

Introduced Parasites of Freshwater Fish in Southern California, U.S.A.

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Summary

In 1999-2001, six species of native fish and eleven species of non-native fish (a total of 1,993 specimens) were collected in 14 coastal watersheds of Southern California and examined for parasites. Three species of introduced parasites, a cestode *Bothriocephalus acheilognathi*, a protozoan *Ichthyophthirius multifiliis*, and a crustacean *Lernaea cyprinacea* were widely distributed in the region. *B. acheilognathi* was found in 9 watersheds in two species of native and five species of non-native fish, *I. multifiliis* in 4 watersheds in three native species, and *L. cyprinacea* in 4 watersheds in three native and four non-native species of fish.

Introduction

For centuries, intra- and intercontinental transfer of fish was a common practice to enrich the depauperate native fauna and to rear economically important species in new locations. Successful practice of introduction was darkened with unpredictable side effects. Some imported fishes carried parasites that widely spread in new geographic area and infected local species (Hoffman and Schubert, 1984).

During the 20th century, over 140 species of fish were introduced to California (Swift et al., 1993; Dill and Cordone, 1997). Some of them have been infected with parasites that were naturalized and persisted in southern California waterways. Three of these introduced parasites are considered as extremely dangerous for both native and non-native fish. There are a pseudophyllidean cestode *Bothriocephalus acheilognathi* or the Asian fish tapeworm, a ciliated protozoan *Ichthyophthirius multifiliis*

or "Ich", and a crustacean *Lernaea cyprinacea* or the anchor worm. *B. acheilognathi* was recorded in 1984 by California Department of Fish and Game in the imported grass carp at three irrigation systems in Riverside and Imperial counties, and in the golden shiner from three bait fish farms and from the Lake Hodges in San Diego County (Chen, 1987). In 1995, *I. multifiliis* and *L. cyprinacea* were found in the threespine stickleback from one location in Los Angeles County (Chen, unpublished data). Although these parasites cause a strong negative impact on fish health (Bauer et al., 1973; Hoffman, 1999; Scholtz, 1999), little is known about their spreading into water bodies of southern California.

The goal of the paper is to present contemporary data on the distribution and infection parameters of *Bothriocephalus acheilognathi*, *Ichthyophthyrus multifiliis*, and *Lernaea cyprinacea* in fish from southern California.

Material and Methods

In 1999-2001, a parasitological survey was conducted on 1,933 fish from 14 coastal watersheds of southern California (Figure 1). The fish examined represented 18 species. There were six native species, cyprinids arroyo chub *Gila orcutti*, mojave tui chub *Siphateles bicolor mohavensis*,

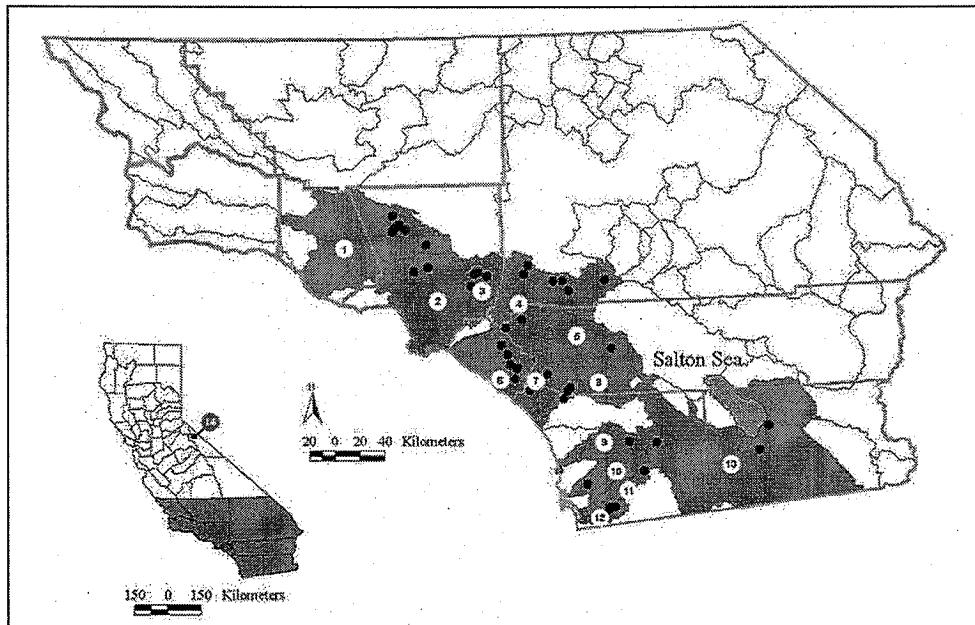


Figure 1. Watersheds Examined in California for Fish Parasites
 1-Santa Clara; 2-Los Angeles; 3-San Gabriel; 4-Santa Ana; 5-San Jacinto; 6-San Juan; 7-San Mateo; 8-Santa Margarita; 9-San Dieguito; 10-San Diego; 11-Sweetwater; 12-Otay; 13-Salton Sea; 14-Walker

and speckled dace, *Rhinichthys osculus*, gasterosteid threespine stickleback *Gasterosteus aculeatus*, catastomid Santa Ana sucker *Catostomus santaanae*, and salmonid rainbow trout *Oncorhynchus mykiss*. Twelve non-native species were cyprinids golden shiner *Notemigonus crysoleucas*, common carp *Cyprinus carpio*, goldfish *Carassius auratus* and fathead minnow *Pimephales promelas*, poeciliid mosquito fish *Gambusia affinis*, ictalurids yellow bullhead *Ameiurus natalis* and channel catfish *Ictalurus punctatus*, centrachids green sunfish *Lepomis cyanellus*, blue gill *Lepomis macrochirus*, largemouth bass *Micropterus salmoides*, and redeye bass *Micropterus coosae*, and salmonid brown trout *Salmo trutta*. Fish were collected by seines, gill nets, and electrofishing, and transported to San Diego State University. They were kept alive or placed on ice until necropsy. Standard procedures were used to examine fish for ecto- and endoparasites. All parasites found were collected, counted and studied using light microscopy and scanning electron microscopy. The intensity of protozoan parasites were recorded as high (++, dozens of parasites per field of view) and low (+, one to a dozen parasites per field of view). Prevalence, mean intensity, and abundance of each parasite species as well as sites of fish collection are given in Table 1.

Table 1. Prevalence, intensity and abundance of fish infection by parasites in California, 1999-2001

Fish species(numbers)	Prevalence %	Mean intensity (range)	Abundance	Watersheds
<i>Bothriocephalus acheilognathi</i>				
Arroyo chub(298)	20.0	8.9 (1-155)	1.7	2, 4, 5, 12
Mohave tui chub(22)	41.0	31 (4-82)	12.6	14
Common carp(83)	30.0	3.6 (1-15)	0.9	4
Golden shiner(30)	30.0	6.3 (1-12)	1.9	13
Goldfish(58)	11.0	2.5 (1-4)	0.3	4
Fathead minnow(64)	9.4	1.5 (1-3)	0.2	2, 4
Mosquitofish(331)	20.8	6.0 (1-35)	1.3	1, 2, 4, 7, 8, 13
<i>Ichthyophthyrus multifiliis</i>				
Arroyo chub(169)	67.0	+++		1, 2, 3
Speckled dace(65)	68.0	+++		3
Threespine stickleback(55)	11.0	++		1, 11
<i>Lernaea cyprinacea</i>				
Arroyo chub(249)	23.3	3.6 (1-17)	0.5	1, 2, 4, 8
Threespine stickleback(55)	21.1	2.3(2 - 3)	1.2	1
Santa Ana sucker(32)	12.5	1 (1)	0.1	4
Common carp(83)	14.5	1(1)	0.02	4
Goldfish(36)	8.3	1(1)	0.02	1
Fathead minnow(72)	1.0	1(1)	0.01	2, 4
Green sunfish(36)	28.0	1.3 (1 - 2)	0.7	1

Results

Bothriocephalus acheilognathi was recorded in fish collected in 9 of 14 watersheds surveyed (Table 1). Of six native species examined, only the arroyo chub and the mojave tui chub were infected with the Asian tapeworm. It is the first record in these species of chubs as the final hosts of *B. acheilognathi*. Mojave tui chub, the endemic species inhabiting the Walker River watershed, demonstrated the highest infection parameters with this parasite (Table 1). The arroyo chub infected with *B. acheilognathi* was found in 4 watersheds (Table 1). The highest prevalence, mean intensity, and abundance was registered in this fish from the Santa Margarita watershed (40.8%, 2.5, and 1.0, respectively). The list of non-native fish that harbored *B. acheilognathi* included five species (Table 1). Of them, the common carp and golden shiner showed the highest parameters of infection. The most widespread infected species was the mosquito fish that was found in six watersheds examined (Table 1).

Ichthyophthirius multifiliis was recorded in 4 watersheds. In contrast to *B. acheilognathi*, it parasitized only native species of fish (Table 1). Arroyo chub and speckled dace in all watersheds examined showed the highest parameters of the infection (Table 1). Threespine stickleback was heavily infected only in the Santa Clara watershed (prevalence 100%, high intensity). All three species of the infected fish from the Santa Clara watershed exhibited the clinical manifestation of the "white spot disease".

Lernaea cyprinacea occurred in 4 watersheds where it infected three species of native fish and five species of non-native fish (Table 1). Prevalence of infection varied from low to moderate in both groups of fish. High infection was found only in the arroyo chub from the Santa Clara watershed (prevalence 100%, mean intensity 7.1).

Conclusions

Bothriocephalus acheilognathi, *I. multifiliis* and *L. cyprinacea*, accidentally introduced to Southern California with the imported fish are widely spread in the major coastal water systems of the region. Parasites infect 5 species of native fish and 6 species of non-native species in 9 of 14 watersheds studied. Mosquitofish is the most wide spread fish infected with *B. acheilognathi*, and the arroyo chub harbors all three species of parasites mentioned above. Fish infection with introduced parasites may represent a high potential risk for conservation efforts, aquaculture and sport fisheries in Southern California.

References

BAUER, O.N., V.A. MUSSELIUS, and Y.A. STRELKOV. Diseases of pond

fish. Jerusalem. Israel Program for scientific translation for US Department of Interior, 1973.

- CHEN, M.F. California's warmwater fish disease infection program: An evolutionary process. Proc. 67th Ann. Conf. West. Assoc. Fish Wildlife Agencies. Salt Lake City, Utah, July 12-15, p. 228-237. 1987.
- DILL, W.A. and A.J. CORDONE. 1997. History and status of introduced fishes in California, 1871-1996. Cal. Dept. Fish Game Bull. 178, 1997.
- HOFFMAN, G.L. Parasites of North American freshwater fishes. 2nd edition. Itaka, New York. Constock Publish. Assoc., a Division. Cornell Univ. Press. 1999.
- HOFFMAN, G.L. and G. SCHUBERT. Some parasites of the exotic fishes. In: Distribution, biology and management of exotic fishes. Baltimore, USA and London, UK: John Hopkins Univ. Press. 1984.
- SCHOLZ, T. Parasites in cultured and feral fish. Vet.Parasitol. 84, p. 317-335. 1999.
- SWIFT, C.C., T.R. HAGLUND, M. RUIZ, and R.N. FISHER. The status and distribution of the freshwater fishes of southern California. Bull. South Calif.Ac. Sci. 92, 1993.