Vector Species of *Dracunculus medinensis* in West Akim District of southern Ghana

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Abstract

Field studies were performed to identify the vector species of *Dracunculus medinensis*. From these studies, *Mesocyclops kieferi* was implicated as a major vector. The identified possible intermediate hosts species of *Dracunculus medinensis* in the study area in order of importance were *Mesocyclops kieferi* > *Mesocyclops aspericornis* > *Thermocyclops inopinus* > *Thermocyclops spinosus*. An evaluation of the infection potentials of the *Cyclops* species implicated as potential vectors of *Dracunculus medinensis* is recommended. There is the need to carry out a nation-wide investigation to establish the "true" vectors of the worm in the country.

Introduction

Dracunculiasis is caused by the Guinea worm, *Dracunculus medinensis* L., and is endemic in parts of Africa and Asia. The vectors are commonly referred to as *Cyclops*, but *D. medinensis* exhibits a high level of host specificity and only a few species act as vectors in nature. Recent progress in copepod systematics has refined the level of taxonomic resolution of these freshwater copepods and it is now known that the universal vector species, *Mesocyclops leukarti,* does not occur either in Africa or India (Boxshall & Braide, 1991). There is, therefore, the need to record these taxonomic changes, review earlier records and to update the nomenclature of the hosts where possible (Boxshall & Braide, 1991). The study sought to identify and document the vector species of *Dracunculus medinensis* in some communities declared as endemic for Guinea worm disease.

The study villages for vectors of Dracunculiasis and factors that aid in the disease transmission are typical rural communities in southern Ghana, without potable water supply. The residents, therefore, depend solely on pond water both for drinking and for other domestic uses. These ponds are, however, unreliable sources of water supply, with some drying up during the dry season. The ponds are shallow, and the villagers wade into them when fetching water especially in the dry season. Whilst some of these ponds are periodic streams, the local people dig others. The maximum capacities of these dugout ponds are usually in the neighbourhood of 200–300 m^3.

Materials and methods

Study area and features of sampling sites

The study was carried out in three villages (Tiokrom, Dzakpatra and Mepom) in the East Akim District of the Eastern Region of Ghana. Whilst Tiokrom and Dzakpatra are small settlements, Mepom is a sub-urban settlement. Both Tiokrom and Mepom are accessible by main roads while Dzakpatra is quite remote. All the three villages were observed to use water sources that vary seasonally. During the rains, water is collected and stored in pots and basins. In the long dry season (November to

May), drinking water is obtained from ponds. Unlike Dzakpatra and Tiokrom, which have been declared as Guinea worm endemic villages by the Guinea Worm Eradication Programme, Mepom is not. The residents of Mepom though a sub-urban settlement, depend on four different ponds for water, with all hitherto stand-pipes (with water pumped from Accra) broken down.

Identification of Cyclops *species*

Sources of water (mostly ponds) in the endemic communities were sampled for copepods. Having recorded the copepod count per litre of water, the specimens were preserved in 70% ethyl alcohol. The identification of the *Cyclops* was done using a phase-contrast microscope (Model: Optiphot-2; Nikon, Japan). Here, only mature and gravid females were examined and identified accordingly. This was to make sure that specimens used in the identification process displayed the relevant morphological features on their bodies. The key used in the identification exercise was that prepared by Olsen (1993).

The key is quite adequate because a review of West African records reveals that *D. medinensis* is transmitted in tropical Africa by seven species of *Cyclops*. There are four *Thermocyclops spp., two Mesocyclops spp.* and a *Metacyclops spp.* (Johnson, 1990). The use of this key was supplemented by another key prepared by Boxshall and Braide (1991). The two keys use distinct morphological features on such body parts as the fifth pair of legs, the caudal rami, the antennae, the seminal receptacle, the maxillary palpi, the total body length and the relative lengths of the body segments.

The identification process involved observing the specimens in water-free glycerine on a clean slide under a microscope. The *Cyclops* were then teased with a dissecting pin until the structure under investigation was appropriately orientated for observation.

Results

Tiokrom pond

The identified *Cyclops* species from the Tiokrom pond included *Thermocyclops inopinus, T. incisus* and *Mesocyclops kieferi*. Whilst *T. inpinus* was the common species observed in June 1995, *M. kieferi* was the most common species from July 1995 to February 1996 (Table 1).

Dzakpatra pond

As shown in Table 2, *M. kieferi* was the dominant *Cyclops* in this pond throughout the period of the study except in June 1995 when *T. inopinus* became the dominant species. There was also variability in the species richness in the pond, with some months recording as high as five different species whilst others recorded only one.

Mepom ponds

Kwesi Acheampong pond. The *Cyclops* species identified from this pond are presented in Table 4. As shown in the Table, species diversity was higher in June and July (with four different species from the genus *Mesocyclops,* and one each from the genera *Thermocyclops* and *Diacyclops*). This species richness declined until in November when only *Mesocyclops kieferi* was observed. Also, *M. kieferi* was the most common species throughout the year (except in June and July when *M. aspericornis* was equally common).

Mataligu pond. The results from this

TABLE 1

Cyclops *species collected from Tiokrom pond*

Month	Cyclops *count* (l^{1})	*Species identified*	*Dominant species*
June 1995	16	*M. kieferi* *T. inopinus* *T. incisus*	*T. inopinus*
July 1995	12	*M. kieferi* *T. incisus*	*M. kieferi*
Aug. 1995	8	*M. kieferi* *T. inopinus*	*M. kieferi*
Sep. 1995	18	*M. kieferi* *T. inopinus*	*M. kieferi*
Oct. 1995	13	*M. kieferi*	*M. kieferi*
Nov. 1995	9	*M. kieferi*	*M. kieferi*
Dec. 1995	5	*M. kieferi*	*M. hieferi*
Jan. 1996	2	*M. kieferi*	*M. kieferi*
Feb. 1996	4	*M. kieferi*	*M. kieferi*
Mar. 1996	0	-	-
Apr. 1996	0	-	-
May 1996	0	-	-

TABLE 2

Cyclops *species collected from Dzakpatra pond*

Month	Cyclops *count* (l^{1})	*Species identified*	*Dominant species*
Jun. 1995	12	*M. kieferi* *T. inopinus* *Allocyclops* spp.	*T. inopinus*
Jul. 1995	9	*M. kieferi* *T. inopinus*	*M. kieferi*
Aug. 1995	8	*M. kieferi* *T. inopinus* *Allocyclops* spp. *Ectocyclops* spp.	*M. kieferi*
Sep. 1995	13	*M. kieferi* *T. inopinus*	*M. kieferi*
Oct. 1995	10	*M. kieferi* *Afrocyclops* spp.	*M. kieferi*
Nov. 1995	6	*M. kieferi*	*M. kieferi*
Dec. 1995	6	*M. kieferi*	*M. kieferi*
Jan. 1996	4	*M. kieferi*	*M. kieferi*
Feb. 1996	1	*M. kieferi*	*M. kieferi*
Mar. 1996	0	-	-
Apr. 1996	0	-	-
May 1996	0	-	-

pond did not vary very much from that of the Kwesi Acheampong pond, except that the only observed predominant *Cyclops* species here was *M. kieferi*, whereas the former had *M. aspericornis* as well in June and July (Table 3).

With respect to the *Cyclops* species in the study area, seven different species were identified, four belonging to the genus *Mesocylops* and three to the genus *Thermocyclops*. These were *M. kieferi, M. aspericornis, M. tenuisaccus, M. spinosus, T. inopinus, T. oblongatus* and *T. incisus*. Other genera identified were *Allocyclops, Afrocyclops, Diacyclops* and *Ectocyclops.*

Discussions

The number of *Cyclops* species and their population density varied considerably in the various ponds throughout the study. It was found that there were significant differences both geographically and temporally. The calculated F-ratio for variation of *Cyclops* density between villages was 5.611 with an F-critical value of 2.892. Also, the F calculated for variability with respect to month was 16.282 with an F-critical of 2.093. The observed trend could be attributed to a number of factors. Firstly, the amount and variety of food in the ponds could lead to the explosion or decline in numbers of the individual species and, therefore, the overall *Cyclops* densities. Secondly as was the case from June to August, the fall in numbers might be due to an appreciable increase in the volumes/capacities of the ponds due to the heavy rains during this period. Also implicated were the nature and location of the ponds. With the exception of the pond

TABLE 3

Cyclops species collected from Mepom (Mataligu) pond

Month	Cyclops *count* (l^{1})	*Species identified*	*Dominant species*
Jun. 1995	20	*M. aspericornis* *M. kieferi* *M. tenuisaccus* *M. spinosus* *T. oblongatus* *Diacyclops* spp. *Allocyclops* spp.	*M. kieferi*
Jul. 1995	21	*M. aspericornis* *M. kieferi* *M. spinosus* *M. tenuisaccus* *T. oblongatus* *Diacyclops* spp.	*M. kieferi* *M. aspericornis*
Aug. 1995	10	*M. spinosus* *M. kieferi* *M. aspericornis*	*M. kieferi* *M. aspericornis*
Sep. 1995	13	*M. kieferi* *T. oblongatus* *M. tenuisaccus*	*M. kieferi*
Oct. 1995	12	*M. aspericornis* *M. kieferi*	*M. kieferi*
Nov. 1995	6	*M. kieferi*	*M. kieferi*
Dec. 1995	8	*M. kieferi*	*M. kieferi*
Jan. 1996	2	*M. kieferi*	*M. kieferi*
Feb. 1996	3	*M. kieferi*	*M. kieferi*
Mar. 1996	0	-	-
Apr. 1996	7	*M. aspericornis* *M. kieferi* *Diacyclops* spp.	*M. kieferi*
May 1996	7	*M. kieferi* *Diacyclops* spp.	*M. kieferi*

TABLE 4

Cyclops species collected from Mepom (Mataligu) pond

Month	Cyclops *count* (l^{1})	*Species identified*	*Dominant species*
Jun. 1995	22	*M. aspericornis* *M. kieferi* *M. tenuisaccus* *T. oblongatus* *M. spinosus* *Diacyclops* spp.	*M. aspericornis* *M. kieferi*
Jul. 1995	19	*M. aspericornis* *M. kieferi* *M. spinosus* *M. tenuisaccus* *T. oblongatus* *Diacyclops* spp.	*M. kieferi* *M. aspericornis*
Aug. 1995	10	*M. spinosus* *M. kieferi* *M. aspericornis*	*M. kieferi* *M. aspericornis*
Sep. 1995	13	*M. kieferi* *T. oblongatus* *M. tenuisaccus*	*M. kieferi*
Oct. 1995	12	*M. aspericornis* *M. kieferi*	*M. kieferi*
Nov. 1995	6	*M. kieferi*	*M. kieferi*
Dec. 1995	8	*M. kieferi*	*M. kieferi*
Jan. 1996	2	*M. kieferi*	*M. kieferi*
Feb. 1996	3	*M. kieferi*	*M. kieferi*
Mar. 1996	1	*M. kieferi*	*M. kieferi*
Apr. 1996	11	*M. aspericornis* *M. kieferi* *Diacyclops* spp.	*M. kieferi* *M. kieferi*
May 1996	8	*M. kieferi* *Diacyclops* spp.	*M. kieferi*

at Tiokrom, all the others could be considered as periodic streams.

During the rainy season there was an inflow of water from upstream and a consequent outflow downstream. Therefore, these water bodies more or less maintained a constant volume of water during the rains, but were reduced to stagnant ponds when the rains ceased by October. A steady decline in the pond volumes occurred from October to February when there was no influx of water from the catchment areas. These changes in the physical properties of the ponds influenced not only the density of Cyclops, but also the overall fauna and flora composition with month/season. The observed increases in numbers from February to June may be brought about by the availability of both organic and inorganic food materials such as cow dung (note that this was used as feed in the laboratory culture), and other animal droppings being washed into the water bodies. This loading of the ponds with animal droppings is further buttressed by the fact that domestic animals used these ponds as their main sources of drinking water in the dry season.

As observed by Desfontaine & Prod'Hon (1982), there was often an increase in the prevalence of Guinea worm cases at the onset of the rains when villagers tended to collect unwholesome water from rock-pools and other small water bodies because the dried up river beds were not yet filled with water. This situation provides an ideal condition for effective transmission of Dracunculiasis since man-water contact frequency increased remarkably.

Desfontaine and his colleague attributed the increase in Guinea worm prevalence during this period of the year to contamination of the ponds by people with active cases, since there was often a scramble for water at the collection sites. Their observation is further supported by the findings of the present investigation. Thus, the inflow of suitable and adequate food materials at the onset of the rains leading to proliferation of *Cyclops* numbers and species was a suitable time for transmission. At this time, not only would there be adequate *Cyclops* for the transmission of Guinea worm, but also the preferred vector species as well as a suitable human behaviour pattern. These factors coincided to give the larvae the chance of infecting the vector species, as both the frequency of water contact by the patients and the vector numbers was increased. Thus, it was not only the contamination of the water bodies by people with active cases that accounted for the periodic increases in cases, but also the proliferation of *Cyclops* numbers and species due to adequate food materials washed into the ponds by the first rains.

Conversely, by the time the rains reached a peak in August and the ponds were full to capacity, there was little or no organic inflow from the surrounding areas. Such conditions would lead to a reduction in the available *Cyclops* food, and only ponds with floating and/or submerged vegetation such as *Lemna, Pistia* and *Ceratophyllum* would tend to support high *Cyclops* densities. Thus, whilst the decrease in densities in August could be due to increase in the volume of water in the ponds, the decrease in *Cyclops* count from October to February could be attributed mainly to the fact that the ponds were depleted of food.

Physical interference with the pond substratum such as excavations might upset the *Cyclops* population dynamics, and probably other organisms as well. This situation actually occurred in Tiokrom and Dzakpatra where the ponds were excavated in March and April respectively to enable seepage of ground water into the pond basin. The Dzakpatra pond, however, recorded its highest capacity in May because the villagers had dammed the downstream outlet of the pond after the excavation exercise, causing the pond to fill up when the early rains came in April/May.

It was also observed that this pond contained no *Cyclops* during this period. This could be attributed to the fact that any *Cyclops* eggs left in the pond basin after the excavation would not have hatched and developed to the adult stage yet. Another possible explanation would be that the removal of the soft mud from the substratum caused a change in the physico-chemical condition of the pond. Also the amount of organic matter in the water body necessary for *Cyclops* growth and reproduction would have decreased by the removal of the bottom layer of the pond which was rich in decayed and/or decaying organic matter.

Considering the numbers and consistency in occurrence of the various potential vectors, *M. kieferi, M. aspericornis, T. oblongatus, T. inopinus* and *T. incisus, M. kieferi* were highly implicated as the major vectors that transmitted the disease in the study areas. These species did not only appear as the commonest *Cyclops* species in the area, but also was present in the ponds throughout the period of study (June 1995-May 1996), with the exception of Dzakpatra pond that dried up and Tiokrom pond that was physically tampered with thereby interfering with the hydrological regime of the pond. *Mesocyclops aspericornis* could be the next major vector after *M. keiferi* in order of frequency of occurrence, followed by *T. inopinus*. *Mesocyclops aspericornis* was, however, found to be common in only one of the ponds studied (Kwesi Acheampong-Mepom). Apart from not being prevalent in all the ponds, the appearance of this species was also found to be limited to the rainy season only. The other potential vectors were *T. incisus* and *T. oblongatus*, which were not as prevalent as the two *Mesocyclops* species: *M. kieferi* and *M. aspericornis*, thus casting doubt on their vectorial and/or transmission capabilities. They were also observed to be confined to a period of considerable rainfall, when transmission was often rather low or absent altogether.

Conclusion

The possible intermediate host species of Dracunculiasis in the study area in order of importance included: *Mesocyclops kieferi>Mesocyclops aspericornis >Thermocyclops inopinus>Thermorcyclops spinosus.* There is the need for the transmission potentials of the *Cyclops* species implicated as vectors of Dracunculiasis to be investigated.

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