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The influence of climate on the distribution of monogeneans of anurans in Nigeria

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Abstract

Investigations undertaken on the monogeneans of amphibians in Nigeria have shown that host ecology has an influence on the distribution of these monogeneans. Amphibians from humid environments of the rainforest, a freshwater swamp and mangrove harboured no monogeneans, whereas those occurring in drier conditions in the savannah-mosaic and guinea savannah yielded five species of polystomatid parasites: *Polystoma prudhoei* from *Bufo regularis*, *Polystoma galamensis* from *Rana galamensis*, *Eupolystoma alluaudi* from *Bufo regularis* and *Bufo maculatus*, and two unidentified *Polystoma* species from *Bufo regularis* and *Ptychadena oxyrynchus*, respectively. Some of these monogeneans appear to have reproduction cycles which are synchronized with those of the hosts. The prevalence of *E. alluaudi* in *Bufo* spp. caught in New Bussa (68.4% in *B. regularis* and 82.3% in *B. maculatus*) were higher than those reported for this parasite in other locations in West Africa and for *Eupolystoma anterorchis* in *Bufo pardalis* from the Cape Flats of South Africa.

Introduction

The ecology of amphibian hosts has been established to influence the distribution and life-cycle strategies of their monogenean parasites (Tinsley, 1975, 1978b). Combes *et al.* (1976) observed that in Togo, *Polystoma africanum* preferentially infected *Bufo* sp. which inhabited the humid forest region of the country. In contrast, *Eupolystoma alluaudi* infected *Bufo* sp. in the drier savannah zone of the country. The reproduction of monogeneans infecting the aquatic phase of their hosts, especially in temperate regions, is synchronized to coincide with the spawning season of the host (Combes, 1968). This makes for effective transmission of oncomiracidia to the tadpoles in the amphibious phase. In contrast, as a result of the shorter rainy season in the savannah, monogeneans such as *E. alluaudi* and related species have developed adaptations to ensure reproductive success. These include egg production all year round (Tinsley, 1978a), coupled with a long uterus which has the capacity to hold a large number of eggs at any one time (Combes *et al.*, 1973). In addition, oviposition and hatching occurs rapidly, being triggered by the reduced tonicity of the host urine on entering water (Salami-Cadoux, 1975; Tinsley, 1975, 1978a). This visit to the water for spawning presents an opportunity for the adult host to be infected via the cloaca (Combes *et al.*, 1976). More significantly, *Eupolystoma* species have developed a direct internal cycle of reinfection whereby oncomiracidia are able to hatch out in the host's urine within the bladder and establish themselves directly (Salami-Cadoux, 1975; Tinsley, 1975, 1978a). This internal cycle of reinfection leads to massive levels of infection with burdens as high as 1500–2000 worms per toad (Combes *et al.*, 1973; Tinsley, 1975, 1978a).

Aisien *et al.* (2001) reported the occurrence of pentastomids, cestodes, digenetic trematodes and nematodes in amphibians in the rainforest and mangrove of south-west Nigeria, and observed a conspicuous absence of monogeneans in these anurans. However, in a recent investigation of the amphibians in locations in the savannah mosaic and the guinea savannah of Nigeria, a distribution trend was observed in monogenetic trematodes, which strongly suggests that climate plays a role in their distribution and that some of the monogeneans may actually have synchronized their reproduction to coincide with that of their host as occurs in temperate species (Combes, 1968).

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Material and methods

Amphibians were collected from locations in the guinea savannah, savannah-mosaic or derived savannah, rainforest, freshwater swamp forest and in the mangrove forest. In the guinea savannah, specimens were collected at Lokoja (7°49′N, 6°44′E) in September, 2001 and from New Bussa (10°15′N, 4°30′E) in August, 2002. In the savannah-mosaic of Edo State of Nigeria, amphibians were collected at Igarra (7°17′N, 6°06′E), Agenegbode (7°06′N, 6°45′E), Ogbonna (7°07′N, 6°27′E), Auchi (7°03′N, 6°16′E) and Ihievbe (7°06′N, 6°10′E) between June 1999 and December, 2001. Amphibians were also obtained from Ozalla (6°48′N, 6°01′E) from June to September, 1999 and Ugbovbighan-Erah (6°49′N, 6°06′E) from June to September, 2002. These sites are located in the transition zone between the rainforest and savannah-mosaic zones. In the rainforest, amphibians were collected from Benin City and its environs (6°30′N, 5°38′E) in Edo State from December, 1985 to August, 1995 and from Ossisa (5°55′N, 6°29′E) in Delta State in October, 1999. Sapele (6°N, 5°45′E) and Warri (5° 30′N, 5°45′E) which were earlier reported to be in the mangrove (Aisien *et al.*, 2001) are more appropriately located in the freshwater swamps of Delta State. Amphibians were collected from these locations in August, 1987. The other location in the freshwater swamp from which specimens were collected was Aboh (5°33′N, 6°31′E) in October, 1999. In the mangrove swamp, amphibian specimens were obtained from Patani (5°22′N, 6°20′E) in August, 1999.

The amphibians examined included *Bufo regularis*, *Bufo maculatus*, *Dicroglossus occipitalis*, *Ptychadena oxyrynchus*, *P. mascareniensis*, *P. pumilo*, *P. schubotzi*, *Leptopelis viridis*, *Hylarana* (*Rana*) *galamensis*, *Hemisus mamoratus*, *Xenopus muelleri* and *Silurana tropicalis* (table 1). The amphibians were dissected and examined for parasites within 18 h of capture. Monogeneans were fixed flattened under cover slips on microscope slides in 10% formol-saline, stained with acetocarmine, dehydrated in alcohol and permanent mounts made in Canada balsam.

Results

No monogeneans were recovered from amphibians examined from the rainforest, freshwater swamp and mangrove. The prevalence of monogeneans in the amphibians collected from other locations is presented in table 2. In the transition zone, two of 62 (3.2%) *B. regularis* from Ozalla were infected with *Polystoma prudhoei*, with each of them habouring one parasite in the urinary bladder. At Ugbovbighan-Erah, only one of 213 (0.47%) *B. regularis* investigated was infected with *P. prudhoei*. Another *Polystoma* sp. designated as *Polystoma* sp. I showed a prevalence of 16.4%, with a range of 1–20 worms. Worms of this species collected at the onset of the rainy season before the toads started spawning yielded immature parasites. As the rainy season progressed, mature worms of *Polystoma* sp. I with eggs in their uterus were recovered. Specimens of *B. maculatus* and *P. oxyrynchus* examined at Ugbovbighan-Erah were neither infected with *P. prudhoei* nor with *Polystoma* sp. I.

In the savannah-mosaic, 11.3% of *B. regularis* examined at Auchi were infected with *P. prudhoei*. In contrast, *B. regularis* collected from Igarra, Agenegbode, Ogbonna and Ihievbe which are in the same bioclimatic

Table 1. Amphibians examined for monogeneans in the different bioclimatic zones of Nigeria between December, 1985 and September, 2002.

Bioclimatic zones and locations	Amphibian hosts											
	Br	*Bm*	*Do*	*Po*	*Pm*	*Pp*	*Ps*	*Lv*	*Rg*	*Hm*	*Xm*	*St*
Guinea savannah												
Lokoja	18	–	–	–	–	–	–	–	–	–	–	–
New Bussa	38	17	6	–	–	–	–	–	14	–	–	–
Savannah-mosaic												
Igarra	94	–	–	–	–	–	–	–	2	–	15	–
Agenegbode	92	36	5	2	–	–	–	–	2	–	–	5
Ogbonna	84	7	30	7	14	7	1	3	–	–	–	–
Auchi	62	4	1	2	–	–	–	–	–	–	–	–
Ihievbe	69	–	17	4	–	–	–	–	–	–	–	–
Transition zone												
Ozalla	62	–	–	–	–	–	–	–	–	–	–	–
Ugbovbighan-Erah	213	21	1	7	–	–	–	5	–	–	–	25
Tropical rainforest												
Benin City and environs	402	–	155	86	–	–	–	–	–	30	396	–
Freshwater swamp												
Aboh	31	–	11	–	–	–	–	–	–	–	–	–
Warri	–	–	13	–	–	–	–	–	–	–	–	–
Sapele	10	–	15	18	–	–	–	–	–	–	–	–
Mangrove swamp												
Patani	17	38	–	–	–	–	–	–	–	–	–	–
Total	1192	123	254	126	14	7	1	8	18	30	411	30

Bm, *Bufo maculatus*; *Br*, *B. regularis*; *Do*, *Dicroglossus occipitalis*; *Hm*, *Hemisus marmoratus*; *Lv*, *Leptopelis viridis*; *Pm*, *Ptychadena mascareniensis*; *Po*, *P. oxyrynchus*; *Pp*, *P. pumilo*; *Ps*, *P. schubotzi*; *Rg*, *Rana galamensis*; *St*, *Silurana tropicalis*; *Xm*, *Xenopus muelleri*.

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Table 2. Prevalence (%) of monogeneans in amphibians from locations in the different bioclimatic zones of Nigeria between June, 1999 and September, 2002.

Bioclimatic zone and location	Monogenean species	Amphibian species			
		Bufo regularis	*Bufo maculatus*	*Ptychadena oxyrynchus*	*Rana galamensis*
Guinea savannah					
New Bussa	*Eupolystoma alluaudi*	68.4	82.3	–	–
	Polystoma galamensis	–	–	–	21.4
Savannah-mosaic					
Agenegbode	*Polystoma galamensis*	–	–	–	50.0
	Polystoma sp. II	–	–	50.0	–
Ogbonna	*Polystoma* sp. II	–	–	28.6	–
Auchi	*Polystoma prudhoei*	11.3	–	–	–
Transition zone					
Ozalla	*Polystoma prudhoei*	3.2	–	–	–
Ugbovbighan-Erah	*Polystoma prudhoei*	0.47	–	–	–
	Polystoma sp. I	16.4	–	–	–

zone haboured no polystomatids. *Ptychadena oxyrynchus* collected from Agenegbode and Ogbonna were infected with a *Polystoma* sp. designated as *Polystoma* sp. II, with prevalence values of 50% and 28.6%, respectively. One of two *R. galamensis* from Agenegbode harboured one specimen of *Polystoma galamensis* in the urinary bladder. Toads examined from Lokoja did not yield any monogeneans, whereas *B. regularis* and *B. maculatus* collected from New Bussa harboured *Eupolystoma alluaudi* infections, with prevalence values of 68.4% and 82.3%, respectively. *Rana galamensis* also collected from this location were infected with *P. galamensis* (table 2).

Discussion

Monogeneans of amphibians in Nigeria seem to preferentially infect hosts resident in areas of reduced rainfall compared with the rainforest and swampy environments. Despite the large numbers of anurans examined from the various locations in these zones (table 1), no polystomatids were recovered from these hosts. This fact is supported by our observations that monogeneans were present in these amphibians when the vegetation type changed from typical rainforest to the savannah type.

The occurrence of *E. alluaudi* in the guinea savannah of Nigeria is in agreement with the previously reported ecological preference of this parasite (Combes *et al.*, 1976). Moreover, other reports of *E. alluaudi* in Cameroon and Ethiopia (see Tinsley, 1978b) and *E. anterorchis* in the Cape Flats of South Africa (Tinsley, 1978b) were all in the savannah. The absence of monogeneans in the amphibians of the rainforest in Nigeria contrasts with the situation reported in the corresponding zone in Togo. The *Bufo* spp. found in the forest region of Togo harboured *Polystoma africanum*, whose life cycle is well correlated with the host's ecology (Combes *et al.*, 1976).

Little information is available on the life cycle of *P. prudhoei* and other polystomatids from amphibians in the savannah-mosaic zone of south-west Nigeria. However, with *Polystoma* sp. I being found in *B. regularis* at Ugbovbighan-Erah, these monogeneans may fall into the category whose life cycles are synchronized with those of the host. Specimens of *Polystoma* sp. I from *B. regularis* recovered in the early part of the rainy season (i.e. June), were all immature. In July, only one of 30 (3.1%) specimens recovered was mature, with three eggs in the uterus. In August and September, which represent the peak period of the rainy season in Ugbovbighan-Erah, 38.1% and 37.2%, respectively, of the worms recovered were mature. These worms were therefore under the influence of the gonadotropic hormones of the host, which influence their maturation, and result in the production of eggs during the host's spawning season. In this situation, oncomiracidia are available to infect tadpoles during the brief period of the rainy season.

In contrast to the reported low prevalence of *E. alluaudi* in *B. regularis* in Togo by Combes *et al.* (1973) and of *E. anterorchis* in *B. pardalis* from the Cape, South Africa (Tinsley, 1978b), we recorded high prevalences of *E. alluaudi* in *B. regularis* (68.4%) and *B. maculatus* (82.3%) from New Bussa. However, in agreement with the overdispersed parasite distribution observed by Tinsley (1975), a small number of hosts harboured large numbers of worms (ranging from 500 to 1500), with the entire range of developing stages being represented. Previous investigations (Combes *et al.*, 1973; Tinsley, 1975) have shown that such massive levels of infection result when, through the internal cycle of re-infection in *Eupolystoma* species, oncomiracidia hatch out in the host's urine and become established directly in the bladder.

Although *Polystoma galamensis* was recorded in both the savannah-mosaic and guinea savannah, *Rana galamensis* from the guinea savannah (New Bussa) harboured more worms per host. Avery (1971) who examined *R. galamensis* in Zaria, another location in the guinea savannah, did not report the occurrence *P. galamensis* in this frog. The polystomatid reported by Avery from Zaria was *Protopolystoma xenopodis* from *X. muelleri*. This parasite does not seem to share the ecological restriction demonstrated by other polystomatids so far recorded in Nigeria, since *P. xenopodis* also occurs in *Xenopus* sp. from Ogbomosho,

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which is located in the rainforest zone of south-west Nigeria (Thurston, 1970).

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