | herbivore | Epifauna |
| | | Conidae | free | carnivore | Epifauna |
| | | *Reishia clavigera* | free | carnivore | Epifauna |
| Arthropoda | Tanaidacea | | free | detritivore | Epifauna |
| | Isopoda | | free | detritivore | Epifauna |
| | Amphipoda | Aoridae | free | detritivore | Epifauna |
| | | Corophiidae | free | detritivore | Epifauna |
| | | Ischyroceridae | free | detritivore | Epifauna |
| | | Microprotopidae | free | detritivore | Epifauna |
| | | Photidae | free | detritivore | Epifauna |
| | | Talitridae | free | detritivore | Epifauna |
| | Decapoda | Penaeidae | free | detritivore | Epifauna |
| | | Alpheidae | free | omnivore | Epifauna |
| | | Diogenidae | free | detritivore | Epifauna |
| | | Juvenile crab | free | omnivore | Epifauna |

Table S1. continued.

| Phylum | Class or Order | Taxon | Living habit | Feeding habit | Functional group |
|---|---|---|---|---|---|
| Arthropoda | Decapoda | *Mictyris brevidactylus* | free | detritivore | Epifauna |
| | | *Tmethypocoelis ceratophora* | free | detritivore | Epifauna |
| | | *Ilyograpsus paludicola* | free | detritivore | Epifauna |
| | | Ocypodidae | free | detritivore | Epifauna |
| | | Sesarmidae | free | omnivore | Epifauna |
| | | Helice formosensis | free | omnivore | Epifauna |
| | | *Pseudohelice subquadrata* | free | herbivore | Epifauna |
| | | *Metaplax longipes* | free | carnivore | Epifauna |
| | | Grapsidae | free | omnivore | Epifauna |
| | Xiphosurida | Limulidae | free | omnivore | Epifauna |
| | Diptera | Psychodoidea larvae | free | detritivore | Infauna |
| | | Dolichopodidae larvae | free | carnivore | Infauna |
| | | Chironomidae pupae | free | omnivore | Infauna |
| | Sessilia | Balanidae | attached | filter feeder | Epifauna |
| Chordata | Perciformes | Gobiidae | free | carnivore | Epifauna |
| Arthropoda | Decapoda | *Tmethypocoelis ceratophora* | free | detritivore | Epifauna |
| | | *Ilyograpsus paludicola* | free | detritivore | Epifauna |
| | | Ocypodidae | free | detritivore | Epifauna |
| | | Sesarmidae | free | omnivore | Epifauna |

Table S2. Analysis of the difference in macrobenthic variables between the mangrove forests and nonvegetated mudflats at the four sites on the western coast of Taiwan by Student's *t*-test (*t*-test) or the Wilcoxon rank-sum test (Wilcoxon). The bold values indicate significant differences ($p < 0.05$).

| Variable | Site | *p* value | Difference | Statistical method |
|---|---|---|---|---|
| Density | XF | 0.939 | | ***t*-test** |
| | ZN | **<0.001** | Mangrove < Mudflat | Wilcoxon |
| | BD | 0.275 | | ***t*-test** |
| | BM | **0.032** | Mangrove > Mudflat | ***t*-test** |
| Crab density | XF | **0.012** | Mangrove < Mudflat | Wilcoxon |
| | ZN | **<0.001** | Mangrove < Mudflat | Wilcoxon |
| | BD | **<0.001** | Mangrove < Mudflat | Wilcoxon |
| | BM | **<0.001** | Mangrove < Mudflat | Wilcoxon |
| Taxon number (richness) | XF | 0.903 | | Wilcoxon |
| | ZN | **<0.001** | Mangrove < Mudflat | Wilcoxon |
| | BD | 0.508 | | Wilcoxon |
| | BM | **0.015** | Mangrove > Mudflat | ***t*-test** |
| Shannon-Weiner diversity (H') | XF | 0.952 | | Wilcoxon |
| | ZN | **<0.001** | Mangrove < Mudflat | Wilcoxon |
| | BD | 0.729 | | Wilcoxon |
| | BM | **0.024** | Mangrove > Mudflat | ***t*-test** |

Table S3. Analysis of the seasonal and site effects on the macrobenthic variables in the mangrove forests on the western coast of Taiwan by the Kruskal-Wallis test. Dunn's test was used to determine which season or site showed a significant difference. The bold values indicate significant differences ($p < 0.05$).

| Variable | Factor | df | *H* | *p* value | Dunn's test |
|---|---|---|---|---|---|
| Density | season | 3 | 1.066 | 0.785 | |
| | site | 3 | 101.516 | **<0.001** | $XF^{a}ZN^{b}BD^{a}BM^{c}$ |
| Crab density | season | 3 | 13.191 | **0.004** | $win^{ab}spr^{a}sum^{b}aut^{b}$ |
| | site | 3 | 8.468 | **0.037** | no separation |
| Taxon number (richness) | season | 3 | 5.541 | 0.136 | |
| | site | 3 | 125.669 | **<0.001** | $XF^{a}ZN^{a}BD^{a}BM^{b}$ |
| Shannon-Weiner diversity (H') | season | 3 | 5.662 | 0.129 | |
| | site | 3 | 128.049 | **<0.001** | $ZN^{a}XF^{b}BD^{ab}BM^{c}$ |

Table S4. Analysis of the seasonal and site effects on the macrobenthic variables in the nonvegetated mudflats on the western coast of Taiwan by two-way ANOVA (*F* value) or the Kruskal-Wallis test (*H* value). Tukey's or Dunn's test was used to determine which season or site showed a significant difference. The bold values indicate significant differences ($p < 0.05$).

| Variable | Factor | df | *F* | *H* | *p* value | Tukey test/ Dunn's test |
|---|---|---|---|---|---|---|
| Density | season | 3 | - | 5.036 | 0.169 | |
| | site | 3 | - | 12.853 | **0.005** | $XF^{a}ZN^{b}BD^{a}BM^{ab}$ |
| Crab density | season | 3 | 5.062 | - | **0.006** | |
| | site | 3 | 2.332 | - | 0.096 | |
| | season x site | 9 | 4.259 | - | **0.001** | |
| Taxon number (richness) | season | 3 | - | 3.447 | 0.328 | |
| | site | 3 | - | 8.407 | **0.038** | no separation |
| Shannon-Weiner diversity (H') | season | 3 | - | 3.292 | 0.349 | |
| | site | 3 | - | 7.721 | 0.052 | |

Table S5. Comparisons of the densities of *Kandelia obovata* and macrobenthos observed in this study and other studies. FY: Fang-yuan, ZN: Zhunan, XF: Xinfeng, GD: Guandu, ZW: Zhuwei, and WZ: Wazihwei. The locations of the study sites in Taiwan are shown in Fig. S1.

| Site | Location | Tree density (ind. $m^{-2}$) | Macrobenthic density (ind. $m^{-2}$) | Infaunal density (ind. $m^{-2}$) | Epifaunal density (ind. $m^{-2}$) | Source |
|---|---|---|---|---|---|---|
| Futian mangrove, China | 22°32'N, 114°03'E | 0.23 | 13265 | 12776 | 489 | [3] |
| Qi'ao Island mangrove, China | 22°25'N, 113°37'E | 2.35 | 711 | - | - | [4] |
| Dazhou Island, China | 24°24'N, 117°55'E | 4.00 | 200 | 51 | 149 | [5] |
| Tai O mangrove, Hong Kong | 22°15'N, 115°51'E | 0.60 | 7679 | 7305 | 374 | [6] |
| FY, Taiwan | 23°55'N, 120°18'E | 2.07 | 146 | 130 | 16 | [7] |
| ZN, Taiwan | 24°40'N, 120°50'E | 1.91 | 1330 | 1139 | 191 | this study (2018) |
| ZN, Taiwan | 24°40'N, 120°50'E | 1.69 | 1626 | 1288 | 339 | this study (2019) |
| XF, Taiwan | 24°54'N, 120°58'E | 2.39 | 1030 | 762 | 268 | this study (2018) |
| XF, Taiwan | 24°54'N, 120°58'E | 2.21 | 1517 | 1087 | 430 | this study (2019) |
| GD, Taiwan | 25°7'N, 121°27'E | 0.65 | 5407 | - | - | [8] |
| ZW, Taiwan | 25°8'N, 121°27'E | 2.29 | 2575 | - | - | [8] |
| ZW, Taiwan | 25°8'N, 121°27'E | 1.00 | 1538 | 1388 | 149 | [9] |
| WZ, Taiwan | 25°9'N, 121°25'E | 1.26 | 171 | - | - | [8] |
| WZ, Taiwan | 25°9'N, 121°25'E | 0.52 | 1728 | 1557 | 171 | [10] |

Table S6. Comparisons of *Avicennia marina* tree and pneumatophore density and the density of macrobenthos in this study and other studies. CK: Chiku, BM: Beimen, BD: Budai, and FY: Fangyuan. The locations of the study sites in Taiwan are shown in Figure S1.

| Site | Location | Tree density (trees $m^{-2}$) | Pneumatophore density (ind. $m^{-2}$) | Macrobenthic density (ind. $m^{-2}$) | Infaunal density (ind. $m^{-2}$) | Epifaunal density (ind. $m^{-2}$) | Source |
|---|---|---|---|---|---|---|---|
| Puhinui Creek, New Zealand | 35°34'S, 174°30'E | 2.09 | 140 | 1932 | - | - | [11] |
| Matapouri Estuary, New Zealand | 36°99'S, 174°80'E | 0.38 | 359 | 7298 | 1715 | - | [12] |
| Segara Anakan Lagoon, Java | 7°48'S, 109°03'E | 0.12 | - | 882 | 262 | 620 | [13] |
| Segara Anakan Lagoon, Java | 7°48'S, 109°03'E | 0.73 | - | 356 | 216 | 140 | [13] |
| Zhanjiang mangrove, China | 21°35'N, 110°35'E | 1.00 | - | 125 | - | - | [14] |
| Zhanjiang mangrove, China | 21°52'N, 109°77'E | 0.33 | - | 133 | - | - | [15] |
| Tai O mangrove, Hong Kong | 22°15'N, 115°51'E | - | 750 | 8395 | 7987 | 408 | [6] |
| Futian mangrove, China | 22°32'N, 114°03'E | 0.26 | 250 | 13400 | 12906 | 494 | [3] |
| CK, Taiwan | 23°7'N, 120°5'E | 0.32 | - | 11132 | 10343 | 789 | [16] |
| BM, Taiwan | 23°29'N, 120°11'E | 0.59 | 119 | 1178 | 476 | 702 | this study (2019) |
| BM, Taiwan | 23°29'N, 120°11'E | 0.31 | 245 | 4830 | 3485 | 1344 | this study (2019) |
| BD, Taiwan | 23°36'N, 120°13'E | 0.61 | 119 | 1880 | 303 | 1577 | this study (2018) |
| BD, Taiwan | 23°36'N, 120°13'E | 0.35 | 245 | 3059 | 2046 | 1012 | this study (2018) |
| FY, Taiwan | 23°56'N, 120°18'E | 0.50 | 259 | 973 | 334 | 639 | [7] |
| FY, Taiwan | 23°56'N, 120°18'E | 1.11 | 409 | 1170 | 872 | 298 | [7] |

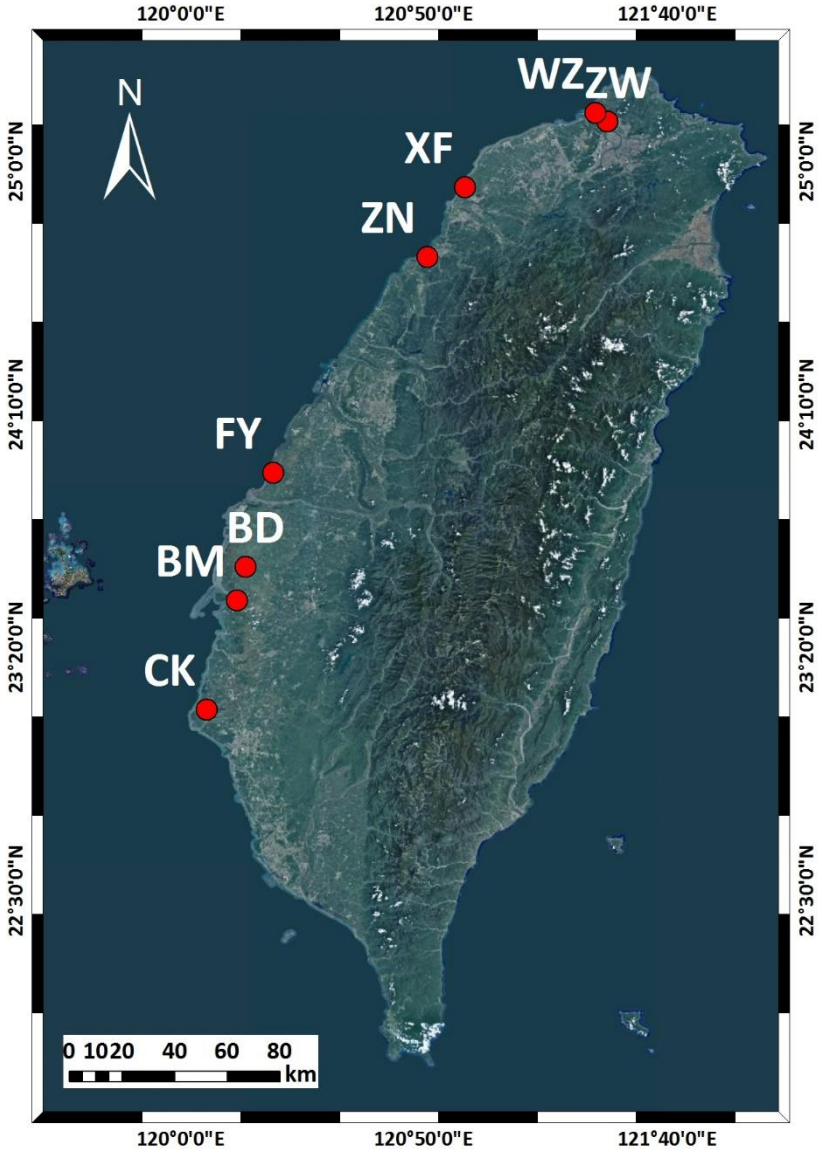


Figure S1. Locations of the study sites on the western coast of Taiwan. From north to south: WZ, Wazihwei; ZW, Zhuwei; XF, Xinfeng; ZN, Zhunan; FY, Fangyuan; BD, Budai; BM, Beimen; CK, Chiku. GD (Guandu) overlaps with ZW. Among these sites, XF, ZN, BD and BM were sampled in this study.

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