Continued Diminished Prevalence of the Lucke Renal Adenocarcinoma in Minnesota Leopard Frogs

ABSTRACT: No Lucké renal adenocarcinomas were detected at autopsy of 1216 northern leopard frogs *(Rana pipiens)* collected in Minnesota during the spring and autumn of 1978 and the spring of 1979, seasons in which the tumor was formerly obtained with a high frequency. The prevalence of renal tumors has been declining in Minnesota since at least 1966, and *R. pipiens* has become progressively scarce in Minnesota since that time. We suggest a causal relationship between reduced frog populations and decreased tumor prevalence.

INTRODUCTION

The renal adenocarcinoma of the northern leopard frog *(Rana pipiens)*, originally described by Lucké (1934), is believed to be caused by a herpesvirus (Lucké, 1952; McKinnell, 1973; Naegele *et al.*, 1974; Tweedell, 1967; Tweedell and Wong, 1974). Frogs afflicted with the tumor were found in upper midwest and NE United States (McKinnell, 1965; Rafferty, 1967; Tweedell, 1965). The previous prevalence of the tumor in natural populations of frogs permitted a characterization of the relationship of temperature and season to tumor cell fine structure and herpesvirus replication. Virus particles appear in tumors more rapidly after the onset of hibernation and the virions persist in tumors longer in the spring than would be predicted on the basis of laboratory studies (McKinnell and Ellis, 1972a, 1972b; McKinnell *et al.*, 1972).

We reported a precipitous decline in tumor abundance in 1977 (McKinnell *et al.*, 1979). This report presents 1978 and 1979 data which support and extend our previous observations.

MATERIALS AND METHODS

Rana pipiens were collected with net or by hand near or in the water of Minnesota lakes used for hibernation. Pithed frogs were autopsied under a magnifier (3×) with fluorescent illuminator. Sex and snout-vent length were recorded. Both dorsal and ventral aspects of the mesonephros were examined and a dissecting microscope was used to examine areas of the mesonephros suspected of bearing tumors.

RESULTS

No renal tumors were detected in 15 collections totaling 1216 frogs examined in 1978 and 1979 (Table 1). The frogs were obtained from areas near lakeshores where frogs with renal tumors had previously been collected, and at seasons (spring and autumn) with known high tumor prevalence (McKinnell and McKinnell, 1968). Only collections of frogs with mean snout-vent length equal to or exceeding 65 mm were included in this study.

The decline in renal tumor prevalence has been occurring at least since 1966. During 1963,

TABLE 1.—Mean length of collections made in 1978 and 1979 of Minnesota leopard frogs *(R. pipiens)*

County — Date	N	Mean length (mm)
Douglas — 4 Mar. 78	27	70.5
Scott — 14 Sept. 78	5	80.4
Kandiyohi — 22 Sept. 78	63	72.9
Kandiyohi — 5 Oct. 78	63	71.5
Kandiyohi — 14 Oct. 78	47	69.5
Kandiyohi — 19 Oct. 78	123	73.0
Otter Tail — 20 Oct. 78	261	68.5
Kandiyohi — 21 Oct. 78	19	74.0
Hennepin — 29 Oct. 78	77	65.0
Scott — 30 Oct. 78	10	69.0
Scott — 31 Oct. 78	125	66.3
Pope — 20 Mar. 79	185	69.0
Pope — 11 Apr. 79	116	68.2
Scott — 18 Apr. 79	78	67.1
Hennepin — 23 Apr. 79	17	68.4
Totals	1216	

we autopsied 1088 frogs and reported tumor prevalence of 8.5% (McKinnell, 1965). Progressively lower prevalences were observed in subsequent years (6.3%, 674 frogs, 1966-1968; 2.9%, 1100 frogs, 1970-1971) until no tumors at all were detected in 685 frogs in 1977 (McKinnell *et al.,* 1979). In addition, tumors remained undetected in 1216 frogs in 1978 and 1979. The sizes of the samples are large enough to assure the statistical significance of the differences in percentages of tumors.

DISCUSSION

Frog collections with mean snout-vent length less than 65 mm were not included in this study. We have found that renal tumors in natural populations of frogs occur when mean snout-vent length is greater than 65 mm (McKinnell *et al.,* 1979).

Much has been written recently about the environment and cancer. Some authors suggest a causal relationship between environmental factors *(e.g.,* automobile exhausts, industrial chemicals, biocides, etc.) and cancer (Higginson, 1969; Schottenfeld and Haas, 1979). Does the present study indicate that pollution control in Minnesota has improved so much that the prevalence of frog renal tumors is correspondingly reduced? We believe not. We suggest instead that another environmental factor, crowding, is directly related to tumor prevalence. Elsewhere we presented evidence that frogs were at an all-time low density in Minnesota in 1977 (McKinnell *et al.,* 1979) and they continue to be scarce in 1978 and 1979. Breeding ponds that were recently observed to contain only a dozen or so adult frogs formerly contained several hundred. We suggest that when frogs become scarce, there is a reduced likelihood that one or more adults with tumors containing herpesvirus will release oncogenic viruses into breeding ponds. Immunologically susceptible young tadpoles (Tweedell, 1967) will not become infected with the oncogenic herpesvirus if none are released into their environment. Thus, tumor prevalence may be related to crowding.

Our data do not exclude the possibility that one or more carcinogenic pollutants have declined, resulting in decreased tumor prevalence. However, there is at present no environmental pollutant proven to induce the Lucké tumor.

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