Experimental studies on Korea *Taenia* (Cheju strain) infection in domestic animals. Annals of Tropical Medicine and Parasitology **83:** 395–403.

———, ———, ———, AND Z. S. PALOWSKI. 1992. Experimental infection with *Taenia saginata* (Poland strain) in Taiwanese pigs. Journal of Helminthology **66:** 198–204.

———, C. Y. LIN, C. C. CHEN, AND W. C. CHUNG. 1995. Morphological description of *Taenia saginata asiatica* (Cyclophyllidea: Taeniidae) from man in Asia. Journal of Helminthology **69:** 299–303.

———, ———, C. C. WU, AND W. C. CHUNG. 1996. Experimental studies on pathway for migration and development of Taiwan *Taenia* in domestic pigs. International Journal for Parasitology **26:** 45–48.

SILVERMAN, P. H., AND R. B. MANEELY. 1955. Studies on the biology of some tapeworms of the genus *Taenia*. III. The role of the secreting gland of the hexacanth embryo in the penetration of the intestinal mucosa of the intermediate host, and some of its histochemical reactions. Annals of Tropical Medicine and Parasitology **49:** 326–330.

SLAIS, J. 1970. The morphology and pathogenicity of the bladder worms: *Cysticercus cellulosa* and *Cysticercus bovis*. Publishing House of the Czechoslovak Academy of Sciences, Prague, Czech Republic, 284 p.

J. Parasitol., 82(6), 1996 p. 1034–1036

Association between Duration of Humid Season and Geographical Distribution Patterns of Different Species of Chewing Lice (Mallophaga: Insecta) Infesting Domestic Chickens in Nigeria

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ABSTRACT: In a countrywide study of the geographical distribution patterns of chicken lice in Nigeria, 3 species, *Menacanthus pallidulus* (Neumann 1912), *Goniodes dissimilis* Denny, 1842, and *Menopon gallinae* (Linnaeus, 1758), were completely restricted to within areas with a long humid season (6—12 humid mo per yr). In constrast, 4 species, *Cuclotogaster occidentalis* Tendeiro, 1954, *Menacanthus cornutus* (Schommer, 1913), *Amyrsidea powelli* (Bedford, 1920), and *Goniodes gigas* (Taschenberg, 1879), thrived only in areas where the humid season was of a short duration (≤5 mo). The last 3 named species extended also into the fringes of areas with a long humid season (6–8 humid mo) at significantly reduced numbers. They were entirely absent in areas with a particularly protracted humid season (9–12 humid mo). Three other species, *Numidilipeurus tropicalis* (Peters, 1931), *Goniocotes gallinae* (DeGeer, 1778), and *Lipeurus caponis* (Linnaeus, 1758), were just as abundant in areas of a long humid season as they were in areas with a short humid season. It was concluded that there was an association between duration of the humid season and the geographical distribution patterns of certain species of chicken lice in Nigeria. The duration of the humid season might thus provide a means of predicting the potential occurrence of some species of chicken lice in a particular area.

Lice are considerable economic pests of chickens, with losses arising particularly from emaciation, reduced egg production, retarded growth, blemished skin, and mortality (Bishopp, 1942; Reid and Linkfield, 1957; Derylo, 1974a, 1974b, 1974c). In Nigeria, up to 10 species of lice have been reported from this host (Caswell, 1959; Fabiyi, 1980, 1986).

Buriro and Akbar (1978), investigating the prevalence of chicken lice and other ectoparasites in Sind Province, Pakistan, observed that the distribution of the large chicken louse, *Goniodes gigas* (Taschenberg, 1879), was climate-related, thriving only in areas with a short humid season. In Nigeria, there is no information available about any association between distribution of lice and climate.

The present study was designed to determine the geographical distribution patterns of chicken lice in Nigeria. Emphasis was placed on delineating the climatic areas in which each species thrived.

A total of 450 chickens from all representative climatic zones of Nigeria, stretching from the semidesert town of Geidam in the north to the ever-humid town of Degema in the south, and as far west as Badagry to as far east as Mongono, were examined for lice from 1988 through 1990. These localities, their locations, together with the duration of the humid season they experience each year, based on a modification of Papadakis' (1961) humidity areas illustrated for Nigeria, are shown in Table I. In this context, a month is regarded as humid if the rainfall alone exceeds potential evapotranspiration and as dry when rainfall plus water stored in the soil from previous rains amount to 50% or less of the potential evapotranspiration.

In order to eliminate possible differences in infestations due to intrinsic variables such as sex, breed, age, physiological condition, weight, behavior, and social status, as well as extrinsic variables such as season and habitat, only mature, nonbrooding adult females were used. They were all of native breed weighing between 1.25 and 1.75 kg and were managed under the deep litter management system. Sampling was at random at each of the locations and confined to the hot season of February to April of each year, with preliminary observations having shown no consistent differences in levels of infestations between years during this season.

In each locality, birds were examined only from flocks for which contact with birds from elsewhere had not occurred for at least a year. This procedure was followed to ensure that only the species that could successfully maintain their life cycle, and hence perpetuate their races in such a locality, were included. None of the birds had a history of recent treatment with a pesticide.

All birds were examined alive. Prior to examination, birds were segregated. About 2 g of 85% sevin powder (1-naphthyl-*N*-methyl carbamate) were manually applied over the entire body of each chicken to kill ectoparasites. Approximately 5 min later, the chicken was held over a thick large sheet of paper (60 × 60 cm), and its feathers and skin were rubbed and ruffled vigorously for about 5 min. Lice that fell off the chicken were collected, stored in 70% ethanol, cleared in potassium hydrox-

TABLE I.. Localities where lice were collected together with their geographical locations and duration of humid season* in Nigeria.

Locality	Geographical location		Duration of humid season (mo)
	Latitude N	Longitude E	
Geidam	12°56′	11°56′	
Nguru	12°53′	10°28′	1
Mongono	12°45′	13°20′	
Dankalwa	12°06′	12°57′	2
Maiduguri	11°51′	13°05′	
Sokoto	13°02′	05°16′	
Talata Marafa	12°04′	06°15′	
Kano	12°03′	08°32′	3
Azare	11°40′	10°10′	
Garkida	10°27′	12°38′	
Funtua	11°24′	07°19′	
Zaria	11°08′	07°41′	4
Zungur	10°30′	10°10′	
Bauchi	10°18′	09°50′	
Kaduna	10°21′	07°25′	
Jos	09°52′	08°54′	
Vom	09°44′	08°46′	5
Kafanchan	09°36′	08°18′	
Shendam	08°54′	09°28′	
Preshiep	08°58′	09°32′	
Keffi	08°50′	07°52′	6
Makurdi	07°44′	08°32′	
Ilorin	08°31′	04°32′	
Omu-Aran	08°05′	05°04′	7
Rore	08°04′	05°03′	
Erinle	08°08′	04°32′	
Ibadan	07°26′	03°54′	8
Auchi	07°04′	06°14′	
Ilawe Ekiti	07°28′	05°42′	
Uromi	06°43′	06°20′	9
Obudu	06°39′	09°09′	
Ogoja	06°39′	08°42′	
Epe	06°35′	03°59′	
Orlu	05°47′	07°02′	10
Itu	05°12′	07°59′	
Ikot Ekpene	05°11′	07°43′	11
Port Harcourt	04°51′	07°01′	
Badagry	06°25′	02°54′	12
Degema	04°44′	06°46′	

* A humid season implies that rainfall alone exceeds potential evapotranspiration for each of the constituent months in the season (Papadakis, 1961).

ide, and mounted in Lipshaw's mounting medium on slides for identification with a phase-contrast compound microscope.

Identification of lice was based on the keys by Ansari (1955), Emerson (1956), and Matsudaira and Kaneko (1969). *Amyrsidea powelli* (Bedford, 1920) and *Cuclotogaster occidentalis* Tendeiro, 1954, were not treated by the above authors and their identification was determined from the original description.

An analysis of variance was used to test for significant associations between humid season duration and abundance of individual species of lice (Zar, 1984). The Walter–Duncan *K*-ratio *t*-test was used for separation of means. Differences were considered significant at a probability level of $P < 0.05$.

The pattern of geographical distribution of each species of louse in relation to the duration of the humid season is depicted in Table II.

The distribution of 3 species, *Menacanthus pallidulus* (Neumann, 1912), *Goniodes dissimilis* (Denny, 1842), and *Menopon gallinae* (Linnaeus, 1758), was restricted to areas with an extended humid season (6–12 humid mo per yr). However, whereas *M. gallinae* was distributed throughout this range, *G. dissimilis* was confined to areas with at least 8 humid mo and *M. pallidulus* occurred only within areas of at least 9 humid mo.

In contrast, 4 species, *Menacanthus cornutus* (Schommer, 1913), *A. powelli, G. gigas* and *C. occidentalis,* thrived only in areas with a short humid season (≤5 humid mo). The first 3 of these species extended into the fringes of areas with a long humid season (6–8 humid mo) but at significantly lower numbers (Table II). They were completely absent in areas with a particularly prolonged humid season (9–12 humid mo).

Three other species recorded, *Goniocotes gallinae* (DeGeer, 1778), *Numidilipeurus tropicalis* (Peters, 1931), and *Lipeurus caponis* (Linnaeus, 1758), did not display preference for any particular climatic area (Table II), each being just as abundant in areas of a long humid season as in areas with a short humid season.

The results of this study demonstrate that, as in Pakistan (Buriro and Akbar, 1978), the distribution of *G. gigas* is related to climate in Nigeria. The results further reveal for the first time that the distributions of *M. pallidulus, G. dissimilis, M. gallinae, M. cornutus, A. powelli,* and *C. occidentalis* are also climate-related. Throughout the study, *M. pallidulus, G. dissimilis,* and *M. gallinae* were found only in areas with an extended humid season and *C. occidentalis, M. cornutus, A. powelli,* and *G. gigas* thrived only in areas with a short humid season. The latter group of species seldom achieved no more than low levels of intensity in the fringes of the areas with a long humid season when present at all and were completely absent in areas where the humid season was particularly prolonged.

The findings with respect to *M. pallidulus, G. dissimilis, M. gallinae, G. gigas,* and *M. cornutus* in this study are consistent with those of others, particularly Manuel (1981), who recorded only *M. pallidulus, G. dissimilis,* and *M. gallinae* from this list in the Philippines, an ever-humid country, and Derwesh (1965) who recoverd only *G. gigas* and *M. cornutus* from Iraq with no more than a short humid season anywhere.

As for *M. cornutus* and *G. gigas,* the occurrence of *A. powelli* and *C. occidentalis* is generally associated with areas of a short humid season elsewhere. Thus, in a limited study (J. P. Fabiyi, unpubl. obs.) in the neighboring republics of Chad, Niger, Cameroons, and Benin, these last 2 named species of lice were found thriving only in areas with a short humid season. Unlike *M. cornutus* and *G. gigas,* which have a cosmopolitan distribution in areas with a short humid season, however, *A. powelli* and *C. occidentalis* probably do not occur outside Africa (Fabiyi, 1972).

It seems, therefore, that in Nigeria and other parts of the world, it may be possible to predict whether or not *M. pallidulus, G. dissimilis, M. gallinae, G. gigas,* and *M. cornutus* are likely to be found in a particular area on the basis of the length of the humid season. Similarly, the occurrence of *C. occidentalis* and *A. powelli* can be predicted on the same basis if due note is taken of their restriction within their ecologic zone. Until

TABLE II.. Distribution patterns of various species of chicken lice (Mallophaga) in relation to duration of humid season* in Nigeria.

Duration of humid season (mo)	No. of chickens	*M. pallidulus*	*G. dissimilis*	*M. gallinae*	*G. gigas*	*M. cornutus*	*A. powelli*	*C. occidentalis*	*N. tropicalis*	*G. gallinae*	*L. caponis*
1	37	0[b]	0[b]	0[b]	75[a]	3,010[a]	2,701[a]	24[a]	88[a]	450[a]	25[a]
2	32	0[b]	0[b]	0[b]	61[a]	4,170[a]	2,200[a]	18[a]	94[a]	570[a]	19[a]
3	32	0[b]	0[b]	0[b]	68[a]	3,680[a]	2,140[a]	18[a]	106[a]	602[a]	23[a]
4	36	0[b]	0[b]	0[b]	70[a]	3,620[a]	2,700[a]	10[a]	113[a]	577[a]	18[a]
5	48	0[b]	0[b]	0[b]	35[b]	5,160[a]	2,100[a]	15[a]	115[a]	483[a]	17[a]
6	38	0[b]	0[b]	5,702[a]	31[b]	120[b]	110[b]	0[b]	120[a]	562[a]	21[a]
7	42	0[b]	0[b]	5,120[a]	26[b]	89[b]	87[b]	0[b]	89[a]	465[a]	18[a]
8	37	0[b]	60[a]	6,150[a]	22[b]	82[b]	81[b]	0[b]	105[a]	690[a]	22[a]
9	42	902[a]	53[a]	6,010[a]	0[c]	0[c]	0[c]	0[b]	110[a]	470[a]	20[a]
10	40	880[a]	61[a]	7,100[a]	0[c]	0[c]	0[c]	0[b]	96[a]	450[a]	16[a]
11	36	950[a]	71[a]	5,600[a]	0[c]	0[c]	0[c]	0[b]	102[a]	506[a]	20[a]
12	30	1,200[a]	63[a]	6,120[a]	0[c]	0[c]	0[c]	0[b]	85[a]	610[a]	16[a]

* A humid season implies that rainfall alone exceeds potential evapotranspiration for each of the constituent months in the season (Papadakis, 1961).
† Mean numbers per host within each louse species with a common superscript are not significantly different ($P < 0.05$).

now, the occurrence of only 3 species, *G. gallinae, L. caponis,* and *N. tropicalis* could be predicted with certainty. The first 2 species could be predicted on the grounds that they are universally present throughout the world and the last 1 on the grounds that it is generally distributed throughout the tropics and subtropics (Emerson, 1956), which fit the observation for the 3 species in this study. The ability to predict the likely occurring species of lice provided by this study is valuable for both academic and practical purposes. The various species apparently differ with respect to pathogenesis (Bishopp, 1942; Derylo, 1974a, 1974b, 1974c; Fabiyi, 1980) and perhaps in vector potential.

I thank the various poultry keepers who allowed me access to their birds and assisted in the collection of lice at various locations across the country.

LITERATURE CITED

ANSARI, M. A. R. 1955. Synoptic table for the determination of Mallophaga infesting the domestic fowl (*Gallus gallus domesticus*). Indian Journal of Entomology **17:** 245–270.

BISHOPP, F. C. 1942. Poultry lice and their control. United States Department of Agriculture, Yearbook, Washington, D.C., p. 1048–1054.

BURIRO, S. N., AND S. S. AKBAR. 1978. Incidence and occurrence of ectoparasites of poultry in Pakistan. Zeitschrift für Angeiwandte Entomologie **86:** 1–18.

CASWELL, G. H. 1959. Insects and other arthropods affecting livestock on the Faculty Farm—A preliminary report. University College, Ibadan, Faculty of Agriculture, Division Report no. 5, p. 21–22.

DERWESH, A. I. 1965. A preliminary list of identified insects and some arachnids (including mites) in Iraq. Bulletin of The Ministry of Agriculture, Iraq, no. 121, 123 p.

DERYLO, A. 1974a. Badania nad szkodliwoscia gospodarcza waszolow (Mallophaga). I. Wplyw wszolow na zadrowatnosc kur i indyknow. Medycna Weterynaryjna **30:** 353–357.

———. 1974b. Badania nad szkodliwoscia gospodaroza wasolow (Mallophaga). II. Wplyw wszolow na niesnoso i wylogi kur. Medycna Weterynaryjna **30:** 406–410.

———. 1974c. Badania nad szkodliwoscia gaspodaroza waszolow (Mallophaga). III. Wplyw wszolow na obnzenie ciezaru kur i indrykow. Medycna Weterynaryjna **30:** 544–547.

EMERSON, K. C. 1956. Mallophaga (chewing lice) occurring on the domestic chicken. Journal of The Kansas Entomological Society **29:** 63–79.

FABIYI, J. P. 1972. The occurrence of *Cuclotogaster occidentalis* and *Amyrsidea* sp. *powelli* group (Mallophaga: Insecta) on the domestic fowl in the Vom area of Benue-Plateau State, Nigeria. Veterinary Record **91:** 198.

———. 1980. Survey of lice infesting domestic fowl on Jos Plateau, Northern Nigeria. Bulletin of Animal Health and Production in Africa **28:** 215–219.

———. 1986. Exclusion in Nigeria of chickens and guinea-fowls from the host range of *Menacanthus stramineus* (Mallophaga: Insecta). Revue D' elevage et de Medicine Veterinaire des pays Tropicaux **39:** 377–379.

MANUEL, M. F. 1981. The ectoparasites (lice and mites) occurring on domestic chickens in the Philippines. Philippine Journal of Veterinary Medicine **30:** 87–100.

MATSUDAIRA, Y., AND K. KANEKO. 1969. Notes on biting lice (Mallophaga) collected from domestic fowl in Japan. Sanitary Zoology **20:** 219–229.

PAPADAKIS, J. 1961. Crop ecology in West Africa, FAO: UN Publication MR/16439/1, Vol. 2, Rome, 46 p.

REID, W. M., AND R. L. LINKFIELD. 1957. New distribution record and economic importance of *Menacanthus cornutus* (Schommer) on Georgia broilers. Journal of Economic Entomology **50:** 375–376.

ZAR, J. H. 1984. Biostatical analysis, 2nd ed. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 718 p.