THE EFFECTS OF INTERFERENCE INTERACTIONS ON FISH COMMUNITIES AS ASSESSED BY BAITED REMOTE UNDERWATER VIDEOGRAPHY (BRUV)

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Abstract
Interference competition can exclude subordinate species from habitats and alter community structure. An example is the predatory release of mesopredators resulting in changes in their prey and competitor community. Baited, remote, underwater videography is a powerful census tool that can be biased if dominance excludes species from view. At interspecific encounters during BRUV deployments in the Adriatic Sea, Croatia, no such general bias occurred. BRUVS detected few negative co-occurrences for species pairs and they rarely interfered at opportunities near the bait. Most species pairs positively co-occurred and were unique for each habitat type, which indicates that habitat heterogeneity plays an important role in driving fish biodiversity.
This research was supported by the Croatian Science Foundation under the project COREBIO (3107).

Keywords: Fish behaviour, Biodiversity, Competition, Monitoring, Mediterranean Sea

Every species has a fundamental niche which then is reduced to its realized niche by mechanisms such as predation, source-sink dynamics, and competition. One possible outcome of competition is the exclusion of a species from a patch of resources by another species, e.g. by a combination of intense interference competition and superior resource exploitation [1]. Interspecific interference competition may bias the community structure inferred from fish censuses because of behaviorally induced negative co-occurrences at sampling stations [2]. Such mechanisms can be best detected when the census method allows for observations of individuals' behaviour in combination with unbiased measures of community descriptors. Non-consumptive methods that provide direct observations of fish within their occupied habitats, such as diver visual census and remote video-based methods, are increasingly popular [3]. They are recognized capable of providing high statistical power because they allow collection of large sample numbers with little time, cost, and effort. While biases relating to type of bait and the resulting bait plume within the BRUV method are well studied, little is known about the effects of competitive interference between fish at the bait station. Our research was motivated by three major questions: 1. Are interspecific interference interactions and negative co-occurrences commonly detected at BRUV stations? 2. Can negative co-occurrences of species pairs be explained by the interspecific interference behaviours observed for such pairs? 3. Do interspecific interferences at BRUV stations create a method bias that over-counts aggressive/dominant species and under-counts submissive/subordinate species?

Two independent datasets were generated from two collections of BRUV video footages generated in 2012/13 and 2014/15 at 3/25 and 9/12 locations/deployments. In the first we purposefully searched for pairs of fish in interference interactions (121 found) and from the same videos we collected community descriptors, including diversity, richness, and relative abundance at the BRUV. In the second study we chose random individuals, followed their path through the camera view-field, noted and observed all encounters (840 found), and calculated the probabilities of encounters with interspecific interferences (167 found). A total of 32 fish species were observed.

Of the encountering fish pairs observed, 79 % lacked any interaction, the two individuals in each pair showed consistent neutral behavior and there was no indication of dominance or subordination. Of the species-pairs observed in interference interactions, the only significantly aggressive/dominant species were *Serranus scriba, S. hepatus* and *Coris julis*, all three are mesopredators. The only significantly submissive/subordinate species were *Symphodus tinca, Spicara smaris*, and *Symphodus cinereus*, all of which were commonly observed in the BRUV's field of view. We calculated Pearson product-moment correlation coefficients, testing the hypothesis of no relationship using t-distribution. The only significant negative co-occurrence pairs found were *Diplodus annularis*/*Serranus hepatus* (-0.51, p = 0.006), *D. annularis*/*Coris julis* (-0.62, p = 0,04), *D. annularis*/*Symphodus cinereus* (-0.75, p = 0.02), and *Symphodus melanocercus*/*Coris julis* (-0.75, p = 0.03). None of these pairs had a high probability of engaging in interference interactions. An analysis of species-specific arrival times at the BRUV revealed that *Diplodus annularis* appears consistently and significantly later at the BRUVs than the three species with which it has significant negative co-occurrences. On the basis of our study it can't be determined if this temporal negative co-occurrence is due to avoidance learned from past interferences or caused by other unknown behavioral traits. *D. annularis* has been found to be an aggressive species when provoked but almost all interferences observed in our two studies were intraspecific. We found many significantly positive co-occurrences in all habitat types. Almost all were unique to a particular habitat type, indicating habitat-consistent assemblages. The only potential for bias in our BRUV–based censuses caused by species interactions may be related to the high abundances of a few schooling species, such as *Boops boops*, *Spicara maena*, and *S. smaris*. These typically arrive in large and active groups, display primarily intraspecific interferences, and tend to stay near and circle around the bait throughout the deployment, which physically crowds access to the bait by other species. This situation, however, does not result in negative co-occurrences. Rather, other species remain active in the field of view of the BRUV and can be positively correlated with these gregarious species. One other similar case of bait occupation is the presence of *Muraena helena*, a large sneak-and-attack predator. Once settled at the bait it will frequently feed off the bait through the remainder of the deployment, however no aggressive approaches of other species and no avoidance by other species have been observed, in fact other species benefit from the clouds of smaller bits of bait generated by *M. helena*.

Overall we conclude that interference is not common at BRUV even when the density of fish around the bait is high, there is little indication for bias in favour of aggressive and against submissive species in fish censuses by BRUV, and negative co-occurrences are rare and not matched by frequent interspecific aggression. However, the inclusion of observations from deployments with large schools of gregarious fish and large predators which physically limit access to the bait should be considered with care. We also conclude that BRUV is capable of censusing a substantial portion of the fish community and of recognizing habitat specific assemblages that are consistent across samples within and among locations 10s-100s km apart.

References
1 - Reitz SR, Trumble JT. 2002. Competitive displacement among insects and arachnids. Annual Review of Entomology 47: 435–465.
2 - Stoner, A.W 2004. Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. Review paper, Journal of Fish Biology 65, 1445–1471.
3 - Harvey E.S., McLean D. L., Frusher S. , Haywood M. D. D. , Newman S. J., Williams A. 2012. The use of BRUVs as a tool for assessing marine fisheries and ecosystems: a review of the hurdles and potential. University of Western Australia (publisher).