

Note

The intertidal fish collections of Ed Ricketts at Tofino, British Columbia, Canada, 1945 and 1946

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Abstract

Few studies exist on the intertidal fish fauna of the west coast of Vancouver Island, British Columbia. The earliest known regional insights into intertidal fish diversity for the Tofino area were made by iconic marine ecologist Edward Flanders Ricketts. We reviewed his 1945 and 1946 collection cards, now available online. He made 111 collections of 20 species and 294 specimens. Most of these species were cottids (nine species) or pricklebacks (three species), with flatfish, greenlings, poachers, snailfish, gunnels, sand lance, and clingfishes each represented by one or two species. We briefly compare the data with contemporary studies and suggest opportunities for using his museum-curated physical specimens for further analyses.

Key words: Intertidal fishes; Ricketts' historical collections; Vancouver Island

Baseline studies of the intertidal fish communities on the west coast of Vancouver Island (WCVI), British Columbia (BC), Canada are incomplete, but necessary to help understand faunistic changes resulting from climatic shifts (e.g., sea level rise, temperature shifts; Vadeboncoeur 2016) and to help document changes in fish biodiversity in this region. Studies available include the historical surveys by Bean and Weed (1919) at Ucluelet Inlet, tide pool studies by Green (1971) on rocky shores at Botany Beach near Port Renfrew, the autecological work on various species of tide pool cottids at Port Renfrew and Bamfield over the years (e.g., Khoo 1974; Nakamura 1976; Craik 1981; Wuitchik *et al.* 2018), and the recent work by Robinson and Yakimishyn (2013) in eelgrass beds in Pacific Rim National Park near Tofino (Figure 1). Other than the work at Botany Beach, Bamfield, and the recent work in eelgrass beds near Tofino, data describing the intertidal fish along the extensive shorelines (>400 km) of WCVI are not available. Here, we analyze a relatively unknown data set.

The earliest known baseline work was by California-based iconic marine ecologist Edward Flanders

Ricketts (1897–1948), co-author of the acclaimed book *Between Pacific Tides* (Ricketts and Calvin 1939), during his 1945 and 1946 collections near Tofino, BC. In addition to operating a marine specimen supply business to service schools and colleges, Ricketts' interests in marine flora and fauna were wide-ranging and he was very knowledgeable about northeast Pacific coastal fishes and their habitats. Observations of intertidal fishes are mentioned on numerous pages in Ricketts and Calvin (1939), which recognized their importance and diversity. For example, before describing a California fish Garibaldi (*Hypsypops rubicundus*) and its habitat, the authors state: “vertebrates have scant place in this account, since an adequate treatment would require a separate book” (Ricketts and Calvin 1939: 153). Ricketts was in contact with noted ichthyologists of the day, such as Rolf Bolin (Hopkins Marine Laboratory at Monterey) and Loren P. Woods (The Field Museum in Chicago), who verified his identifications. Ricketts publicized fisheries conservation and recently has become recognized as an early expert on the population dynamics of Pacific Sardine (*Sardinops sagax*; Tamm 2008).

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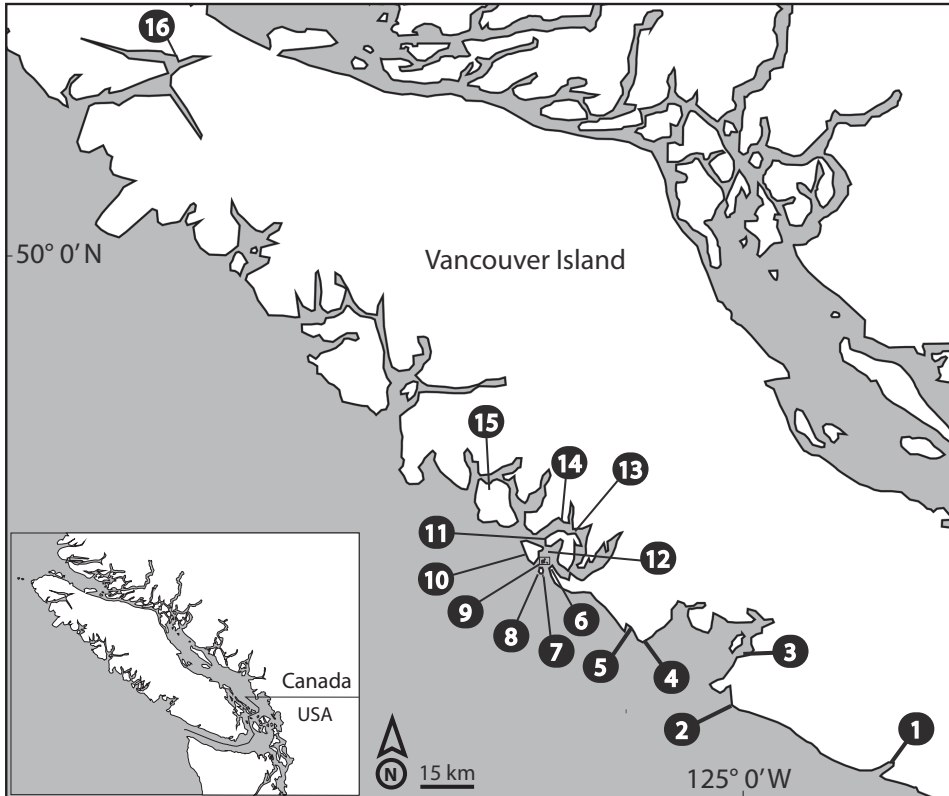


FIGURE 1. The west coast of Vancouver Island, British Columbia, Canada showing general locations of Ricketts' sampling sites in 1945 and 1946: 1. Port Renfrew, 2. Pachena Point, 3. Bamfield, 4. Ucluelet, 5. Florencia Bay, 6. Tofino, 7. Echachis Island, 8. Wickaninnish Island, 9. Clayoquot (Stubbs) and Felice (Round) Islands, Devils Rock (see Figure 2 for detailed view), 10. Vargas Island, 11. Kakawis, 12. Deadmans Island, 13. Tsapee Narrows, 14. Quait Bay, 15. Flores Island, 16. Coal Harbour.

Ricketts' "Pisces" collection of cards is available at Ricketts (1946a) in the system described in detail by Albert and Albert (2014). Each card holds fish data for both Haida Gwaii (formerly Queen Charlotte Islands) and WCVI by species. We used collection data only where species identifications were verified and, therefore, omitted records where identities were listed as "undetermined" or described as juvenile fish too small for identification. In some cases, Ricketts identified species himself in the field, but on most cards, Woods is named. Each of the samples was given a "lot" number, which was recorded on the species card, suggesting all the specimens in a collection were identified by Woods. Ricketts subsequently completed the collection cards, accounting for why both "Queen Charlotte Islands" and WCVI data appear on the cards. There were 26 cards with WCVI collection data. With a few exceptions, each card included typed or handwritten data on collection site, number of fish specimens preserved, habitat, tide level when the specimens were collected, and notes

on identification. Wave exposure information was also given frequently.

Ricketts used his experience and powers of observation as a naturalist to collect in conveniently located sites in a variety of intertidal habitats and maximize the diversity of species. It is our interpretation that he most likely did this to obtain a significant number of specimens to offer his clients; build up his own collection of northeast Pacific coastal organisms at his laboratory in Monterey; and collect fish for Woods (e.g., in a letter to Woods in July 1946, he writes: "I hope you get a good representation of Vancouver Island tidepool fish from these collections" [Ricketts 1946b: 386]). Search effort was not quantified on the data cards. Similar to a fisher exploring a new area or a naturalist seeking to document the biodiversity of an unexplored region, he used a variety of methods or protocols (e.g., dipnets, rotenone, hand collection) tailored to maximize his catches in the various locations and habitats he sampled. The utility of such semi-structured sampling is increasing as

contemporary citizen science data (e.g., iNaturalist) are increasingly used in mapping species distributions and assessing changes in biodiversity.

Ricketts' collections (5 June–7 July 1945, 17 May–17 July 1946) were made across the WCVI (Figure 1), with most samples concentrated on three islands near the mouth of Clayoquot Sound: “Stubbs Island” (officially Clayoquot Island; 10 sites), “Round Island” (officially Felice Island; two sites), and Wickaninnish Island (two sites; Figure 2). He also collected less frequently from 10 additional sites, some within or near Clayoquot Sound, such as Ucluelet, but others quite distant, such as Coal Harbour on Quatsino Sound, 195 km northwest (location 16 in Figure 1).

Ricketts did not precisely geolocate his sample sites and transit survey methods were difficult to use on wave-swept beaches. We were able to approximate the location of many sites from descriptions on the cards, which were often stated in terms of directions

and distances to features that are still present, e.g., major wharves; these sites are identified by letters in Figure 2. However, in three cases, only a general area, such as “Stubbs Island,” was provided; for convenience, we show these mid-island (Figure 2). Therefore, we described Ricketts' collection sites at the “island” level, recognizing that some of his cards do give specific locations that are recognizable today. For example, he visited Devils Rock (location “e” on Figure 2), a site well known as habitat for Giant Pacific Octopus (*Enteroctopus dofleini*; often given the common name “devil fish”) on the northeast side of Stubbs Island (M. Bartlett pers. comm. 27 November 2020).

Ricketts described 16 habitats at his collection sites, as well as “habitat type not reported”. Seven were variations on rocky substrates, one was gravel, four were sand, one was eelgrass, and three were “reef” or “reef pools”. In some instances the cards did not record wave exposure as a habitat variable. In these

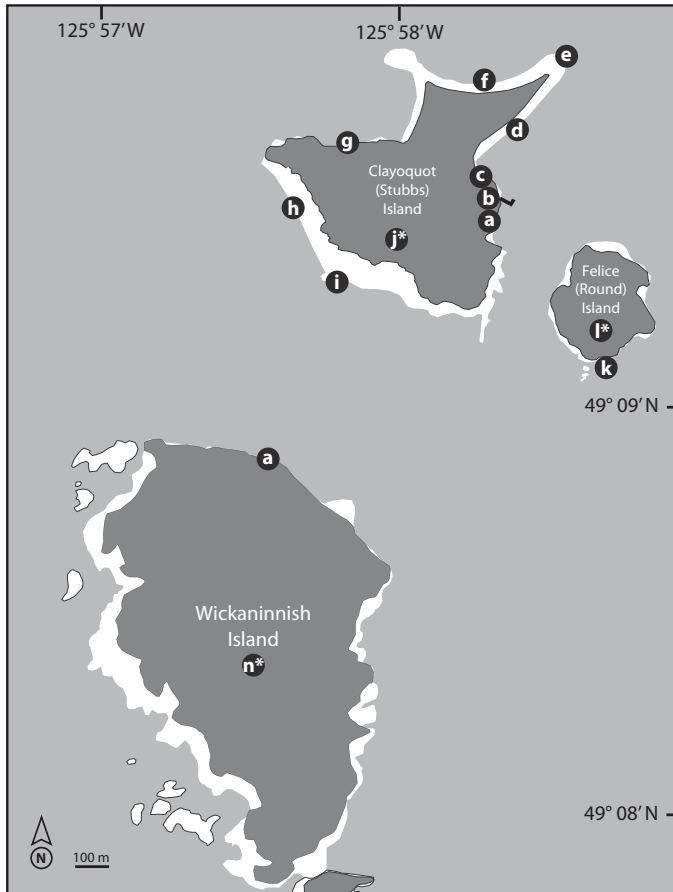


FIGURE 2. Estimated positions of Ricketts' intertidal fish sampling on Clayoquot (Stubbs) Island, Felice (Round) Island, and Wickaninnish Island in 1945 and 1946. Letters with an asterisk indicate a collection site on the island where a specific location was not recorded. White areas around islands represent intertidal and coastal bedrock; dark grey represents forested areas.

cases, we estimated exposure based on assumed location and reference to Howes *et al.* (1994), accessed through BC's provincial spatial data repository. We found that Ricketts sampled in four wave exposure zones, as categorized in Howes *et al.* (1994): exposed or semi-exposed (10 collections), protected (33 collections), semi-protected (51 collections), and 17 collections at sites where exposure was not noted and we could not estimate wave energy.

Ricketts made 111 collections yielding 20 species and 294 specimens in 1945 and 1946 (Table 1). Most of his collections and specimens were from Clayoquot (Stubbs) Island (62 collections, 211 specimens), mainly close to the Clayoquot Hotel where he stayed (Tamm 2004; Ricketts 2006). Eighteen species were found on this island. Ricketts made 19 collections on Felice (Round) Island, comprising 27 specimens in nine species. On Wickaninnish Island he made 12 collections with 23 specimens in 12 species. At the 10 additional sites, ranging from Coal Harbour to Ucluellet, he made 18 collections with 33 specimens in six species.

Most of the fish species collected were cottids (Cottidae; nine species) or pricklebacks (Stichaeidae; three species), with flatfish (Pleuronectidae), greenlings (Hexagrammidae), poachers (Agonidae), snailfish (Liparidae), gunnels (Pholidae), sand lance (Ammodytidae), and clingfishes (Gobiesocidae) represented by one or two species. We updated the species nomenclature using Fishbase (Froese and Pauly 2021). Tidepool Sculpin (*Oligocottus maculosus*; 87 specimens), Black Prickleback (*Xiphister atropurpureus*; 37 specimens), High Cockscomb (*Anoplarchus purpureus*; 28 specimens), and Rosy Lip Sculpin (*Ascelichthys rhodorus*; 22 specimens) were the most commonly collected species (Table 1).

Although Ricketts' fish collections were not designed as detailed ecological surveys, his species lists are similar to those found by later researchers who conducted specific ecological studies on intertidal fish in the region, with the caveat that Ricketts' data sets are limited and sampling strategies and methods are difficult to compare.

Of the 20 fish species collected by Ricketts, 15 have been caught in recent and extensive Clayoquot Sound eelgrass beach seine surveys (2001–2019; Robinson and Yakimishyn 2013; Robinson pers. comm. 31 December 2020) where 73 species were found, while five species—Rockhead (*Bothragonus swanii*), Calico Sculpin (*Clinocottus embryum*), Mosshead Sculpin (*Clinocottus globiceps*), Fluffy Sculpin (*Oligocottus synderi*), and Rock Prickleback (*Xiphister mucosus*)—were not observed. Ricketts noted that all five of these species were found in low tide pools in rock or reef habitat. If they are still

present in the area, they may be living in these specialized habitats not sampled by the eelgrass surveys in Clayoquot Sound. Ten common or occasional species caught in eelgrass were not collected by Ricketts. This was likely because of his sampling methods, as well as his predilection to collect in exposed reefs or semi-protected areas, where common or occasional inshore species such as the sea perch (Embiotocidae), sticklebacks (Gasterosteidae), and some rockfishes (Sebastidae) are not found. These ubiquitous taxa are found in a variety of mainly protected habitats as well as eelgrass. Ricketts did sample in eelgrass, but only at one location on Felice (Round) Island, where he collected a specimen of Red Irish Lord (*Hemilepidotus hemilepidotus*).

There might be opportunities to resample Ricketts' sites to investigate whether the species he inventoried have changed. However, because we do not have exact location data and his sampling effort is not known, it might be difficult to replicate his work. Further investigations of his extensive field notes for the 1945 and 1946 work, recently archived online (Ricketts 1946b), could help to determine his site locations more precisely. Some specific sampling locations, e.g., Devils Rock on Clayoquot (Stubbs) Island, are known and may be worth revisiting. Depending on study parameters, such as sample size, there are also possible opportunities to use Ricketts' 1945 and 1946 physical collections of fishes for analyses of past environmental conditions and genetic analysis, as specimens were archived and available for researchers at the Field Museum in Chicago (C. McMahan pers. comm. 14 November 2019). For example, microplastic fragments in stomachs of archived specimens might be compared with those in present-day fish. A case study on this approach with four species of freshwater fish was recently presented by Lou *et al.* (2021). Ricketts' specimens were fixed in formalin and are stored in ethanol in the Field Museum (C. McMahan pers. comm. 21 January 2022). Although these storage media can make DNA genetic studies problematic, new methods are being developed to improve the use of such archived specimens (Appleyard *et al.* 2021).

Recently, Levings (2020) revealed Ricketts' collections of invertebrates and ecological observations on the inside waters of British Columbia. His inventories of intertidal fishes on the WCVI, which we have summarized here, are another important component of the legacy left by the iconic naturalist.

Author Contributions

Writing – Original Draft: C.D.L. and C.B.; Writing – Review and Editing: C.D.L. and C.B.; Conceptualization: C.D.L. and C.B.; Investigation: C.D.L.

TABLE 1. Number of collections and specimens of the 20 fish species Ricketts inventoried on his 1945 and 1946 trips to Clayoquot (Stubbs) Island, Felice (Round) Island, Wickaninnish Island in Clayoquot Sound, and 10 additional sites on the west coast of Vancouver Island, British Columbia, Canada.

| Family/species | Total no. collections/total no. specimens | | | |
|---|---|-----------------------------|------------------------------------|---------------------------------|
| | Stubbs Island (n = 62/211) | Round Island (n = 19/27) | Wickaninnish Island (n = 12/23) | Additional sites (n = 18/33) |
| Agonidae | | | | |
| Rockhead (<i>Bothragonus swanii</i>) | — | — | 1/1 | — |
| Ammodytidae | | | | |
| Pacific Sand Lance (<i>Ammodytes hexapterus</i>) | 1/1* | — | — | — |
| Cottidae | | | | |
| Smoothhead Sculpin (<i>Artedius lateralis</i>) | 2/4 | — | 1/3 | — |
| Rosylip Sculpin (<i>Ascelichthys rhodorus</i>) | 6/19 | 2/2 | 1/1 | — |
| Sharpnose Sculpin (<i>Clinocottus acuticeps</i>) | 2/4 | — | — | — |
| Calico Sculpin (<i>Clinocottus embryum</i>) | 1/6 | — | 1/1 | 1/1 |
| Mosshead Sculpin (<i>Clinocottus globiceps</i>) | 1/1 | — | 1/1 | — |
| Red Irish Lord (<i>Hemilepidotus hemilepidotus</i>) | 2/3 | 1/1 | — | — |
| Pacific Staghorn Sculpin (<i>Leptocottus armatus</i>) | 1/6 | — | — | — |
| Tidepool Sculpin (<i>Oligocottus maculosus</i>) | 7/67 | — | — | 7/20 |
| Fluffy Sculpin (<i>Oligocottus synderi</i>) | 4/7 | — | 1/5 | — |
| Gobiesocidae | | | | |
| Northern Clingfish (<i>Gobiesox maeandricus</i>) | 6/12 | 4/5 | 1/1 | 4/6 |
| Hexagrammidae | | | | |
| Kelp Greenling (<i>Hexagrammus decagrammus</i>) | 1/1 | — | — | — |
| Liparidae | | | | |
| Tidepool Snailfish (<i>Liparis florae</i>) | 3/8 | 2/3 | 1/1 | — |
| Pholidae | | | | |
| Penpoint Gunnel (<i>Apodichthys flavidus</i>) | 7/13 | 2/5 | 1/1 | — |
| Crescent Gunnel (<i>Pholis laeta</i>) | — | 1/2 | — | 1/1 |
| Pleuronectidae | | | | |
| English Sole (<i>Parophrys vetulus</i>) | 2/8 | — | 1/5 | — |
| Stichaeidae | | | | |
| High Cockscomb (<i>Anoplarchus purpurescens</i>) | 6/20 | 2/3 | 1/2 | 3/3 |
| Black Prickleback (<i>Xiphister atropurpureus</i>) | 8/29 | 4/5 | 1/1 | 2/2 |
| Rock Prickleback (<i>Xiphister mucosus</i>) | 2/2 | 1/1 | — | — |

*From the stomach of a Coho Salmon (*Oncorhynchus kisutch*).

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