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RESEARCH NOTE

Seaweed Fish Baits in Bulusan, Sorsogon, Philippines

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Little attention has been directed toward the local use of seaweeds as fish baits despite their relevance to the success of fishing operations. Fish baits represent little more than a subset of the major local use of seaweeds in the Philippines. In Sorsogon, Bulusan has a history of small-scale fishing with three traditional fishing gears – namely, fish pot, hook and line, and long line. In this study, we provide traditional knowledge on the selection of seaweeds as fish baits among fishers in Bulusan. Currently, the traditional fishing practice in the area retains the use of nine seaweed fish bait taxa – namely, *Acanthophora spicifera*, *Eucheuma denticulatum*, *Gracilaria gigas*, *Kappaphycus alvarezii*, *Sargassum polycystum*, *Ulva clathrata*, *Ulva flexuosa*, *Ulva lactuca*, and *Ulva reticulata*. The last four species (collectively known as the ulvoids) were the most familiar seaweed fish baits. Eleven (11) target fish species were identified, being *Naso* and *Siganus* as the most dominant genera. Additional 22 species (17 fishes and five non-fishes) were recognized as incidental catch. We found that critical approaches take part in the continued construction of the contemporary Bulusanon fishing culture, particularly in knowledge about seaweed fish baits. The traditional fishing practice in Bulusan draws our attention to discuss caveats on its possible impact on marine environments, particularly in the light of overfishing and coral-algal phase shifts. Aspects of ethnobiological resources documented in this study may provide a framework for attaining sustainable fishery management, alongside preserving knowledge of the local old hands.

Keywords: ethnobotany, hook and line, fishing management, fish pots, long line, *Sargassum polycystum*, ulvoids

Seaweeds are consumed by a diverse assemblage of fish. It is, therefore, unsurprising that humans have had long practical use of seaweeds as fish baits. Acting as a direct food or attractant to target fish, baits are key to the success of fishing operations (Løkkeborg *et al.* 2014). There exists a considerable number of studies about the different types of fish baits and their use (Kumar *et al.* 2016; Masilan and Neethiselvan 2018). However, despite the long history of strong relationships of humans with seaweeds (Khalilieh and Boulos 2006; Erlandson *et al.* 2007; Dillehay *et al.* 2008; Pérez-Lloréns *et al.* 2020; Mouritsen *et al.* 2021), little is known about the use of seaweeds on local fishing

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technique. In the Philippines, information about seaweed fish baits is known only in passing [see Cordero (1987), Trono and Ganzon-Fortes (1988), Hurtado-Ponce *et al.* (1992), and Ayson and Encarnacion (2008)].

The province of Sorsogon terminates the southern tip of the Luzon Island, Philippines (Figure 1). One of its municipalities situated at its eastern side is Bulusan. Spanning the embayment facing the San Bernardino Strait, Bulusan sea receives the nutrient-rich waters from the Pacific Ocean (Gordon *et al.* 2011) and the equally nutrient-rich basaltic seafloor of Mount Bulusan (Divis 1980). Together, these contribute to support a wide array of marine life, particularly fishes. Small coastal communities of Bulusan, hence, constitute a large proportion of whom are dedicated to fishing. According to the Bureau of Fisheries and Aquatic Resources, as of 2022, the registered fishers in Bulusan stand to 529. Despite the modern age, Bulusan fishers still practice traditional fishing.

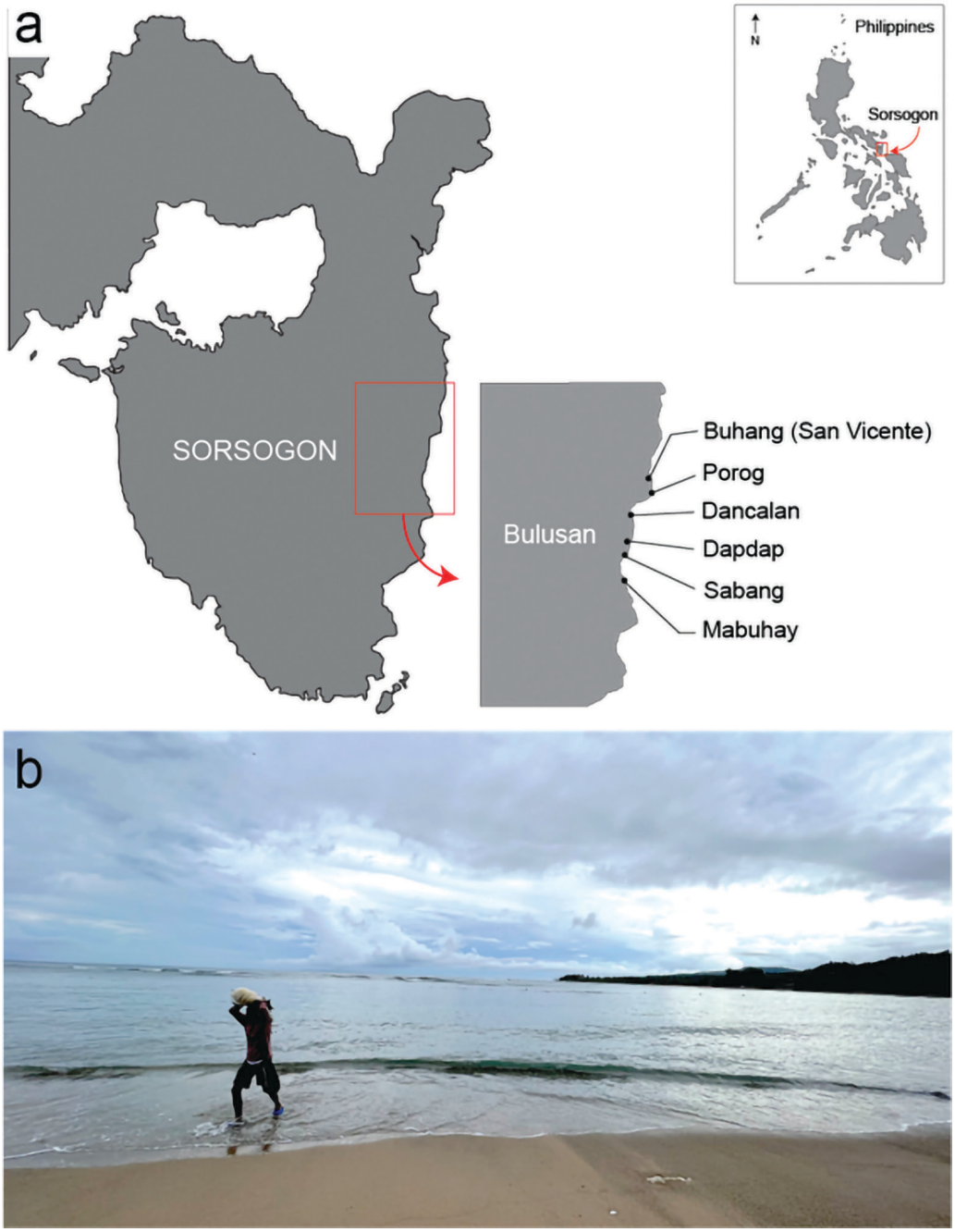

Figure 1. Bulusan, Sorsogon, Philippines. [a] Bulusan map with emphasis on study sites where surveys were done. [b] A photo showing the embayment of Bulusan, Sorsogon, Philippines.

Bulusan is also a seaweed diversity-rich area (Trono 1975, 1976; Kraft *et al.* 1999; Dumilag *et al.* 2020). Bulusanon, the locals of the area, are long familiar with the use of seaweeds. Our recent ethnobotanical survey in Bulusan allowed us to observe the daily grinds of local fishers there. That beside the use of seaweeds as food and medicine (Dumilag *et al.* 2022), the Bulusanon fishers also use them as fish baits. The use of seaweed in fishing practice among fishers in the area is still undescribed. The aim, therefore, of this study is to document the seaweed fish baits known and traditionally used by local fishers in Bulusan.

Participated by 87 respondents, a field survey was conducted in October 2022 on six coastal *barangays* (smallest political unit in the Philippines) in Bulusan – namely, Dancalan (n = 13), Dapdap (n = 10), Buhang (San Vicente, n = 29), Mabuhay (n = 12), Porog (n = 3), and Sabang (n = 20). Respondent selection was done using convenience sampling. Responses were populated using semi-structured interviews highlighting questions on demographic profile, gear type, fishing gear deployment, local name and use of seaweed as fish bait, and fish catch composition. Participants were exclusive of male fishers with an average age of 47 and a 44-year-mean of local residency. Most were married (70.5%).

In Bulusan, seaweeds were used for each of the three types of traditional fishing gears – namely, the fish pot ("bubo"), hook and line ("banwit"), and long line ("pakitang"). Fish pot was the most utilized fishing gear (95% of the respondents). All seaweeds identified in the study were used in the fish pots. Other seaweeds used in hook and line (4% of the respondents) and long line (1% of the respondents). These types of fishing gears required common baits such as trash fish and artificial baits (Kumar *et al.* 2016). In Bulusan, seaweeds however remain to be the exclusive choice of the type of fish baits, particularly those that use fish pots. Intuitively, the choice of seaweed as fish bait can be explained by having algivorous fishes as the target catch.

A total of nine seaweed taxa were identified as fish baits (Table 1). Locally referred to as "lumot," ulvoids (*Ulva clathrata*, *Ulva flexuosa*, *Ulva lactuca*, and *Ulva reticulata*) were the most common (Figure 2), followed by *Sargassum polycystum* (including its combination to ulvoids) (Figure 3). Other studies indicated that ulvoids and *Sargassum* spp. were also the most used seaweed fish baits. For instance, ulvoids (as then *Enteromorpha*) were also used by fishers in Visayas (Cordero 1987; Bucol 2016). Extra-Philippine areas where ulvoids were used include Bahrain and Taiwan (Basson 1989; Wang and Chiang 1994). *Sargassum* species were also used in several countries in Asia (Tang *et al.* 2015; Pereira 2016). In this study, *Acanthophora spicifera*, *Eucheuma denticulatum*, *Gracilaria gigas*, and *Kappaphycus alvarezii* appeared to be less popular to local fishers but were widely regarded as vegetable seaweeds (Pereira 2016). We did not find previous reports that used the same species as fish baits, although congeneric taxa were deployed as experimental bait materials reported in other studies (Anderson *et al.* 1993; Chen *et al.* 2020; Yahya *et al.* 2020).

Mixed seaweed fish baits were also observed. The most dominant was the combination of ulvoids and *S. polycystum* (20%). The use of other combined seaweeds was, however, practiced by only a few respondents. Combination of seaweeds as fish baits elsewhere is mostly confined to a common taxonomic group. This was here represented by a mixed species of ulvoids (*i.e.* under a single family, Ulvaceae). The combination of seaweeds as fish baits involving taxonomically distant groups have been previously accounted by Cordero (1987), particularly the use of ulvoids and a sponge to catch small octopus (locally referred to as "tamala"). To the best of our knowledge, the exclusive combination of two or more seaweed species belonging to different

Table 1. List of seaweed species used as fish baits in Bulusan, Sorsogon, Philippines.

No.	Species name	Taxonomic group (phylum, order)	Local name	Gear type
1	*Acanthophora spicifera*	Rhodophyta, Ceramiales	"Gulaman na matarom"	Fish pot
2	*Eucheuma denticulatum*	Rhodophyta, Gigartinales	Eucheuma	Fish pot
3	*Gracilaria gigas*	Rhodophyta, Gracilariales	"Gulaman insusuli"	Fish pot
4	*Kappaphycus alvarezii*	Rhodophyta, Gigartinales	Eucheuma	Fish pot
5	*Sargassum polycystum*	Ochrophyta, Fucales	"Kulapu"	Fish pot, hook and line, long line
6	*Ulva clathrata*	Chlorophyta, Ulvales	"Lumot"	Fish pot, hook and line
7	*Ulva flexuosa*	Chlorophyta, Ulvales	"Lumot"	Fish pot, hook and line
8	*Ulva lactuca*	Chlorophyta, Ulvales	"Lumot"	Fish pot, hook and line
9	*Ulva reticulata*	Chlorophyta, Ulvales	"Lumot"	Fish pot, hook and line

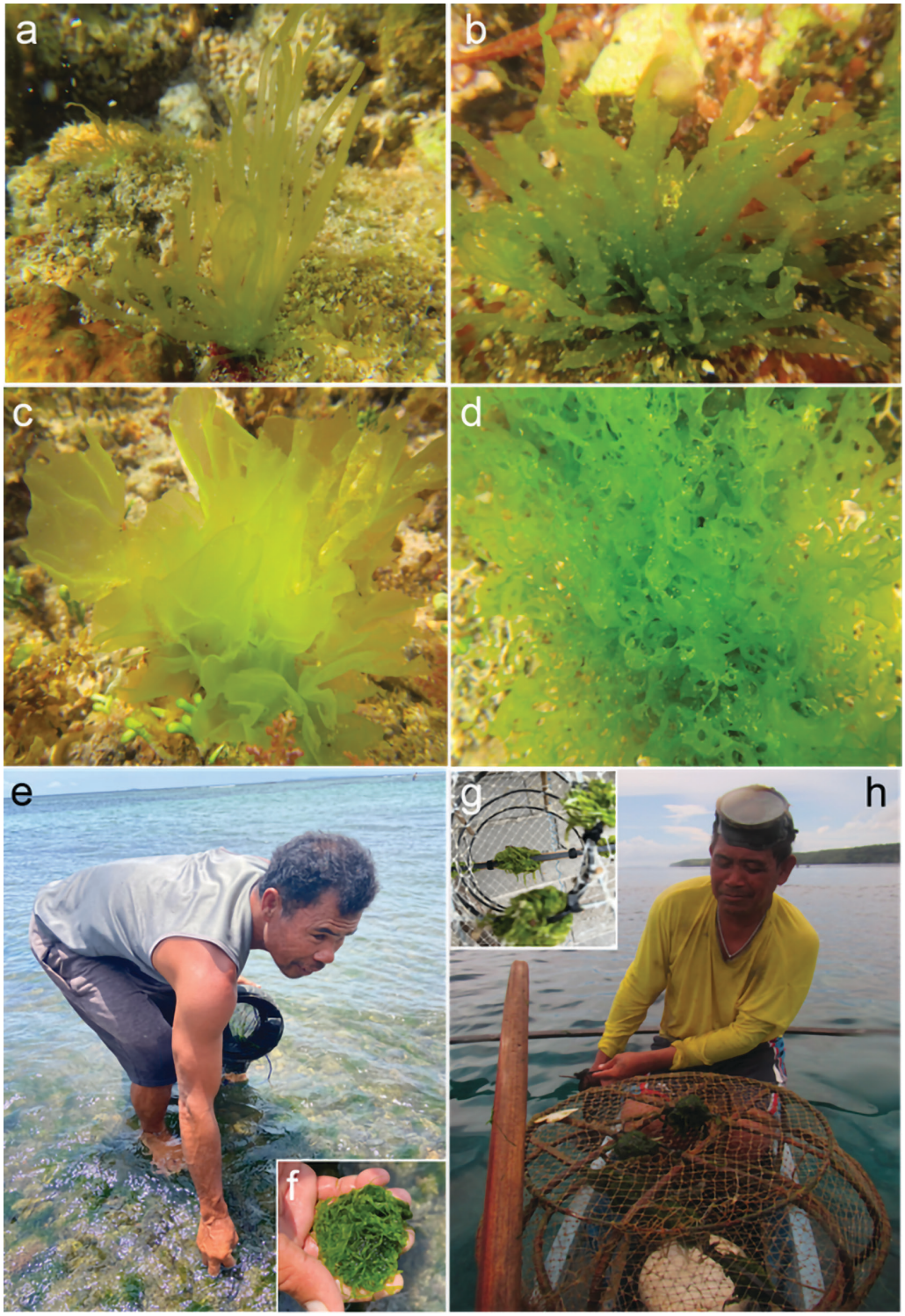

Figure 2. Seaweed species (ulvoids or locally referred to as "lumot") used by fishers as bait in Bulusan, Sorsogon, Philippines. Underwater habits of [a] *Ulva clathrata,* [b] *Ulva flexuosa,* [c] *Ulva lactuca,* and [d] *Ulva reticulata*. [e] A fisher gathering *U. clathrata* to be used as fish bait. [f] A close view of *U. clathrata* heap. [g] A heap of *U. clathrata* placed as bait in a fish pot. [h] A fisher about to deploy a fish pot with *U. clathrata* as bait.

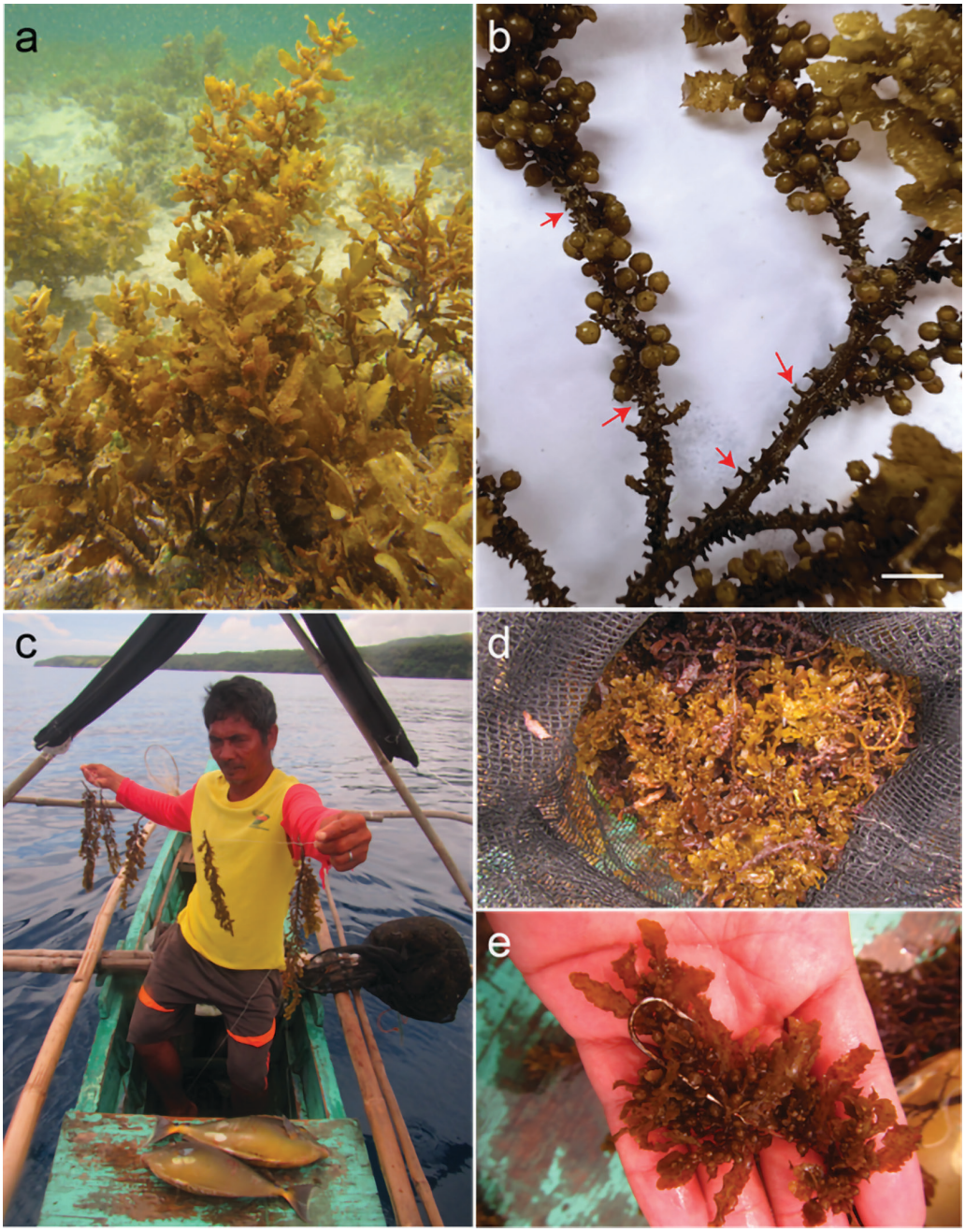

Figure 3. *Sargassum polycystum* as fish bait used by fishers in Bulusan, Sorsogon, Philippines. [a] Underwater habit of *S. polycystum*. [b] A detailed image of the Y-shaped protuberances on primary axis diagnostic of *S. polycystum*, scale = 0.50 cm. [c] A fisher preparing to deploy the long line with *S. polycystum* as a bait. [d] A heap of *S. polycystum* kept in a net bag. [e] A close-up image of *S. polycystum* tied in a fishing hook.

seaweed genera is first documented here, at least for the Philippines. Accordingly, actual encounters of seaweed-fish interactions in the wild has allowed Bulusanon fishers to test the effectiveness of the combination of seaweed baits, to which they found successful. This indicates that trial-and-error approaches take part in the continued adaptation of modern Bulusanon fishing culture.

Captured fish taxa (Figure 4) through seaweed baits were initially recognized by the respondents *via* local names and later assigned species name following several references (Carpenter and Niem 1999; Broad 2004; Froese and Pauly 2022). A total of 11 algivorous fishes were caught and identified during the survey (Table 2). Figure 5 shows the relative frequency of seaweed fish bait per type of deployed gear and species of fish caught. Using fish pots, the most dominant captured fishes belonged to Acanthuridae (unicornfish; 23.28%) and Siganidae (siganids; 69.46%). These include species of *Naso* and *Siganus*, which commanded relatively higher price at PHP 300/kg or USD 5.30 (as of November 2022). Majority of the fishes caught were used as sustenance, whereas their market chains either ended up to consumers through peddling or selling directly to public markets. We found 22 incidental catch (17 fishes, 5 non-fishes), which were mainly piscivores. The identified by-catch fishes indicated possible predator of those target fish caught *via* pots. Most of the non-fish taxa (*e.g. Loligo* sp, *Octopus* sp., *Panulirus* sp., *Portunus* sp., and *Sepia* sp.) captured in fishing gears containing seaweed bait do not have direct relationship with that of the bait but of the gear itself. One explanation for this pattern could be that these species used the fishing gears for spawning (Blanc and Daguzan 1998; Watanuki and Kawamura 1999; Jantzen and Havenhand 2003; Sobrino *et al.* 2011).

An increasing body of evidence indicates that current fishing practices should anchor to sustainable strategies and economic viability (Arlinghaus *et al.* 2002; Tolentino-Zondervan and Zondervan 2022), to which the use of

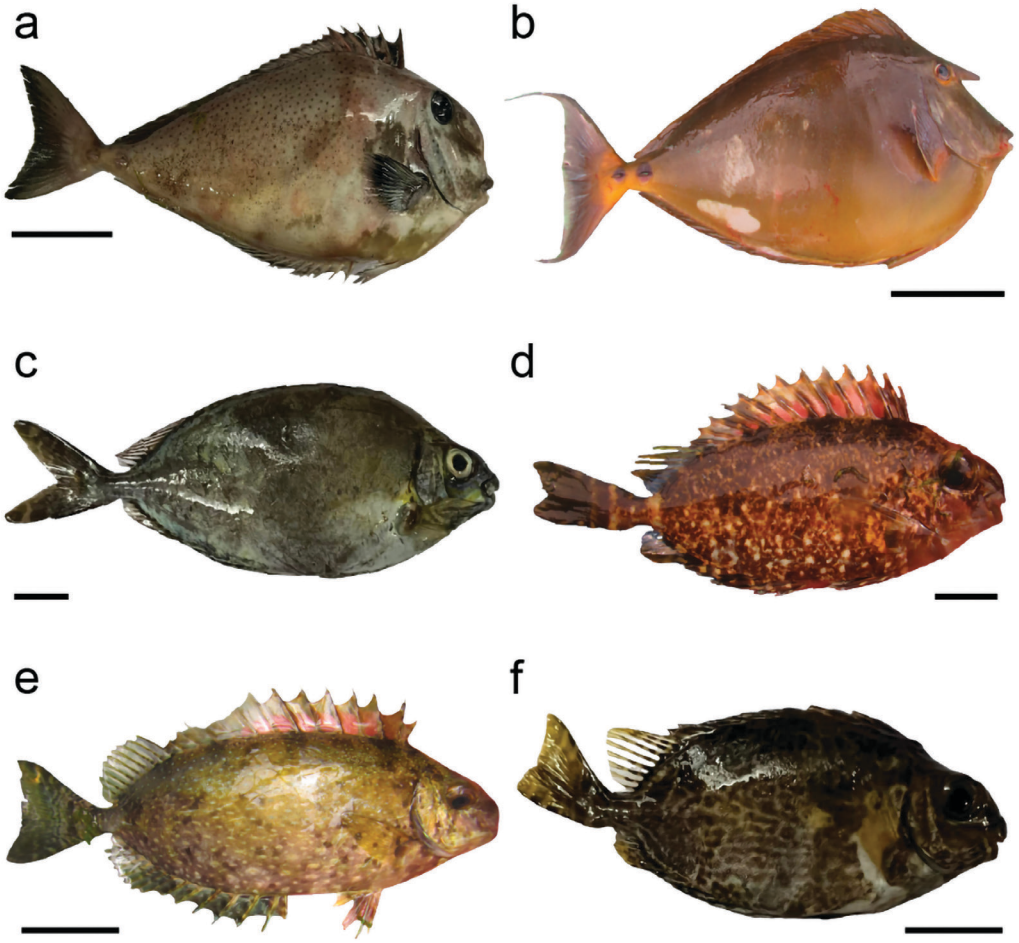

Figure 4. Dominant fishes caught using seaweeds as bait in Bulusan, Sorsogon, Philippines. [a] *Naso maculatus,* scale = 9 cm. [b] *Naso unicornis*, scale = 8 cm. [c] *Siganus argentus*, scale = 2 cm. [d] *Siganus cananiculatus*, scale = 1 cm. [e] *Siganus fuscescens*, scale = 3 cm. [f] *Siganus spinus*, scale = 2 cm.

Table 2. List of target fish caught from traditional fishing gears with seaweed fish baits including incidental catch in Bulusan, Sorsogon, Philippines.

No.	Family	Species name	Local name
Target fish			
1	Acanthuridae	*Naso annulatus*	"Kubalan"
2	Acanthuridae	*Naso lituratus*	"Labahita," "Pulang ikog"
3	Acanthuridae	*Naso maculatus*	"Tapasan"
4	Acanthuridae	*Naso unicornis*	"Surahan"
5	Acanthuridae	*Naso vlamingii*	"Danoi"
6	Siganidae	*Siganus argentus*	"Bungdo"
7	Siganidae	*Siganus cananiculatus*	"Balawis"
8	Siganidae	*Siganus fuscescens*	"Turos"
9	Siganidae	*Siganus guttatus*	"Al-ap," "Moblad"
10	Siganidae	*Siganus spinus*	"Turos"
11	Siganidae	*Siganus virgatus*	"Taragbago"
Incidental catch			
1	Carangidae	*Caranx* spp.	"Mamsa"
2	Dasyantidae	*Dasyatis* spp.	"Pagi"
3	Haemulidae	*Plectorhinchus vittatus*	"Alatan"
4	Hemiscylliidae	*Chiloscyllium* spp.	"Pating"
5	Holocentridae	*Sargocentron tiere*	"Maya-maya"
6	Labridae	*Thalassoma* spp.	"Labayan," "Lubayan"
7	Lethrinidae	*Lethrinus* spp.	"Kamasuhon," "Katambak," "Tambak"
8	Loliginidae*	*Loligo* spp.	"Pusit"
9	Mugilidae	*Crenimugil* spp.	"Balanak"
10	Mugilidae	*Ellochelon vaigiensis*	"Tabudyos"
11	Mullidae	*Parupeneus* spp.	"Agingayon," "Agingoy," "Timbungan"
12	Muraenidae	*Gymnothorax* s spp.	"Ahas," "Igat," "Panangitan," "Paningkitan"
13	Octopodidae*	*Octopus* spp.	"Pugita"
14	Palinuridae*	*Panulirus* spp.	"Banagan"
15	Plotosidae	*Plotosus* spp.	"Hito"
16	Portunidae*	*Portunus* spp.	"Kasag"
17	Scaridae	*Scarus rubroviolaceus*	"Bun-ak"
18	Scaridae	*Scarus* spp.	"Angol"
19	Sepiidae*	*Sepia* spp.	"Kanoos"
20	Serranidae	*Cephalopholis* spp.	"Lapu-lapu"
21	Terapontidae	*Terapon* spp.	"Bat-kan"
22	Tetraodontidae	*Arothron* spp.	"Butete"

traditional gear and baits encompasses. For example, pots as compared from other fishing gears (*e.g.* passive nets and trawls) are shown to have lower discard rates, reduced interaction with by-catch predators (*e.g.* marine mammals), minimal seabed impact, and lower energy use (Petetta *et al.* 2021). Accordingly, catch specimens retrieved are of better quality (alive or uninjured) and, hence, may command higher selling price (Kopp *et al.* 2020). Synthetic bait and its paraphernalia (*i.e.* straps, box, packaging bands, and wrappings) are some of the fishing debris that demonstrably harm wildlife (*e.g.* animal entanglement and ingestion), pollute marine environments

Figure 5. Relative frequency of seaweed fish baits used per fishing gear type and catch resources in Bulusan, Sorsogon. The weight of the frequency is indicated by the thickness of the lines.

(as beach litters), and cause marine hazards (*e.g.* damage to vessel propulsion systems and the clogging of intakes) (Jones 1995; Derraik 2002). The use of natural baits like those of seaweeds, nevertheless, can aid mitigate the impacts of waste plastics.

Fishing methods using seaweed baits that target herbivorous fish, like what was observed in Bulusan, could be harmful if not properly managed or regulated. It is well-known that herbivorous fishes such as siganids and unicornfishes play an essential role in controlling macro-algal growth on coral reefs (Mumby *et al.* 2006; Bennett and Bellwood 2011; Sura *et al.* 2021). Non-selective fishing gears, albeit, are less harmful to the coral reefs (Hicks and McClanahan 2012). Overfishing of herbivore fishes may lead to regime shifts from coral to algal dominance, which in turn reduces the number of habitats for coral reef fishes and their species richness and community abundance (McManus and Polsenberg 2004; van Duyl *et al.* 2023). Increased productivity of macro-algae may upset the balance of nutrient levels in reefs that could lead to a considerable loss in overall fish biomass (Eriksson *et al.* 2009; Sieben *et al.* 2011; de Ramon N'Yeurt and Iese 2015). How fishing operations impact coral reefs and the odds of macro-algal occurrence in Bulusan remain unknown; hence, further studies are warranted.

Finally, Bulusanon fishers manifest accurate and detailed knowledge on the diet of target fishes because of the specific seaweed bait they use when catching them. Local knowledge therefore can be an important resource for understanding interactions among target fish and its effect on food chains, specifically that of the seaweed-fish

interactions. This study expands available information on the local use of seaweeds in Bulusan and that can be tapped for future fishing management strategies. Improving fishing management requires understanding of how traditional knowledge operate on it. We emphasize that local sustainable fishery management may be achieved when administrators seriously engage sophisticated decisions that consider ethnobiological results, such as those provided in this study.

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