TUMORS IN SOUTHERN CALIFORNIA DEMERSAL FISHES

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Tumors of the skin and mouth have been reported in more than 50 species of bony fishes from both freshwater and marine environments. In southern California coastal waters, the two species most frequently affected with these types of tumors, both in the earlier and more recent surveys, were the Dover sole (*Microstomus pacificus*) and the white croaker (*Genyonemus lineatus*) (Table 1).

The Dover sole is only one of at least eight species of flatfish from the coastal waters of the eastern Pacific that have been reported to have skin tumors. Since tumor bearing fishes are widely distributed along the coast from British Columbia to California, much information can be gained from comparative studies of disease characteristics. Our continued analyses of data from trawl surveys off southern California have contributed to such studies. In addition, in the past year, preserved specimens from the Project's museum collection have been examined at several research laboratories, including those of Dr. J. C. Harshbarger (Smithsonian Institution) and Prof. H. F. Stich (University of British Columbia).

DISTRIBUTION OF DISEASED POPULATIONS

There are still no obvious geographical trends in the frequency of tumor bearing Dover sole in trawl catches from the coastal waters of southern California. During 1972 73, overall prevalence of the anomaly was 1.0 percent in 13,626 individuals collected off Palos Verdes and 0.8 percent in 3,586 individuals taken in San Pedro Bay (Table 2). The size of the fish most often affected was also very similar in the two areas. The Palos Verdes collections contained a few tumor bearing Dover sole that were larger than any taken in San Pedro Bay, but this was probably a result of the low incidence of the disease in that size group (longer than 175 mm, standard length) and the larger number of individuals collected off Palos Verdes. Although the trawl study area (Point Dume to Dana Point, 20 to 200 m) is large enough to reveal differences in the distribution of Dover sole with eroded fins, it may still be too small to see patterns in the prevalence of tumor bearing individuals of this species, which range along the entire coast from the Bering Sea to northern Baja California.

A study of the life history of the white croaker was undertaken for the Coastal Water Research Project by Ms. Laurie Philips of Occidental College. In examining 1,862 specimens collected in trawl surveys from Point Vicente to Sunset Beach in 1962 72, she found 0.98 percent to have lip papillomas. Affected individuals were in the larger size classes, and none were found within the Los Angeles Long Beach Harbor, where there is a large population of the species; this may in part be the result of size differences in the populations within and outside the breakwater. Although white croaker with lip

papillomas were relatively abundant in trawls around the Orange County shallow outfall in 1970, only four were collected during 1972 73.

TUMOR DEVELOPMENT AND THE LIFE CYCLE OF THE DOVER SOLE

The data suggest that the occurrence of tumors in the Dover sole is a function of the early life history of the species. To trace the development of the skin tumors, over 650 larval Dover sole taken in the southern California Bight were examined and measured. Collections were made by the University of Southern California (1961 69); the California Cooperative Fisheries Investigation (1950 68); and Scripps Institution of Oceanography, Shirley Imsand (1971 72). Mr. Ricard Gammon, formerly of the Project, participated in this work. The larvae, 7 to 64 mm (standard length) in size, were present in waters to a depth of 200 m at all times of the year and were collected as far as 100 miles from shore. Although relative abundances could not be determined because of differences in sampling frequencies and methods, it is evident that larvae 7 to 15 mm appeared in the plankton in the spring and grew until they were 50 to 60 mm in size (Figure 1). Only 5 of the 650 specimens had any type of anomalous lump or growth (tissue sections from these specimens have not yet been examined). There is some indication from these larval collections that Dover sole settle out of the plankton in both spring and the fall; however, the majority appear to settle out in the spring.

In the vicinity of the Orange County outfall system in San Pedro Bay, recently settled Dover sole were present in the February and lIay trawl catches and appeared exclusively at the two deepest stations. Tumor bearing fish did not appear in this age group until the August catches.

Most flatfish species, including the Dover sole, produce symmetric planktonic larvae that undergo metamorphosis (e.g., eye migration) prior to settling. The fact that small tumors occurred most frequently on the eyed side of affected Dover sole, as in other flatfish species, suggests that tumor development begins during or after metamorphosis. It is possible that changes associated with metamorphosis predispose the young fish to environmental stresses that result in the development of growth anomalies.

The tumors, which are noninvasive, range from round nodules 1 mm in diameter to irregularly shaped patches 40 mm in length. They are located on any part of the body, including the fins, and their color is determined to some extent by the degree of pigmentation in the skin on that part of the body; colors range from black to off white. The tumors may be round or irregular, smooth or convoluted, and may have well defined edges.

CONCLUSIONS

The recent data reveal that, among demersal trawl caught fishes, the Dover sole is the only species from southern California coastal waters consistently affected with epidermal tumors. Although white croaker with lip papillomas were relatively abundant in 1970, few have been collected since then.

Several factors suggest that the occurrence of skin tumors in Dover sole is a genetic or developmental disease. Along the coast, almost all of the flatfish species reported to have skin tumors belong to one family the right handed flounders (Pleuronectidae); tumors in left handed flounders (Bothidae) are rare. The disease is also most prevalent in juvenile fishes. It appears following metamorphosis, a major developmental change in the growth of the individual. Finally, most small tumors appear on the eyed side of affected specimens and may be associated with the skin changes that occur during metamorphosis, which result in differential pigmentation of the eyed and blind sides.

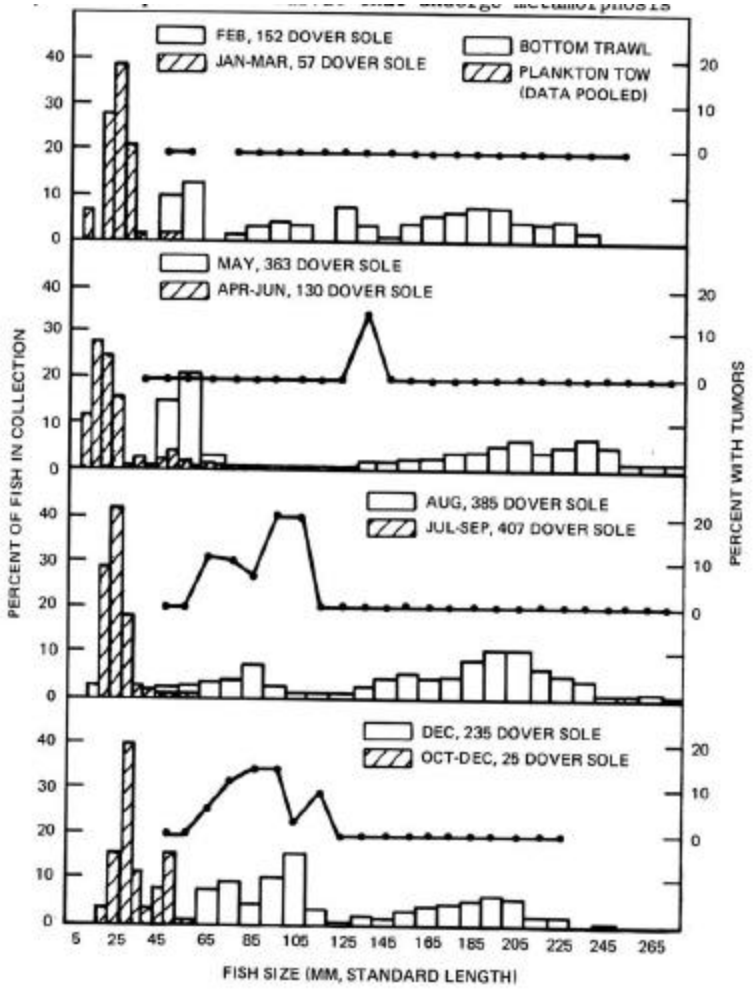
Other factors, however, suggest an environmental influence. The Dover sole is the only demersal flatfish species in southern California waters reported to have skin tumors. Since larval Dover sole are in the plankton for at least 1 year Clonger than most flatfish species), it is possible that individuals that originate in one region may be widely distributed and that exposure to a specific tumor causing agent may occur prior to metamorphosis in an area distant from the point of settling an area in which other tumor bearing flatfish are found.

Another indication of an environmental influence is the fact that tumors appear in newly settled Dover sole in the fall collections, the same time of the year that the anomaly is noted in the English sole off the coast of Washington. The early life histories of the two species are different, and the occurrence of small tumors at the same time of year in both species suggests that conditions in early summer (e.g., rapid temperature change, changes in food availability, changes in the distribution or activity of an infective agent) may be involved in the initiation of the disease in the young fish. (Tumor bearing English sole are collected in San Francisco Bay and off the coast of Washington. Although juveniles are present in our trawl catches, sufficient numbers have not been collected to evaluate the incidence of the disease in this species.)

When large numbers of individuals from Palos Verdes and San Pedro Bay were compared, there were no differences in prevalence of tumor bearing Dover sole. However, since the entire southern California coastal region is influenced by urban development, at least one survey distant from the southern California area should be conducted as a control. The prevalence of the tumor disease does not appear to be related to proximity to a particular wastewater discharge or, for that matter, to any act of man, yet its relationship to the distribution of a specific, as yet unknown microbial or chemical agent cannot be ruled out.

FIGURES

Figure 1.
Dover sole collected in plankton tows (1950-72) and bottom trawls (1971) in Southern California coastal waters



TABLES

Table 1.
Growths reported in trawl-caught demersal fish species collected in 350 samples from Point Dume to Dana Point, May 1972 to December 1973

Species	Common Name	No. Examined	No. Affected
Microstomus pacificus	Dover sole	19,546	191
Genyonemus lineatus	White croaker	2,691	5
Citharichthys stigmaeus	Speckled sanddab	13,695	2
Pleuronichthys verticalis	Hornyhead turbot	509	1
Symphurus atricauda	California tonguefish	2,592	1
Sebastes levis	Cow rockfish	167	1
Sebastes dalli	Calico rockfish	153	1
Zaniolepis latipinnis	Longspine combfish	1,348	1
Cymatogaster aggregata	Shiner perch	6,301	1

Table 2.
Prevalence of epidermal tumors in Dover sole collected off the Palos Verdes Peninsula (135 samples) and in San Pedro Bay (64 samples), 1972-73.

	Palos Verdes Peninsula			San Pedro Bay		
		Tumor-Bearing Fish			Tumor-Bearing Fish	
Fish Size (mm SL)	No. of Fish	No.	%	No. of Fish	No.	%
25	--	--	--	1	--	--
35	2	--	--	3	--	--
45	4	--	--	116	--	--
55	20	--	--	160	--	--
65	44	3	6.8	55	3	5.4
75	58	1	1.7	37	4	10.8
85	67	6	9	32	5	15.6
95	217	15	6.9	68	4	5.9
105	532	44	8.3	89	1	1.1
115	873	35	4	139	6	4.3
125	1,021	18	1.8	141	--	--
135	1,025	8	0.78	151	1	0.68
145	990	4	0.4	216	3	1.4
155	1,034	1	0.1	283	2	0.71
165	1,284	5	0.39	312	--	--
175	1,293	--	--	281	1	0.36
185	1,237	--	--	288	--	--
195	1,137	--	--	288	--	--
205	1,023	2	0.2	217	--	--
215	796	--	--	203	--	--
225	449	1	0.22	182	--	--
235	303	--	--	114	--	--
245	142	--	--	81	--	--
255	46	--	--	61	--	--
265	18	--	--	34	--	--
275	7	--	--	18	--	--
285	2	--	--	5	--	--
295	1	--	--	3	--	--
305	--	--	--	4	--	--

315	--	--	--	1	--	--
>315	1	--	--	3	--	--
Total	13,626	143	1	3,586	30	0.84