Survey of the Shallow-water Sea Cucumbers of Chuuk, Federated States of Micronesia

Results of a Survey Performed 30 June to 9 July 2013

A Report Prepared for the Korea South Pacific Ocean Research Center, Korea Institute of Ocean Science and Technology

Submitted by

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EXECUTIVE SUMMARY

The islands of Chuuk in the Caroline Islands of central Micronesia possess a diverse array of echinoderms, including holothuroids (sea cucumbers). We were invited to perform a survey to assess the diversity of holothuroids in Chuuk's shallow-water marine environments. In six days of surveying between 30 June to 9 July 2013, we surveyed 11 sites around the islands and barrier coral reefs and found a minimum of 34 species of holothuroids, several of them new records for the island and for Micronesia. The commercially most valuable species were very rare, almost certainly because of overfishing. These species include *Bohadschia vitiensis*, *Thelenota anax* and *Holothuria (Microthele) whitmaei*. The most interesting finds included a potentially speciose assemblage of small apodan species from Synaptidae abundant in seagrass. Another unexpected find was an unusual species from the subgenus *Metriatyla*, *H*. (*M*.) *albiventer*, not known from elsewhere in Micronesia. Including previous surveys by us (SWK and AKM), a total of 42 morphological units attributable to species of holothuroids have now been identified from Chuuk's waters. We also uncovered an additional minimum of 46 species of other echinoderms: 11 echinoids (sea urchins), 18 asteroids (sea stars), 12 ophiuroids (brittle stars) and five crinoids (feather stars). Several of the holothuroids from the family Synaptidae appear to be new to science and formally undescribed. Based on our initial survey, we estimate that Chuuk's holothuroid fauna may well be in excess of 60 species.

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INTRODUCTION

In early 2013, we were invited to submit a proposal to the Korea Institute of Ocean Science and Technology (KIOST) to study the echinoderms of Chuuk, Federated States of Micronesia (FSM), at their field station, Korea South Pacific Ocean Research Center (KSORC) in Chuuk State, FSM.

We reasoned that the starting point of any biological investigation is the taxonomic identification of the organism or organisms involved. However, a major impediment in Micronesia, including Chuuk State, to initiating conservation and management measures has been the identification of the islands' rich natural resources. This is not a trivial problem. Many organisms on Indo-Pacific coral reefs are poorly known. Unidentified and formally undescribed species abound. Recent genetic work (e.g., Kim et al. 2013) indicates that even large, common animals belong to species complexes or are hybrids. Without an understanding of the systematics of the organisms in Chuuk, without an ability to ascribe a stable nomenclature to these organisms, even an inventory of the islands' biodiversity is impossible. How diverse are Chuuk's coral reefs. No one knows, primarily because of the difficulty in identifying most organisms living there.

A second major impediment for conservation and management is then relaying information about taxonomy in a non-technical format of maximum use to resource managers and local scientists. Most information on the identification of coral-reef organisms lies buried in an old, labyrinthine literature written in several languages. Recently, illustrated invertebrate guides to Indo-Pacific coral reefs have been produced (e.g., Colin & Arneson 1995), but while often evincing beautiful illustrations suffer from incorrect names and are not comprehensive for any one locality

Hence, the primary goal of this project is to produce an illustrated guide to the echinoderms in the habitats surrounding the main islands of Chuuk, its lagoon and outer barrier reefs. We will first collect and identify an exhaustive sampling of the islands' echinoderms and then produce a published volume providing illustrations and accounts of the taxonomy, biology and distribution of each species.

The proposed survey would also form part of our U.S. National Science Foundation-sponsored efforts, in collaboration with other holothuroid taxonomists worldwide, to document the global diversity of holothuroids inhabiting coral reefs.

Thus, from 30 June to 9 July 2013, we surveyed the holothuroids and other echinoderms around the islands of Chuuk. In sum, during this period, we

- surveyed 11 reef sites around the island for their echinoderm fauna,
- assembled a preliminary checklist of the island's echinoderms,
- collected and preserved voucher specimens of each species,
- photographed vouchers or representative specimens of each species,

At least three other types of work products also should be anticipated, with various timelines to completion:

- A final report documenting our surveys and collections.
- An illustrated field guide to the island's holothuroid fauna, primarily as a tool for marine resource personnel.
- Peer-reviewed scientific publications, to include, minimally, the first comprehensive faunistic treatment of the island's echinoderms and the formal taxonomic description any species new to science.

The following report provides a provisional checklist to the island's echinoderms, then discusses the scientific significance of these findings. The term "provisional" indicates that the checklist consists of identifications of specimens made in the field. Hence, a few of the designations will, in all likelihood, change, or in instances where a species could not be immediately assigned, even provisionally, species' identities will be clarified after full laboratory examination. Still, most species designations provided here are trustworthy and thus, on whole, the list is useful for scientific and public discussion of Chuuk's echinoderms, particularly holothuroids, now under harvesting pressure. Indeed, as far as we know, this is the first attempt at a comprehensive compilation of Chuuk's echinoderms.

METHODS

Site selection

Sites were selected around the islands and barrier reef for the presumed high density and species richness of holothuroids. GPS coordinates of each site were recorded. Most major shallow-water marine habitats were investigated, including reef flats, forereef slopes to 25 m depth, seagrass beds, channels and areas adjacent to mangroves. Given the time constraints, we eschewed mangrove channels, rivermouths, steep drop-offs and elsewhere with little accumulation of well-sorted sediment, since such areas, while in some cases having a possibly rich echinoderm fauna (e.g., crinoids in the case of drop-offs), were likely to have few holothuroids, the focus of the survey.

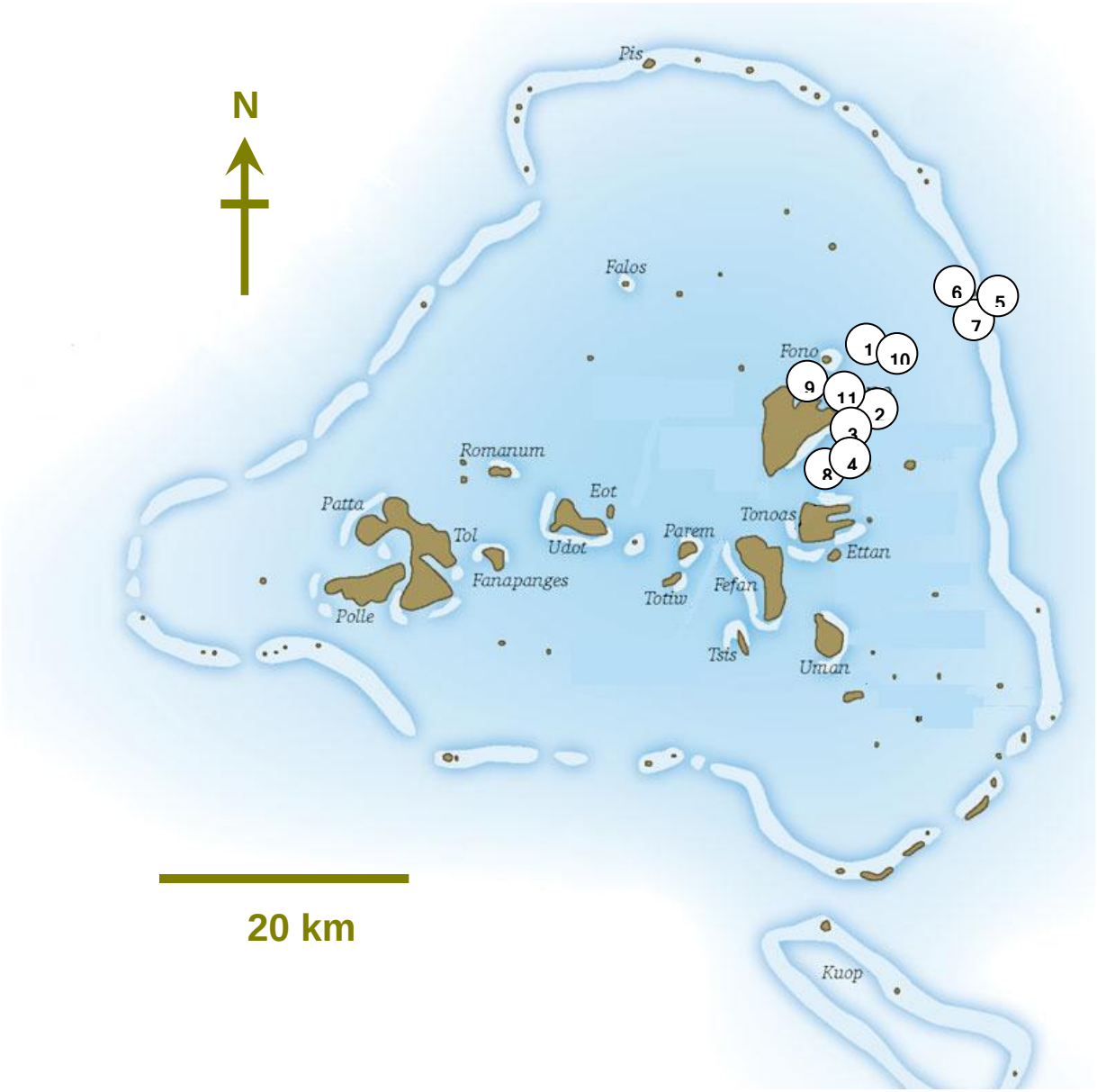

Figure 1. Chuuk, showing concentration of survey sites around the island of Weno. Sites are numbered according to Appendix 2. Map from http://http:/elblogdealquimias.blogspot.com/

Biodiversity inventory

Divers recorded all species of echinoderms that they observed at each site to a maximum of 25 m in depth. Collected specimens, or representatives thereof, from nearly all species were photographed *in situ*. One or two voucher specimens of each species were collected, photographed against a black

background and preserved in 95% ethanol. Before preservation, holothuroids were first relaxed in seawater laced with magnesium chloride or chilled to near freezing. No special methods were used to assess infaunal species; divers fanned sediment to uncover such forms or combed the sediment's surface for the tests of burrowing echinoids. Divers looked through rubble and in crevices to find cryptic forms. Night snorkels and dives were used extensively as most coral-reef invertebrates, including echinoderms, are nocturnally active and exposed.

RESULTS

In a total of six days of surveying, 11 sites were visited around Weno island and the northwest barrier reef. In the subsection below, *Stock survey*, we outline the species composition and ecology of commercially valuable species. In the second and final subsection, *Biodiversity inventory*, we report on the species composition and ecology of other holothuroids and echinoderms.

Stock survey

Several commercially valuable species of holothuroids occurred in Chuuk's waters. The most valuable species seen in moderate abundance were *Holothuria* (*Halodeima*) *atra* (trade name: lolly fish) and *Stichopus chloronotus* (green fish). Both of these occurred on the reef flats around the island.

Holothuria (*Microthele*) *whitmaei*, the black teat fish occurred much less frequently (only a few animals were observed during the entire survey) on mid- to outer reef flats islandwide. In other parts of Micronesia, this species also is found on the forereef slope to a maximum depth of about 23 m. In older literature, this species goes by the name of *H.* (*M.*) *nobilis*, a name now reserved for a closely related species from the western Indian Ocean.

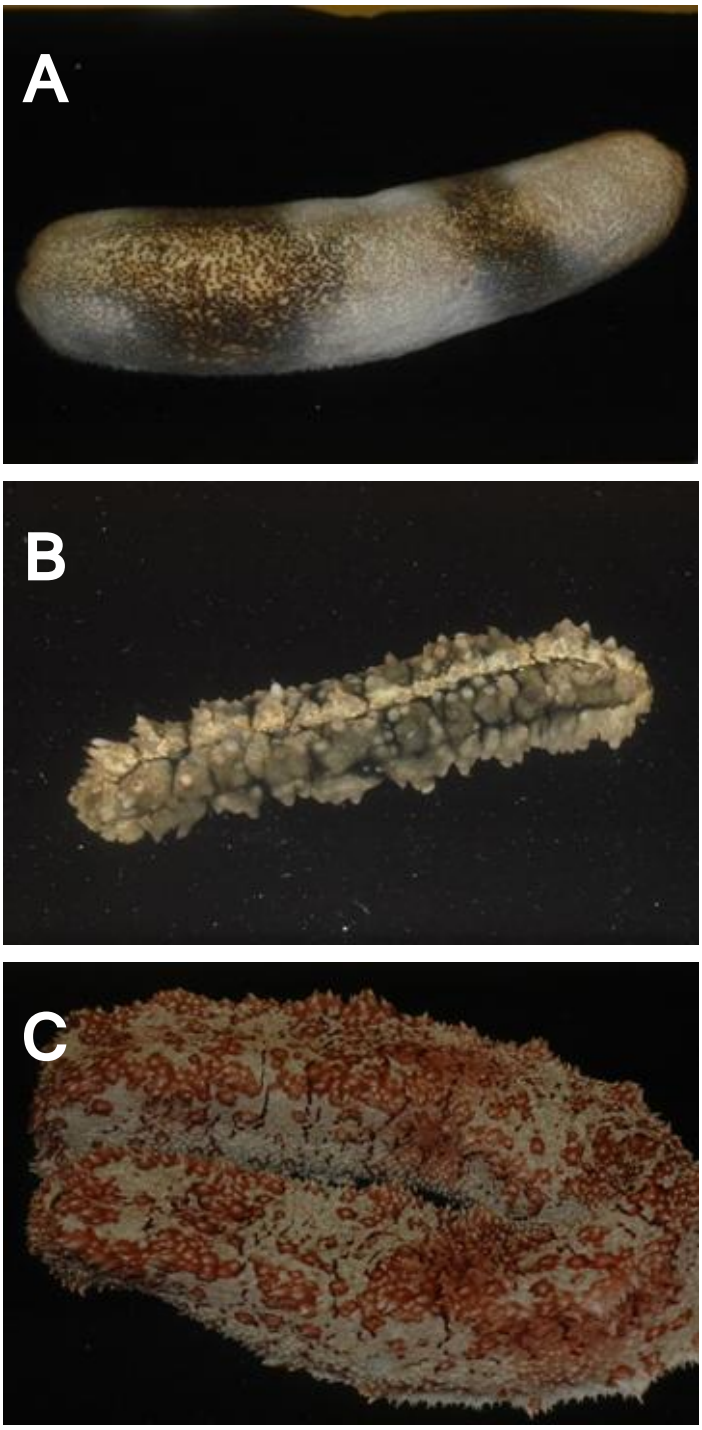

Figure 2. Some commercially valuable species of holothuroids found on Chuuk. A) *Bohadschia vitiensis.* B) *Stichopus horrens*. C) *Thelenota anax*.

The sand fish (*Holothuria* (*Metriatyla*) *scabra*) (Figure 2A) was not found during this survey, but has been found previously in seagrass beds adjacent to mangroves (SWK).

Animals were usually quite large and were usually found on sand bottoms, though individuals were still occasionally seen on forereef slopes on rubble or amongst corals.

Other commercial species, however, occurred at low densities. These included *Bohadschia argus* (spotted fish) (Figure 2A) and *Stichopus horrens* (dragon fish) (Figure 2B). The amber fish (*Thelenota anax*) (Figure 2C) was also quite rare, occurring on the outer reef slops. *Stichopus hermannii* (curry fish) (Figure 2D) was very rare, as were most other species in this genus.

In sum, Chuuk appears to have several commercially important species of holothuroids that could be harvested in large numbers. How much of these resources can be sustainably harvested is, however, a separate question and should be addressed in a separate study.

Biodiversity inventory

A total of 88 provisional taxonomic units attributable to species of echinoderms were identified from Chuuk's waters, 63 of them during this survey: 34 holothuroids, five echinoids (sea urchins), 14 asteroids (sea stars), seven ophiuroids (brittle stars) and three crinoids (sea lilies). (See Appendix 1 for species list). The high number of holothuroids is probably due to an outsized collection effort for these species on our part, rather than a true representation of their proportional richness in the island's echinoderm fauna.

Several unexpected finds were made. The first was an unusual species from the subgenus *Metriatyla*, *H*. (*M*.) *albiventer*, not known from elsewhere in Micronesia. At least five (15%) of the holothuroids are in all probability new to science and formally undescribed. Three were forms usually ascribed to *Holothuria* (*Thymiosycia*) *impatiens* (Figure 3A). The second group, all unidentified species from the family Synaptidae (Figure 3B), was seen in seagrass and algae at several sites. These appear closest to the genera *Synaptula* or *Polyplectana* No potential new specimens were members of the other classes of echinoderms.

DISCUSSION

Prospects for a Sustainable Beche-de-mer Fishery

Figure 3. Some undescribed species of holothuroids found on Chuuk. A) *Holothuria (Thymiosycia)* sp. cf. *impatiens* and B) an unidentified synaptid, cf.*Synaptula* sp.

Chuuk has very few commercially valuable species of holothuroids. We observed populations of some desirable commercial species, occurring at most of the sites we visited around the island. While most of these species are not the most valuable varieties or remain in great abundance, they, nevertheless, constitute an important and valuable resource for the island.

Chuuk's Diverse Echinoderm Fauna

Chuuk now has at least 88 species of echinoderms recorded from its waters, including at least 42 species of holothuroids. These counts are likely large underestimates. Yet, the most interesting results from the survey were the new species discovered, all of them holothuroids. At least four species encountered appear to be unknown to science. With the possible exception of the unusual small synaptids, none appear to be restricted to Chuuk. While uncommon enough to have long avoided formal taxonomic treatment, most of these species have nevertheless been observed at other localities in the tropical western Pacific by us and others (Kerr et al. 2006, 2007; G. Paulay, personal communication).

In sum, Chuuk's biodiversity is both rich and under-explored. The present survey is one of the most complete marine surveys of the island's reefs and indicates that the Chuukese marine fauna is unique and of considerable scientific merit. Surveys of other groups of marine organisms on Chuuk will undoubtedly reveal a comparable number of interesting discoveries, many of them species new to science.

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Appendix 1. Provisional Checklist of Shallow-water Echinoderms from Chuuk, Central Caroline Islands, Micronesia. FLMNH and KSORC indicate locations of vouchers from previous surveys overseen by us (SWK and AKM). Quoted descriptors following the scientific names are informal names used by the authors until a proper name can be designated. Vouchers are housed at KSORC, the University of Guam Invertebrate Collection (UGI), and the Florida Museum of Natural History (FMNH).

Species	Survey		
	This study	FLMNH	KSORC
HOLOTHUROIDEA			
Actinopyga mauritiana	X		X
Actinopyga cf. *palauensis*	X		
Afrocucumis africana	X	X	X
Bohadschia argus	X	X	X
Bohadschia argus X B. vitiensis	X		
Bohadschia kellokeri	X		
Bohadschia ocellata	X	X	X
Bohadschia vitiensis	X	X	X
Chiridota sp.	X		X
Euapta godeffroyi		X	X
Euapta tahitiensis	X		X
Holothuria (*Acanthotrapezia*) *coluber*	X	X	X
Holothuria (*Cystipus*) *rigida*	X		
Holothuria (*Halodeima*) *atra*	X	X	X
Holothuria (*Halodeima*) *edulis*	X	X	X
Holothuria (*Lessonothuria*) *lineata*	X		X
Holothuria (*Mertensiothuria*) *hilla*	X	X	X
Holothuria (*Mertensiothuria*) *leucospilota*	X	X	X
Holothuria (*Metriatyla*) *albiventer*	X		
Holothuria (*Metriatyla*) *scabra*		X	
Holothuria (*Microthele*) *fuscopunctata*		X	X
Holothuria (*Microthele*) *whitmaei*	X		
Holothuria (*Platyperona*) *difficilis*	X	X	X
Holothuria (*Semperothuria*) *flavomaculata*			X
Holothuria (*Semperothuria*) *roseomaculata*		X	X
Holothuria (*Stauropora*) *fuscocinerea*		X	X
Holothuria (*Stauropora*) *pervicax*	X		X
Holothuria (*Theelothuria*) *turriscelsa*			X
Holothuria (*Thymiosycia*) *impatiens* “ESU 2”	X		
Holothuria (*Thymiosycia*) *impatiens* “ESU 3”?	X	X	X

Species	Survey		
	This study	FLMNH	KSORC
Holothuria (*Thymiosycia*) *impatiens* “ESU 4”	X		
Labidodemas sp(p).	X		X
Opheodesoma grisea	X	X	X
Pearsonothuria graeffei	X	X	X
Polyplectana sp.	X	X	X
Stichopus chloronotus	X	X	X
Stichopus herrmanni	X	X	X
Stichopus horrens	X	X	X
Stichopus vastus	X	X	X
Synapta maculata	X	X	X
Synaptidae gen. sp(p).	X	X	X
Thelenota ananas			X
Thelenota anax		X	X
ASTEROIDEA			
Acanthaster planci	X		
Asteropsis carinifera			X
Choriaster granulatus	X		X
Culcita novaguineae	X	X	
Echinaster callosus			X
Echinaster luzonicus	X	X	X
Fromia milleporella	X	X	X
Fromia monilis	X		X
Fromia nodosa	X		X
Fromia sp.	X		
Gomophia cf. *egyptiaca*	X		X
Leiaster speciosus			X
Linckia guildingii	X		
Linckia laevigata	X	X	X
Linckia mulitfora	X	X	X
Mithrodia clavigera			X
Ophidiaster granifer	X		
Ophidiaster duncani	X	X	X
CRINOIDEA			
Cenometra bella		X	
Colobometra perspinosa			X
Comasterid spp.	X		X
Oxycomathnus bennetti			X

Species	Survey		
	This study	FLMNH	KSORC
Phanogenia sp	X		X
ECHINOIDEA			
Clypeaster sp.			X
Echinometra mathaei			X
Echinoneus cyclostomus			X
Echinostrephus aciculatus			X
Eucidaris metularia			X
Diadema savygnii	X	X	X
Echinothrix diadema	X		X
Maretia planulata	X		X
Mespilia globosus			X
Metalia spatangus	X		X
Paraselenia gratiosa	X		X
OPHIUROIDEA			
Ophiarachnella gorgonia			X
Ophiocoma dentata	X		X
Ophiocoma scolopendrina	X		X
Ophiocoma erinaceous "red feet"	X		X
Ophiocoma sp.			X
Ophiolepis suberba	X		X
Ophiomyxa australis	X		X
Ophionereis sp.			X
Ophiothela danae			X
Ophiotylos leucus			X
Ophiuroid spp.	X		X
Macrophiothrix sp.	X		X

Appendix 2. Locality data. Numbers in the first column correspond to those in Figure 1.

	Station	Locality	Habitat	Depth range (m)		Latitude	Longitude
1	CHUK -01	Osakura, fronting KSORC	reef flat, sea grass, reef moat	0	1	7.47795	151.90176
2	CHUK -02	Benedict Pt. "1"	fringing reef slope	7	25	7.45097	151.90668
3	CHUK -03	Benedict Pt. "1"	reef flat	0	1	7.27170	151.54334
4	CHUK -04	Shark Island	reef flat and fringing reef	0	1	7.43020	151.93134
5	CHUK -05	Fannuk	barrier reef fore slope	15	22	7.51598	151.97145
6	CHUK -06	Fannuk	reef flat	0	1	7.51969	151.96843
7	CHUK -07	Fannuk	barrier reef fore slope	15	22	7.51598	151.97145
8	CHUK -08	Alanelimo	reef flat	0	1	7.42558	151.99356
9	CHUK -09	Founumwo	silty bottom	2	12	7.27891	151.534262
10	CHUK -10	Osakura	fringing reef slope	1	7	7.47795	151.90176
11	CHUK -11	West of Osakura	night dive, fringing reef slope	2	20	7.28497	151.53523

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