Periphyton Associated with *Nymphaea lotus* Linn. in Two Different Types of Freshwater Bodies in Southern Ghana

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Abstract

The periphyton communities associated with *Nymphaea lotus* Linn. in two different freshwater bodies, the Kpong head-pond and Odaw stream, both in southern Ghana, were studied. Twenty-eight genera of algae, belonging to five phyla (Chlorophyta, Cryptophyta, Crysophyta, Cyanophyta and Euglenophyta) were observed. The Cyanophyta and the Chlorophyta, respectively, dominated the population in the Kpong head-pond and the Odaw stream. A far greater population of diatoms family (Bacillariophyceae) was found in the Odaw stream than in the Kpong head pond.

Introduction

Aquatic microalgae can only be seen with the aid of hand lens or a microscope. Eminson & Moss (1980) reported that they may be free living or attached to a substrate. Those growing on rocky substrates are called epilithic, those on sediments epipelic, those on sandy substrates grains are called epipsammic, and those growing on living organisms that are not parasitic are epiphytic. Although most epiphytic algae are essentially facultative and are not associated with specific host species (Wahl & Mark, 1999) some are known to grow on specific hosts (Harlin, 1980; Pearson & Evans, 1990). Some of the algae that grow in close association with macrophytes, but are not directly attached to them, constitute the metaphyton. Epiphyton and metaphyton together are called periphyton.

The periphyton community is important in the productivity of the aquatic system where its contribution to dissolved oxygen and available energy through primary production is highly significant. Some periphyton algae also possess special organs for the fixation of nitrogen. The contribution of periphyton to the nutrient content of water cannot be ignored (Aloi, 1990). In the food chain, periphyton species serve as food for herbivores and omnivores. Few studies on periphyton in Ghana have been conducted, including those of Agbeti (1980), Appler (1983) and Ameka (1987). The paper describes the periphyton of *Nymphaea lotus* Linn, which occurs widely in the Kpong head pond and Odaw stream in Ghana. The basis of this study is the expectation that certain groups of periphyton will prefer and inhabit particular macrophyte host irrespective of location. This report is an attempt to augment pernitent information on the occurrence of periphyton in Ghana.

Nymphaea, commonly known as water-lily, is anchored to the bottom of ponds by long roots. A short stem bears several long petioles that hold floating leaves at the surface of the water. The petioles are soft, flexible and smooth, while the leaves are large and circular, about 30 cm in diameter, with serrated margins. A thick waxy cuticle, covering the upper epidermis, prevents wetting. Characteristically, a mature plant has between 10-12 leaves. The petioles and leaves contain large air spaces, which facilitate gaseous exchange and aid in

buoyancy. *N. lotus* has large showy white flowers, that are held above the water by long petioles.

Materials and methods

Sampling sites

Kpong head pond. The Kpong head pond is the name given to the reservoir created between the Kpong and the Akosombo dams, primarily for the generation of hydroelectricity (Fig. 1). It was completed in 1981, with a surface area of about 37.4 km^2, a maximum depth of 15 m and a mean depth of 5 m (Ansa-Asare & Asante, 1998). The mean annual flow of water through the reservoir is 1183 m^3s^{-1}, and water retention time is 5 days (Ansa-Asare & Asante, 1998). The Kpong head pond has about 85% of this total surface area infested with aquatic weeds, with *Echinochloa* sp., *Vossia* sp., *Leptochloa* sp., *Typha domingensis* (emergents) and *Nymphaea lotus,* as the most dominant plants. Submerged plants, including *Ceratophylum demersum,* are also widely distributed. There is a high level of human activity at this site, mostly through fishing.

Odaw stream. The Odaw river is a small river and takes its source from the Akwapim mountains in eastern Ghana. It forms one of a complex network of rivers and streams, converging and ultimately emptying into the Gulf of Guinea, through the Korle lagoon in Accra (Fig. 2). The sampling sites at the Odaw stream have a mean maximum depth of 1 m with low levels of aquatic weed infestation. *Nymphaea lotus* is the dominant plant, with a few members of species like *Pistia stratiotes*, *Lemna* sp. and *Azolla* sp. present.

Sample collection

Following the methodology outlined by Benson-Evans *et al.* (1975), *N. lotus* samples were collected by cutting the petioles just above the substratum. Five samples were picked randomly five times, and the replicates were placed individually into polythene bags and transported to the laboratory within the shortest possible time.

Identification and quantification of samples

In the laboratory, the epiphyton species were removed from the petiole and the abaxial surface of the leaf by gently scrubbing with a toothbrush. **(**Morin & Cattaneo, 1992). The algae were collected into large petri dishes and diluted in 100 ml of water. The number and types in 1 ml of water were counted and recorded. This was done by placing a drop of the sample on a glass slide, staining it with Lugol's iodine, and examining it under a light microscope. All algae were carefully examined and identified using various keys provided by Whitford & Schumacher (1973), Prescott (1975) and Sze (1993). The procedure was repeated 10 times. An average count was calculated to estimate the number of each organism in 1 ml. Specimens were further mounted in dilute glycerin to preserve them for later examination.

Results and discussion

Table 1 shows the mean frequency of periphyton genera recorded on *Nymphaea lotus* during the period of study. Algae from five phyla were observed at both study sites.

Chlorophyta outnumbered other phyla at the Odaw site, where the Crytophytes showed the lowest percentage frequency at that site. In Kpong, Cyanophytes showed the highest percentage frequency while

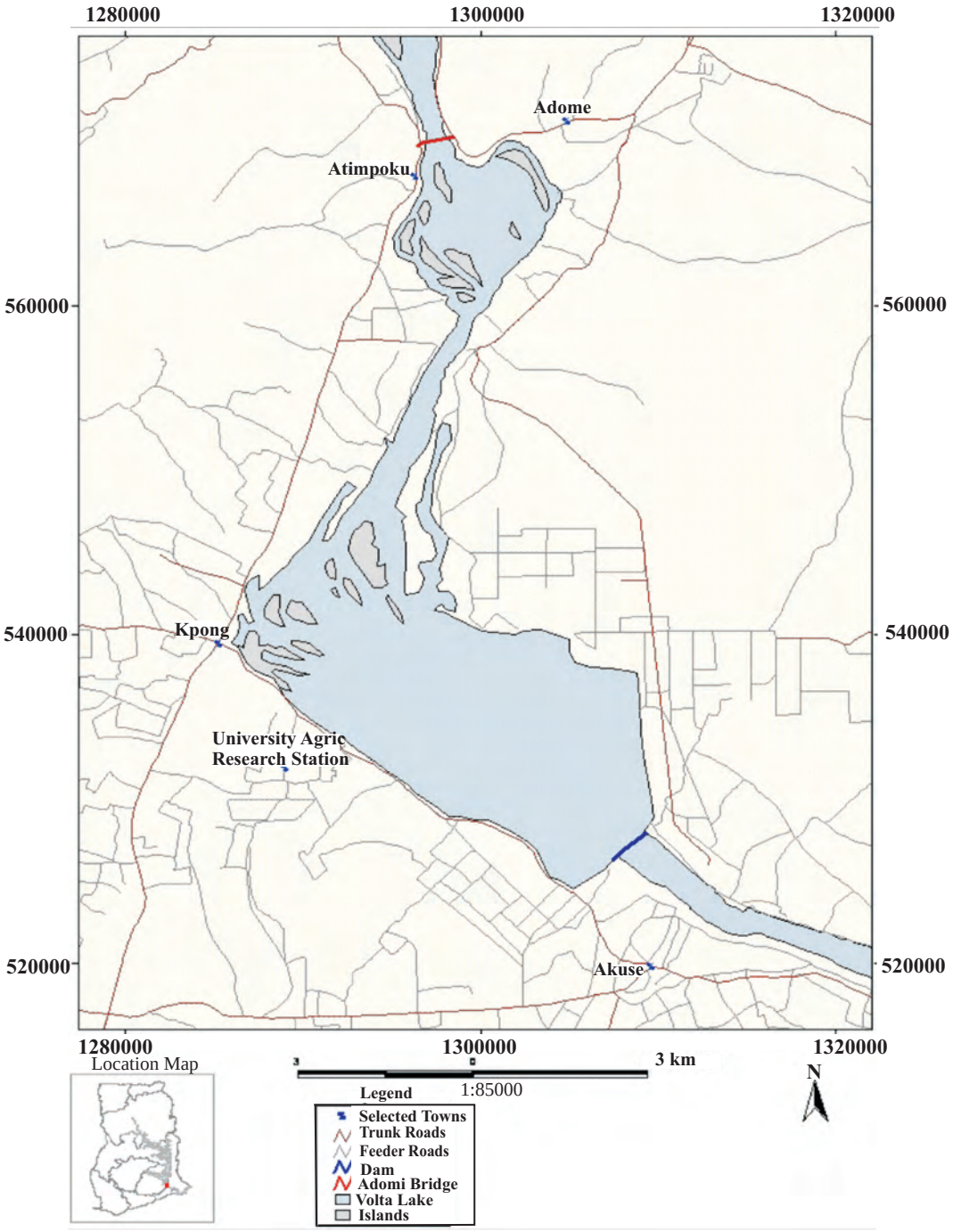

Fig. 1. The Kpong head pond

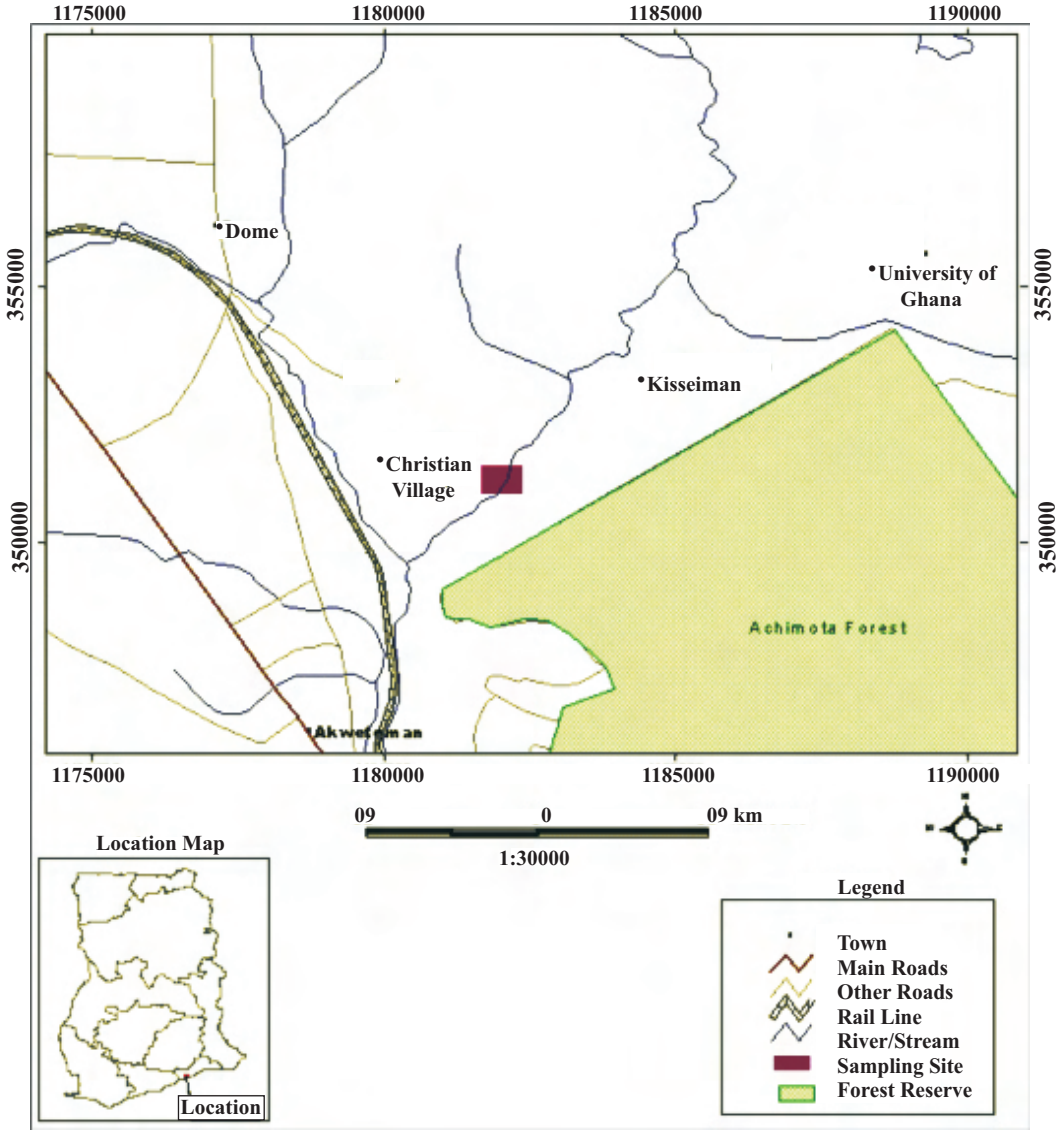

Fig. 2. Map indicating the sampling site on the Odaw river at Christian Village

Cryptophytes showed the lowest percentage frequency. Percentage frequency of Cryptophyta, Cyanophyta and Euglenophyta in Kpong were higher than those in Odaw but percentage frequency of Chlorophyta and Chrysophyta were lower in Kpong than in Odaw. Chlorophyta in Odaw were about three times higher than those in Kpong while Cyanophyta were far more abundant in Odaw than in Kpong.

TABLE 1
Mean frequency of Periphyton genera observed in the Kpong head-pond and the Odaw stream

Phylum	*Class*	*Order*	*Genus*	*Kpong head-pond #cells ml*$^{-1}$	*Odaw stream #cells ml*
Chlorophyta	Chlorophyceae	Chlorococcales	*Ankistrodesmus*	0	4
			Chlorella	10	18
			Chlorococcum	0	14
			Scenedesmus	7	97
			Tetrastrum	0	1
		Ochromondales	*Ochramonas*	0	2
		Siphonales	*Netrium*	3	9
			Penium	8	33
		Tetrasporales	*Sphaerocystes*	1	0
		Ulothrichales	*Microspora*	5	0
		Volvocales	*Chlamydomonas*	3	6
			Chlorogonium	0	2
			Volvox	0	5
		Zygnematales	*Pleurotaenium*	2	0
			Staurastrum	1	0
Cryptophyta	Cryptophyceae	Cryptomonadales	*Chilomonas*	15	1
			Chromonas	0	2
Chrysophyta	Chrysophyceae	Chromulinales	*Phaester*	9	8
		Ochromonadales	*Mallomonas*	8	11
Cyanophyta	Cyanophyceae	Chrococcales	*Coelosphaerium*	1	3
		Oscillatoriales	*Anabaena*	2	3
			Microcoleus	1	0
			Spirulina	60	0
Euglenophyta	Euglenophyceae	Euglenales	*Euglena*	29	14
			Eutreptia	0	1
			Peranema	1	0
			Trachelomonas	1	2

It was observed that the total frequency of periphyton in Odaw was 0.7 times higher than that of Kpong. Family Bacillariophyceae, among the Chrysophyta*, was* very abundant in Odaw (68 algae per ml) but very low in Kpong (11 algae per ml), The total number of algae per leaf area was obtained by multiplying the frequency in 1 ml by 100. Thus, each *N lotus* in Kpong and Odaw had 17,800 and 30,700 algae, respectively.

All genera of Chlorophyta in Kpong had low frequencies. In Odaw, *Scenedesmus* was very high, followed by *Pleurotaenium,* while all other genera were low in frequency. Also, the frequencies of most genera in Odaw were higher than those for the equivalent in Kpong. Two genera of Chrysophyta were found in Kpong while three were found in Odaw. Both *Mallomona* and *Phaester* showed relatively high frequencies in Kpong and Odaw, while *Ochramonas* was low in Odaw and

altogether absent in Kpong. Frequency of *Mallomonas* in Kpong was lower than in Odaw but *Phaester* was higher in Kpong than Odaw.

Among the Cryptophytes, *Chilomonas* showed a very high frequency in Kpong, whereas it was very low in Odaw. Frequency of *Chroomonas* in Odaw was low but none were observed in Kpong. Four genera of algae were observed in Kpong, whereas only two were found in Odaw. Frequencies of *Anabaena* and *Coelosphaerium* were very low in both Kpong and Odaw. Frequencies of these two genera in Kpong were higher than those found in Odaw. *Microcoleus* was low in Kpong but absent in Odaw. *Spirulina* showed a very high frequency in Kpong whereas it was absent in Odaw.

Three genera of Euglenophyta were observed in Kpong and Odaw though they differed in constitution. In Kpong, *Euglena* showed the highest frequency while *Peranema* and *Trachelomonas* showed the lowest. *Eutrepia* was absent. *Euglena* also showed the highest frequency in Odaw, albeit was lower than that from Kpong. *Trachelomonas* and *Eutrepia* were both low in frequency while *Paranema* was absent in Odaw. The frequency of *Trachelomonas* in Odaw was higher than that in Kpong.

Statistical alysisis

Using Levene's test for equality of variances, the populations of the genera in the study sites showed equivalence of significance at 95% confidence interval.

Results and discussion

The two sampling sites exhibited taxonomic diversity. In the Odaw stream, Chlorophyta phyla showed numerical dominance over all the other phyla of the periphyton, while the Cryptophytes showed the lowest percentage frequency. In Kpong, Cyanophytes showed the highest percentage frequency while Cryptophytes showed the lowest percentage frequency. Percentage frequencies of Cryptophyta, Cyanophyta and Euglenophyta in Kpong were higher than those in Odaw but percentage frequencies of Chlorophyta and Chrysophyta were lower in Kpong than in Odaw. Chlorophyta in Odaw were about three times higher than those in Kpong while Cyanophyta were far more abundant in Odaw than in Kpong.

It was observed that the total frequency of periphyton in Odaw was 0.7 times higher than the total frequency of periphyton in Kpong. The family Bacillariophyceae, among the Chrysophyta, was very abundant in Odaw (68 cells per ml) but very low in Kpong (11 cells per ml). Each *N. lotus* leaf in Kpong and Odaw had 17,800 and 30,700 algae, respectively. Consequently, based on the assumption that each plant had 10 leaves, each sample of *N. lotus* had 178,000 and 307,000 algae in Kpong and Odaw, respectively.

Even though Odaw and Kpong Head-pond had algae from the same five phyla, there were huge variations in the composition and abundance of their genera indicating that the periphyton populations associated with *Nymphaea lotus* at these two sites were different. This could be explained as a consequence of the water surface area and, therefore, activity and turbulence of the water bodies at the two sites. There is an intense human activity at the Kpong head pond due to various types of fishing activities, compared to the virtual inactivity at the Odaw sampling

site at Christian village. Further the influence of other members of the massive aquatic vegetation in the Kpong head pond compared to the rather marginal vegetation at the Odaw sampling site could also be implicated.

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